PROJECT MANUAL
VOLUME 3 OF 6

Special Provisions and Special Specifications

The City of Austin

Austin, Texas

MONTOPOLIS WATER RECLAMATION INITIATIVE (WRI) STORAGE RESERVOIR AND PUMP STATION PROJECT

CIP ID Number: 5267.035
IFB 6100 CLMC601
First advertisement date: July 18, 2016

Austin Water

It is the policy of the City of Austin to involve certified Minority Owned Business Enterprises (MBEs) and Women Owned Business Enterprises (WBEs) in City contracting. MBE and WBE goals for this solicitation are contained in Volume 4, MBE/WBE Procurement Program Package.

Prepared by:

Joseph W. Jenkins, P.E.
CH2M HILL
TBPE Firm No. 3699
12301 Research Boulevard, Building 4, Suite 250
Austin, Texas 78759
Phone: (512) 249-3331

SEALS PAGE

DIVISION 1—GENERAL REQUIREMENTS (SECTIONS 01025, 01400, 01650, 01670, 01700, 01730, 01740)
SPECIAL PROVISIONS TO CITY STANDARD TECHNICAL SPECIFICATIONS (SECTIONS SP510S, SP511S, SP772S)
DIVISION 2—SITE CONSTRUCTION (SECTION 02821)
DIVISION 3—CONCRETE (SECTION 03600)
DIVISION 5—METALS (SECTIONS 05500, 05521, 05530)
DIVISION 9—FINISHES (SECTION 09900)
DIVISION 11—EQUIPMENT
DIVISION 14—CONVEYING SYSTEMS
DIVISION 15—MECHANICAL (SECTIONS 15060, 15080, 15205, 15208, 15955)
DIVISION 16—ELECTRICAL (SECTION 16055)

STATE OF TEXAS
JOSEPH W. JENKINS
68717
REGISTERED
PROFESSIONAL ENGINEER

Joseph W. Jenkins
5-11-2016

DIVISION 1—GENERAL REQUIREMENTS (SECTION 01096)

STATE OF TEXAS
DALE P. MURPHY
90614
LICENSED
PROFESSIONAL ENGINEER

5/10/2016

SPECIAL PROVISIONS TO CITY STANDARD TECHNICAL SPECIFICATIONS (SECTIONS SP201S, SP401S)
DIVISION 2—SITE CONSTRUCTION (SECTIONS 02371, 02375)

STATE OF TEXAS
CURTIS R. BASNETT
106916
LICENSED
PROFESSIONAL ENGINEER
5-11-16

DIVISION 3—CONCRETE (SECTION 03315)

STATE OF TEXAS
BENJAMIN MATTHEW BETZOLD
121236
LICENSED
PROFESSIONAL ENGINEER
5-11-16

DIVISION 4—MASONRY
DIVISION 5—METALS (SECTIONS 05120, 05310)
DIVISION 13—SPECIAL CONSTRUCTION (SECTION 13122)

STATE OF TEXAS
RACHEL A. H. MALDOMADO
117500
LICENSED
PROFESSIONAL ENGINEER

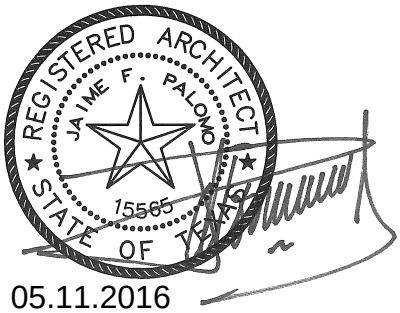
05/11/2016

DIVISION 15—MECHANICAL (SECTIONS 15052, 15053, 15061, 15062, 15077, 15082, 15083, 15140, 15145, 15150, 15155, 15410, 15738, 15838, 15950)

STATE OF TEXAS
LYNN C. BROWN
55248
LICENSED
PROFESSIONAL ENGINEER

05/11/2016

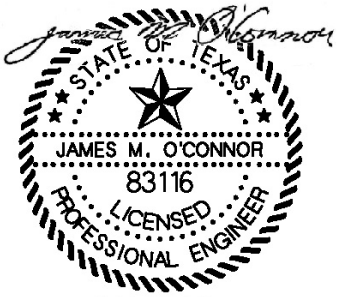
DIVISION 6—WOOD, PLASTICS, AND COMPOSITES
DIVISION 7—THERMAL AND MOISTURE PROTECTION
DIVISION 8—OPENINGS
DIVISION 9—FINISHES (SECTIONS 09200, 09910)
DIVISION 10—SPECIALTIES



05.11.2016

DIVISION 13—SPECIAL CONSTRUCTION (SECTIONS 13315, 13321, 13400, 13410, 13430)

SPECIAL PROVISIONS TO CITY STANDARD TECHNICAL SPECIFICATIONS (SECTIONS SP16110S, SP16200, SP16520, SP16480, SP16700)
DIVISION 16—ELECTRICAL (SECTION 16220)



5/11/2016

This page intentionally left blank

CITY OF AUSTIN
AUSTIN WATER

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

MONTOPOLIS WATER RECLAMATION INITIATIVE (WRI) STORAGE RESERVOIR AND PUMP STATION PROJECT

C.I.P. ID No. 5267.035
IFB 6100 CLMC601
First Advertisement Date: July 18, 2016

****

****

CH2M HILL
Austin, Texas
May 2016

This page intentionally left blank

Document Number		Title

VOLUME 1

INTRODUCTORY INFORMATION

		Seal Sheets
05/06/11		Title Page
07/06/16		Table of Contents

BIDDING REQUIREMENTS, CONTRACT FORMS, & CONDITIONS OF THE CONTRACT

Pre-Bid Information

00020	01/15/16	Invitation for Bids

Instructions to Bidders

00100	06/01/16	Instructions to Bidders

Information Available to Bidders

00220	05/06/11	Geotechnical Data

Bid Forms

00300L	06/01/16	Lump Sum Bid Form

Supplements to Bid Forms

00400	06/01/16	Statement of Bidder's Experience
00405	09/25/05	Certificate of Non-Suspension or Debarment
00410	01/15/16	Statement of Bidder's Safety Experience
00440	10/19/15	Affidavit - Prohibited Activities
00475	05/11/15	Nonresident Bidder Provisions

Agreement Form

00500	01/15/16	Agreement

Bonds and Certificates

00610	02/23/10	Performance Bond
00620	02/23/10	Payment Bond
00630	05/11/15	Nondiscrimination Certificate
00631	03/06/14	Title VI Assurances Appendix A
00650	06/01/16	Certificate of Insurance
00670	03/20/14	Texas Sales and Use Tax Exemption Certificate
00680	06/05/06	Non-Use of Asbestos Affidavit (Contractor Prior to Construction)
00681	06/05/06	Non-Use of Asbestos Affidavit (Contractor After Construction)

General Conditions

00700	05/03/16	General Conditions

Supplementary Conditions

00810	01/15/16	Supplemental General Conditions
TWDB-0552	05/11/16	Texas Water Development Board Supplemental Contract Conditions and Instructions For Construction Services for Projects Funded through State Programs
00819	06/10/05	Security Requirements
00830	05/03/16	Wage Rates and Payroll Reporting
00830BC	07/06/16	Wage Rates Building Construction Trades
00830HH	05/03/16	Wage Rates Highway Heavy

Document Number		Title
Addenda		
00900	01/15/16	Addendum {If any addendum is issued, it will be bound in the front of Contract sets following contract execution.}

SPECIFICATIONS

Division 1 - General Requirements

01010	04/22/13	Summary of Work
01025	*04/01/16*	Measurement and Payment
01040	*12/23/15*	Project Coordination
01050	10/19/15	Grades Lines & Levels
01070	12/01/09	Facility Security Procedure for Contractors
01095	07/21/03	Reference Standards and Definitions
01096	05/06/11	Stormwater Pollution Prevention Plan (SWPPP)
01200	08/09/12	Project Meetings
01300	04/22/13	Submittals
01352	04/22/13	Sustainable Construction Requirements
01353	08/09/12	Construction Equipment Emissions Reduction Plan
01380	08/09/12	Construction Photography & Videos
01400	12/23/15	Quality Control Services
01500	08/09/12	Temporary Facilities
01505	04/22/13	Construction and Demolition Waste Management
01510	02/23/10	Construction Indoor Air Quality Management Plan
01550	08/09/12	Public Safety and Convenience
01650	05/18/16	Facility Startup/Commissioning
01670	12/23/15	Manufacturers' Field Services and Training
01700	12/23/15	Contract Closeout
01730	12/23/15	Operation and Maintenance Data
01740	12/23/15	Common Product Requirements
01900	03/12/12	Prohibition of Asbestos Containing Materials
01900a	06/05/06	Statement of Non-Inclusion of Asbestos Containing Material (E/A Prior to Design)
01900b	06/05/06	Statement of Non-Inclusion of Asbestos Containing Material (E/A After Design)

VOLUME 2

City Standard Technical Specifications

Series 100 – Earthwork

101S	01/04/11	Preparing Right of Way
102S	08/20/07	Clearing and Grubbing
104S	09/26/12	Removing Portland Cement Concrete
110S	11/18/04	Street Excavation
111S	09/26/12	Excavation
132S	08/20/07	Embankment

Series 200 – Subgrade and Base Construction

201S	08/20/07	Subgrade Preparation
210S	02/24/10	Flexible Base
220S	02/24/10	Sprinkling for Dust Control

Document Number		Title
Series 300 – Street Surface Courses		
301S	08/20/07	Asphalt, Oils and Emulsions
302S	09/26/12	Aggregates for Surface Treatments
306S	02/24/10	Prime Coat
307S	02/24/10	Tack Coat
316S	09/26/12	Polymerized Asphalt Interlayer Seal
320S	09/26/12	Two Course Surface Treatment
340S	09/26/12	Hot Mix Asphaltic Concrete Pavement
341S	09/26/12	Paving Fabric
350S	02/24/10	Heating, Scarifying and Repaving
351S	02/21/01	Recycling Agent
360S	09/26/12	Concrete Pavement
Series 400 – Concrete Structures and Miscellaneous Concrete		
401S	09/26/12	Structural Excavation and Backfill
402S	11/13/07	Controlled Low Strength Material
403S	09/26/12	Concrete for Structures
405S	11/13/07	Concrete Admixtures
406S	09/26/12	Reinforcing Steel
408S	11/13/07	Concrete Joint Materials
410S	09/26/12	Concrete Structures
411S	11/13/07	Surface Finishes for Concrete
413S	11/13/07	Cleaning and/or Sealing Joints and Cracks (PCC)
414S	11/13/07	Concrete Retaining Walls
416S	11/13/07	Waterstops
420S	09/26/12	Drilled Shaft Foundations
430S	11/15/11	Portland Cement Concrete Curb and Gutter
432S	01/04/10	Portland Cement Concrete Sidewalks
435S	11/13/07	Portland Cement Concrete Steps
436S	11/13/07	Portland Cement Concrete Valley Gutters
439S	11/13/07	Parking Lot Bumper Curbs
480S	04/04/12	Concrete Paver Units for Sidewalks and Streetscape Requirements
485S	11/13/07	Concrete Paver Units for Sidewalk Ramps
Series 500 – Pipe and Appurtenances		
503S	02/17/00	Frames, Grates, Rings and Covers
506S	03/15/11	Manholes
507S	03/26/08	Bulkheads
508S	02/24/10	Miscellaneous Structures and Appurtenances
509S	09/26/12	Excavation Safety Systems
510	10/03/13	Pipe
511S	09/26/12	Water Valves
551	11/18/04	Pipe Underdrains
558	09/26/12	Structural Plate Structures
559S	10/03/13	Concrete Box Culverts
591S	12/31/13	Riprap for Slope Protection
593S	02/24/10	Portland Cement Concrete Retards
Series 600 – Environmental Enhancement		
601S	09/01/11	Salvaging and Placing Topsoil
602S	06/16/08	Sodding for Erosion Control
604S	12/30/14	Seeding for Erosion Control
605S	06/21/07	Soil Retention Blanket
606S	06/21/07	Fertilizer
607S	05/23/00	Slope Stabilization Applications for Erosion Control

Document Number		Title
608S	09/26/12	Planting
610S	09/26/12	Preservation of Trees and Other Vegetation
620S	05/23/00	Filter Fabric
633S	11/26/01	Landgrading
641S	06/21/07	Stabilized Construction Entrance
642S	09/01/11	Silt Fence
Series 700 – Incidental Construction		
700S	09/26/12	Mobilization
701S	09/26/12	Fencing
703S	09/22/88	Fencing for Excavations
720S	09/26/12	Metal for Structures
721S	09/26/12	Steel Structures
722S	09/26/12	Protective Coatings
723S	09/26/12	Structural Welding
Series 800 – Urban Transportation		
802S	09/26/12	Project Signs
803S	11/15/11	Barricades, Signs and Traffic Handling
824S	02/24/10	Traffic Signs
860S	09/26/12	Pavement Marking Paint
Series 16000 – Water Utility Electrical		
S16110	10/03/11	Raceways, Fittings, and Supports
S16130	10/03/11	Boxes and Cabinets
S16140	10/03/11	Wiring Devices
S16200	10/03/11	General Wiring Methods
S16205	10/03/11	Wire Tagging
S16289	10/03/11	Surge Protective Devices
S16440	10/03/11	Disconnect Switches and Enclosed Circuit Breakers
S16450	10/03/11	Grounding
S16460	10/03/11	Dry Type Transformers – 600 Volts and Below Primary Rated 150 KVA and Smaller
S16470	10/03/11	Panelboards
S16480	10/03/11	Motor Control Center
S16485	10/03/11	Electrical Systems Analysis
S16490	07/07/08	Automatic Transfer Switch
S16520	07/07/08	Site Lighting
S16700	09/16/14	Common Control Panel Requirements for Equipment
S16720	07/07/08	Annunciator
S16730	05/23/11	Uninterruptible Power Supply
S16943	07/07/08	Temperature Transmitter RTD

Additional standard specifications not found in the list above and cross- referenced standard specifications not found in the list above may be obtained as follows:
{City of Austin Standard Specifications, Series 100 through 16000, adopted April 6, 1986, as amended. Available for purchase from

American Legal Publishing Corporation	*Telephone*	*1-800-445-5588*
Folio Business Partners and Publishers	*FAX*	*1-513-763-3562*
432 Walnut Street, 12th Floor	*email*	*amlegal@aol.com*
Cincinnati, Ohio 45202	*Web Page*	*http://www.amlegal.com*

Document Number		Title

VOLUME 3

Special Provisions to City Standard Technical Specifications

SP-1	07/26/13	Measurement and Payment
SP-201S	03/24/16	Subgrade Preparation
SP-401S	03/24/16	Structural Excavation and Backfill
SP-420S	03/24/16	Drilled Shaft Foundations
SP-510S	03/24/16	Pipe
SP-511S	03/24/16	Water Valves
SP-772S	03/24/16	Protective Coating
SP-16110S	03/24/16	Raceways, Fittings, and Supports
SP-16200	03/24/16	General Wiring Methods
SP-16480	03/24/16	Site Lighting
SP-16520	03/24/16	Motor Control Panel
SP-16700	03/24/16	Common Control Panel Requirements for Equipment

Special Specifications

DIVISION 2—SITE CONSTRUCTION

02371	12/23/15	Geotextiles
02375	05/11/16	Underdrain System
02821	12/23/15	Chain Link Fences and Gates

DIVISION 3—CONCRETE

03315	02/22/16	Prestressed Concrete Tank
03600	12/23/15	Nonshrink Grouting

DIVISION 4—MASONRY

04230		Concrete Unit Masonry

DIVISION 5—METALS

05120		Structural Steel Framing
05310		Steel Decking
05500	12/23/15	Metal Fabrications
05521	12/23/15	Aluminum Railings
05530	12/23/15	Metal Gratings

DIVISION 6—WOOD, PLASTICS, AND COMPOSITES

06100	12/01/14	Rough Carpentry

DIVISION 7—THERMAL AND MOISTURE PROTECTION

07100	12/05/14	Waterproofing, Damproofing and Water Repellants
07210	12/05/14	Board Insulation
07610	12/05/14	Standing Seam Metal Roof and Soffit System
07620	12/05/14	Sheet Metal Flashing and Trim
07800	12/05/14	Firestopping
07920	12/05/14	Joint Sealants

Document Number		Title
DIVISION 8—OPENINGS		
08110	12/05/14	Steel Doors and Frames
08330	12/05/14	Overhead Coiling Doors
08450	12/05/14	Fiberglass Sandwich Panel Assemblies
08510	12/05/14	Aluminum Windows
08710	12/05/14	Door Hardware
08800	12/05/14	Glazing
DIVISION 9—FINISHES		
09200	12/05/15	Gypsum Board
09900	12/23/15	Painting and Coating
09910	12/05/14	Architectural Painting
DIVISION 10—SPECIALTIES		
10200	12/05/15	Louvers
10400	12/05/14	Panel Signage
10520	12/05/14	Fire Extinguishers and Accessories
DIVISIONS 11—EQUIPMENT		
11149	12/23/15	Submersible Sump Pumps
11150	12/23/15	Grinder Pump Station
11211	12/23/15	Horizontal Split-Case Centrifugal Pumps
11261	12/23/15	Chlorine Analyzer Controlled Tablet Chlorinator System
11730	12/23/15	Storage Reservoir Submersible Mixer
DIVISION 13—SPECIAL CONSTRUCTION		
13122		Pump Station Metal Building Systems
13315	12/23/15	PLC Network Requirements
13321	12/23/15	Wireless Broadband Subsystem
13400	12/23/15	Process Instrumentation and Control System (PICS)
13410	12/23/15	Instrumentation and Control Cabinets and Associated Equipment
13430	12/23/15	Distributed Control System (DCS)
DIVISION 14—CONVEYING SYTEMS		
14630	12/23/15	Overhead Cranes
DIVISION 15—MECHANICAL		
15052	03/26/15	Common Work Results for Plumbing
15053	12/23/15	Common Work Results for HVAC
15060	12/23/15	Piping Support Systems
15061	03/26/15	Hangers and Supports for Plumbing Piping and Equipment
15062	12/23/15	Hangers and Supports for HVAC Piping and Equipment
15077	03/26/15	Identification for HVAC Piping and Equipment
15080	12/23/15	Process Piping Insulation
15082	03/26/15	Plumbing Insulation
15083	03/26/15	HVAC Insulation
15140	03/26/15	Domestic Water Piping
15145	03/26/15	Domestic Water Piping Specialties
15150	03/26/15	Sanitary Waste and Vent Piping
15155	03/26/15	Sanitary Waste Piping Specialties
15205	12/23/15	Process Piping Specialties

Document Number		Title
15208	12/23/15	Hydropnuematic Tank and Control System
15410	03/26/15	Plumbing Fixtures
15738	03/26/15	Split-System Air-Conditioning Units
15838	03/26/15	Power Ventilators
15950	03/26/15	Testing, Adjusting and Balancing
15955	12/23/15	Process Piping Leakage Testing
DIVISION 16—ELECTRICAL		
16055	12/23/15	Pipe Heat Tracing
16220	12/23/15	Low-Voltage Ac Induction Motors

VOL. 4	06/01/16	**MBE/WBE Procurement Program Package**
VOL. 5	08/01/15	**Geotechnical Report**
VOL. 6	09/03/15	**Stormwater Pollution Prevention Plan (SWPPP)**

END

This page intentionally left blank

SPECIAL PROVISION
To the Measurement and Payment Section of the
City of Austin Standard Technical Specifications

For this Project all adopted and/or referenced City of Austin Standard Technical Specification Items are hereby amended with respect to the clauses cited below. No other clauses or requirements of these Items are waived or changed hereby.

In all adopted and/or referenced City of Austin Standard Specifications, in the Sections titled "Measurement and Payment", delete all text in its entirety and replace with the following paragraph:

"All work items installed, provided, constructed, etc. under this specification shall not be paid for separately but shall be considered subsidiary to the lump sum bid price for the project. No separate pay will be provided for any work governed by this specification. The cost of all work materials, labor, overhead, insurance, equipment, etc. necessary to finish the work complete in place shall be included in the lump sum bid price for the project."

End

SPECIAL PROVISION
To Standard Specification Item No. 201S
Subgrade Preparation

For this project, Item 201S, Subgrade Preparation, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. 201S.3 Paragraph 3 (page 1), **delete** second sentence and add the following revision:
    a. "For access roadway, the Contractor will be required to set blue tops for the subgrade on the centerline, at the quarter points and along the curb lines or edge of pavement at maximum intervals of 50 feet (15 meters)."
2. 201S.3 Paragraph 4 (page 2), **delete** second sentence that starts "All other material…"
3. 201S.3 Paragraph 5 (page 2), **delete** first sentence and **add** the following revision:
    a. "For subgrades supporting structures, it is the intent of this specification to provide the required density and moisture control for the subgrade based on the plasticity characteristics of the approved materials."
4. 201S.3 Paragraph 6 (page 2), first sentence **change** "85 percent" to "90 percent".
5. 210S.3 Paragraph 7 (page 3), first sentence **change** "Prior to placement of any base materials" to "Prior to replacement of any structural fill materials,"

END

SPECIAL PROVISION
To Standard Specification Item No. 401S
Structural Evacuation and Backfill

For this project, Item 401S, Subgrade Preparation, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. 401S.1 Paragraph 1 (page1), **delete** second sentence.
2. 401S.1 Paragraph 1 (page 1), delete third sentence and add the following revision:
    a. "Unless otherwise indicated on the Drawings, the work included hereunder shall provide for the removal of trees and all other obstructions necessary to the proposed construction."
3. 401S.1 Paragraph 2 (page 1), delete first sentence and add the following revision:
    a. "Excavation is not classified, and will be grouped under "Unclassified Structural Excavation", which shall include the removal of all materials encountered regardless of their nature or the manner in which they are removed."
4. 401S.1 Paragraph 3 (page 1), delete in its entirety.
5. 401S.2 Paragraph 1 (page 2), delete the word "cofferdam" from last sentence.
6. 401S.3 Paragraph E (page 2), delete item 3 "Pea Gravel" and replace with the following:
    a. "3. Drain Rock

    Drain rock shall consist of hard, durable opaque coarse aggregate, free of clay, loam, sand, or other foreign substances, conforming to ASTM C 33, No. 67 size number."
7. 401S.3 Paragraph E (page 2), add the following item:
    a. "4. Structural Fill: TxDOT Item 247, Type A, Grade 2."
8. 401S.3 Add the following Paragraph (page 3):
    a. "H. Earthfill

    1. Soil, loam, or other on-site excavated material suitable for use as backfill.

    2. Free from roots and organic matter, refuse, boulders, and other materials larger than 4 inches in diameter or other deleterious materials."
9. 401S.4 Item A Paragraph 7 (page 4), delete first sentence and add the following revision:
    a. "Holes remaining after removal of all obstructions, objectionable material, trees, stumps, etc. shall be backfilled with Structural Fill if within the influence zone of a structure or with Earthfill outside the influence zone of a structure and compacted by approved methods."
10. 401S.4 Item A Paragraph 8 (page 4), delete first sentence. Burning of materials on-site will not be allowed.
11. 401S.4 Item B.8 (page 5), delete paragraph 8 and replace with the following revision:
    a. "8. When the material encountered at the footing grade is found to be partially on rock or incompressible material and partially on a compressible soil which is satisfactory for the foundation, the incompressible material shall be removed as shown on the drawings below the footing grade and backfilled with Structural Fill as shown on the drawings."

12. 401S.4 Item B.9 (page 5), delete paragraph 9.
13. 401S.5 Title (page6), delete “Bridge Foundations and”
14. 401S.5 Paragraph 2 (page 6), delete in its entirety.
15. 401S.6, delete Section in its entirety (page6).
16. 401S.7 Paragraph 3 (page 7), delete paragraph 3 in its entirety.
17. 401S.8 (page 7), delete in its entirety and replace with the following revision:
    a. “401S.8 Backfilling

A. General

As soon as practical, all portions of excavation not occupied by the permanent structure shall be backfilled with Earthfill. Excavations occupied by structure shall be backfilled with Structural Fill.

That portion of backfill which will support any portion of completed roadbed or embankment shall be placed in layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted to meet density requirements of the roadbed embankment material, or as indicated.

That portion of backfill which will not support any portion of completed roadbed or embankment shall be placed in layers not more than 10 inches (250 mm) in depth (loose measurement) and shall be compacted to a minimum of 95 to 102 percent of maximum density as determined by TxDOT Test Method Tex-114-E.

That portion of the backfill which will support any portion of the roadbed or embankment shall be placed in uniform layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted to a minimum of 95 to 102 percent of maximum density, as determined by TxDoT Test Method Tex-114-E and then re-excavated to the proper grade and wetted uniformly to the moisture content required to obtain the specified density and shall be compacted to that density by means of mechanical tampers or rammers, except that the use of rolling equipment of the type generally used in compaction embankments will be permitted on portions which are accessible to such equipment.

That portion of the backfill (Structural Fill) which will support structures shall be placed in uniform layers not more than 8 inches (200 mm) in depth (loose measurement) and shall be compacted to a minimum of 100 percent of the maximum dry density, as determined by TxDOT Test Method Tex-113-E.

All portions of embankment too close to any portion of a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted with mechanical tamps and rammers to avoid damage to the structure.

These provisions require mechanical compaction by means of either rolling equipment or mechanical tampers or rammers, of all backfill and embankment adjoining culverts and adjoining all sides, regardless of whether or not such embankment or backfill is above or below the original surface of the ground and regardless of whether the excavation at structure site was performed conforming to Standard Specification Item No.111S, "Excavation". Unless otherwise indicated on the Drawings, hand tamping will not be accepted as an alternate for mechanical compaction.

When required by the Drawings or by written order of the Engineer or designated representative, cement-stabilized-backfill material shall be used for backfilling.

All portions of fill and backfill described in the preceding paragraph shall be compacted to the same density requirements specified for the adjoining sections of embankment in accordance with the governing specifications. Where no embankment is involved on the project and no relevant specifications are included in the contract, all backfill shall be compacted to a density comparable with the adjacent undisturbed material.

No backfill shall be placed against any structure until such structure has been in place at least 7 days. No backfill shall be placed adjacent to or over single and multiple boxes until the top slab has attained 500 psi (3450 kPa) flexural strength.

Care shall be taken to prevent any wedging action of backfill against the structure and the slopes bounding the excavation shall be stepped or serrated to prevent such action."

18. 401S.9 Paragraphs C., G., and I (page 11), delete each of these paragraphs, renumber as appropriate. These paragraphs do not apply to this project.

END

SPECIAL PROVISION
To Standard Specification Item No. 510S
Pipe

For this project, Item 510S, Subgrade Preparation, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. **Add** the following to 510.2 (8) (g)

SECTION 510.2 (8) (g) 1 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	Description
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	Seamless, conforming to ASTM B88 as follows: Oxygen service — Type K, hard drawn Water (buried) — Type K, soft or hard temper Water (exposed) — Type L, hard drawn Domestic hot water — Type L, hard drawn Compressed air service — Type L, hard drawn Laboratory air service — Type L, hard drawn Laboratory vacuum service — Type L, hard drawn Refrigerant service — Type L, hard drawn P-Trap priming service — Type L, soft temper Sample line service — Type L, hard drawn Laboratory gas service — Type L, hard drawn
Fittings	Oxygen Service: Class 250, ASTM B62 bronze, screwed, dimensions conforming to ASME B16.15 or ASTM B75 wrought copper, socket joint, dimensions conforming to ASME B16.22. Other Services: ASTM B75 commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Oxygen Service: Class 150, ASTM B61 bronze, screwed, ASME B16.24 standard. Other Services: Class 150, ASTM B75 commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts, copper silicon hex nuts conforming to ASTM B98 Grade A hard and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Other Services: ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	1/16-inch-thick nonasbestos compression type, full face, Cranite, John Manville.

SECTION 510.2 (8) (g) 1 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	Description
Solder	Oxygen Service: Silver brazing alloy, 15 percent silver content, 1185 degrees F to 1300 degrees F melting range, conforming to AWS A5.8. Other Services: Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.

2. **Add** the following section to 510.2 (8)

SECTION 510.2 (8) (p) CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Pipe	All	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Screwed:	
	2" & smaller	Schedule 40.
	Welded:	
	2-1/2" thru 10"	Schedule 40.
	12" thru 16"	Schedule 30.
	18" thru 24"	Schedule 20.
	Grooved:	
	2-1/2" thru 6"	Schedule 40.
	8" thru 12" inch	Schedule 30.
	14"	Standard weight.
Joints	2" & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
	2-1/2" & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.

SECTION 510.2 (8) (p) CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Fittings	2" & smaller	Threaded: 150- or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed. Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok.
	2-1/2" & larger	Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47/A47M, ductile iron ASTM A536, forged steel ASTM A234/A234M, or factory fabricated from ASTM A53/A53M pipe. Grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products.
Branch Connections	2" & smaller	For threaded pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet.
	2-1/2" & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.
Flanges	2" & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
	2-1/2" & larger	Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Grooved End Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment. Cast Iron Mating Flange: AWWA C207, Class D or E, hub or ring type to mate with ASME B16.1, Class 125 cast-iron flange. AWWA C207 Class F hub type or ASTM A105/A105M, ASME B16.5 Class 300 to mate with ASME B16.1 Class 250 cast-iron flange.

SECTION 510.2 (8) (p) CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Unions	2" & smaller	Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150- or 300-pound WOG, meeting the requirements of ASME B16.3.
Couplings	2-1/2" & larger	Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products. Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M.
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength. [Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts; ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.]
Gaskets	All flanges	Water, Steam, and Air Services: 1/16-inch-thick, compressed inorganic fiber with nitrile binder, rated 400 degrees F. continuous. Fuel Gas Service: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. Grooved Couplings: EPDM per ASTM D2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 180 degrees F. [NSF 61 approved for potable water service.]
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

3. **Add** the following section to 510.2 (8)

SECTION 510.2 (8) (q) STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 316 seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A778, “as-welded” grade, Type 316L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A778, “as-welded” grade, Type 316L, pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F316 or cast Class 150, ASTM A351/A351M, Grade CF8M/316.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A774/A774M Grade 316L conforming to MSS SP 43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.

SECTION 510.2 (8) (q) STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F316L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240 Type 316L “as-welded grade”, conforming to MSS SP 43, wall thickness same as pipe. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Van Stone Flanges and Anywhere Mating Flange on Equipment is Cast Iron and Gasket is Flat Ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas, and Sewage Services: 1/8 inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

SECTION 510.2 (8) (q) STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	Size	Description
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

4. **Delete** Sections 510.3 (27) and (28) and **replace** with Special Specification 15955 Process Piping Leakage Testing.

END

SPECIAL PROVISION
To Standard Specification Item No. 511S
Water Valves

For this project, Item 511S, Water Valves, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. Add the following to 511S.3 C)

    (1) Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:

        (a) Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.

        (b) Manufacturers and Products:

            (i) Threaded:

                1. Conbraco Apollo; 70-100.

                2. Nibco; T-580-70.

            (ii) Soldered:

                1. Conbraco Apollo; 70-200.

                2. Nibco; S-580-70.

    (2) Type V303 Ball Valve 2 Inches and Smaller for Equipment Air System Shutoff:

        (a) Two-piece, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, 125 psig rated, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel locking handle with vinyl grip.

        (b) Meets OSHA Regulation 29 CFR Part 1910.147 requirements.

        (c) Manufacturers and Products:

            (i) Conbraco Apollo; 75-100-41.

            (ii) Nibco; T-580-70-SV/T-585-70-SV.

    (3) Type V330 PVC Ball Valve 2 Inches and Smaller:

        (a) Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.

        (b) Manufacturers and Products:

            (i) Nibco; Chemtrol Tru-Bloc.

            (ii) ASAHI/America; Type 21.

            (iii) Spears; True Union.

    (4) Type V317, AWWA Rubber Seated Ball Valve:

(a) General: All ball valves shall be of the tight-closing, shaft-mounted type that fully comply with AWWA C507. Design pressure ratings shall be 150 psi and provide tight shutoff against flow in both directions. Design of valve shall be such that with the valve in the open position, the full and unobstructed circular inlet and outlet port diameter shall be as specified in Table 1 of AWWA C507. With the valve in the closed position, the rubber seated valve shall be bubble tight at rated pressure.

(b) Valve Body: The valve body shall have integral support legs or pads and shall consist of two body end pieces and a center body piece through-bolted and O-ring sealed against leakage. Minimum body thickness shall be as specified in Table 2 of AWWA C507. Flanges shall be flat-faced and flange drilling shall be in accordance with ANSI B 16.1 Class 125.

(c) Valve Ball and Shafts: The valve ball shall be constructed of ductile iron ASTM A536 65-45-12 or cast iron ASTM A48, Class 40, and shall be taper-pinned to an upper and lower fitted shaft of Type 304 stainless steel.

(d) Valve Bearings and Seals: The center section shall be fitted with sleeve-type bearings contained in the body hubs. Bearings shall be corrosion resistant and self-lubricating. Materials shall be Teflon-lined with fiberglass backing. Bearings surfaces shall be isolated from flow by O-ring type seals. The ball assembly shall be supported by a two-way thrust bearing assembly consisting of a stainless steel stud and thrust collar in a grease-packed cavity.

(e) Valve Seats – Rubber: All seats shall be of a synthetic rubber compound. Seats shall be retained in the valve body by mechanical means without retaining rings, segments, screws, or hardware of any kind in the flow stream. Seats shall seal a full 360 degrees without interruption and have a plurality of grooves mating with a spherical stainless steel seating surface on the ball. Valve seats shall be field adjustable around the full 360 degrees circumference and replaceable without dismantling the operator, ball or shaft. Where line size permits, seats shall also be capable of being adjusted without removing the valve from the line. Manufacturer shall certify that the rubber seat is field adjustable and replaceable. In single-seated valves, there shall be one set of ball and body seats. In double-seated valves, there shall be two sets of ball and body seats. Single-seated valves shall provide drip-tight closure in one direction. Double-seated shall provide drip-tight closure in two directions.

(f) Valve Actuators: Valve actuators shall conform to the operating requirements of AWWA C507 and shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering. Manual actuators shall be of the traveling nut, self-locking type and shall be equipped with mechanical stop-limiting devices to prevent over-travel of the ball in the open or closed positions. Actuators shall be fully enclosed and designed to produce specified torque with a maximum input of 150 ft-lbs on operating nuts. Actuator components shall withstand an input torque of 450 ft-lbs at extreme actuator positions without damage.

(g) Valve Testing: All ball valves shall be subjected to a hydrostatic, shop leakage and performance tests as specified in AWWA C507.

(h) Fusion epoxy coated inside and outside per AWWA C550.

(i) Valve shall be for buried service, where indicated on the Drawings.

(j) Proof of Design: The manufacturer furnishing valves shall provide proof of design requirements per AWWA C507.

(5) Type V320 Pump Control Valve:

(a) Electrically actuated, flanged ball valve in accordance with latest revision of AWWA C507.

(b) Flanges: 125-pound, flat-faced, and finished to true plane surface within a tolerance limit of 0.005 inch, perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot flange diameter, concentric or spiral serrate finish.

(c) Ball: Designed for flow between the ball and body when in throttled position, and substantially all flow through the ball when in full open position.

(d) Seats: On both the ball and the valve body, flexible metal or resilient seat on either the ball or body and a rigid set opposite, on both ends of ball, securely anchored in place.

(e) Shop Painting:

(i) Interior Unfinished Surfaces:

1. Cook “920-W-965 Epicon-MW HB Epoxy;”
2. Koppers “200 HB Epoxy;”
3. Tnemec “Hi-Build Epoxoline Series 66;”
4. Valspar “89 Series Val-Chem Hi-Build Epoxy;”
5. Wisconsin Protective Coating “Plastic 7122.”

(ii) Exterior Unfinished Surfaces, Operators and Accessories:

1. Cook “391-N-167 Barrier Coat;”
2. Koppers “No. 10 Inhibitive Primer;”
3. Tnemec “77 Chem Prime;”
4. Valspar “13-R-28 Chromox Primer.”

(iii) Polished or Machined Surfaces:

1. Houghton “Rust Veto344”
2. Rust-Oleum “R-9.”

(f) Electric Operator: As specified herein and as noted on Electric Operator Schedule attachment.

(g) Manufacturers:

(i) APCO-Willamette.

(ii) Henry Pratt.

2. Add the following to 511S.3

I. Check Valves:

(1) Type V694 Check Valve 1 Inch to 48 Inches:

a. Elastomer type flanged or slip-on as shown on Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for 50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced neoprene.

b. Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1.

(2) Type V632 Ball Check Valve 2 Inches and Smaller:

a. Flanged end, iron body valve with a cleanout and sinking type hollow steel ball, vulcanized nitrile rubber exterior, flanges ASME B16.1, Class 215, rated 150-pound working pressure, suitable for vertical up or horizontal flow.

b. Manufacturers and Product:

1) FLYGT Corp; 5087.

2) Flomatic Cor.; 208/208B.

3) Golden Anderson; 240-T.

J. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly 3/4 Inch to 10 Inches:

1. Two resilient seated check valves with an independent relief valve between the valves, two nonrising stem or outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.

2. Manufacturers and Products:

WATTS REGULATOR CO.
P.O. Box 628
Lawrence, MA 01842
Model 919Qt (¾" – 2" sizes)
Model 909RW (2½" – 10" sizes)
Model 909RPDA OS&Y RW (RP Detector Assembly
2½" – 10")

ZURN-WILKINS
1747 Commerce Way
Paso Robles, CA 93446
Model 975XL (½" – 2")
Model 375 (2½" – 10")
Model 375 DA (Detector Check Valve 2½" – 10")

APOLLO VALVES/
CONBRACO INDUSTRIES
P.O. Box 247
Matthews, NC 28106
Model RP40 (1/4" – 10")
Model RPDA40 (RP Detector Assembly 3" – 10")

K. Type V714 Pressure-Reducing Valve 3 Inches and Larger:

1. Hydraulically operated, diaphragm actuated, pilot controlled globe valve, ductile iron body, ASME B16.1 Class 150 flanged ends, rated 250 psi, bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks, maintains a constant downstream pressure regardless of fluctuations in flow or upstream pressure.

2. FDA approved fusion bonded epoxy lining [and coating] installed in accordance with AWWA C550.

3. Size/Rating: As shown in Valve Schedule.

4. Manufacturers and Products:

1) Cla-Val; 90-01 Series.

2) Singer; Model 106PR.

L. Type V732 Pressure-Relief Valve 3 Inches and Larger:

1. Hydraulically operated, diaphragm actuated, pilot controlled globe valve, ductile iron body, ASME B16.1 Class 150 flanged ends, rated 250 psi, bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.

2. FDA approved fusion-bonded epoxy lining [and coating] installed in accordance with AWWA C550.

3. Size/Rating: As shown in Valve Schedule.

4. Manufacturers and Products:

1) Cla-Val; 50-01 Series.

2) Singer; Model 106-RPS.

M. Type V780 One-Way Altitude Valve

Hydraulically operated, diaphragm or piston actuated, globe valve with cast iron, ductile iron, or steel body, ANSI B16.1 flanged ends, rated 300 psi, bronze or stainless steel trim, stainless steel stem or bronze piston and liner, externally mounted with cock, fully guided diaphragm assembly, and three-way diaphragm-actuated pilot control. Designed to maintain water level in an atmospheric tank within a 6 inch range. Provide delayed opening pilot operation.

Manufacturers and Products:
GA Ind.
Singer
Cla-Val
WATTS

N. Type V100 Gate Valve 3 Inches and Smaller

1. All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 200 psi CWP, complies with MSS SP-80 Type 1.

2. Manufacturers and Products:

1) Crane; Figure 438, NPT threaded ends.

2) Stockham; Figure B103, NPT threaded ends.

3) Crane Figure 1324, soldered ends.

4) Stockham; Figure B104, soldered ends.

O. OPERATORS and ACTUATORS

(A) Manual Operators

1. General:

a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.

b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.

c. Operator self-locking type or equipped with self-locking device.

d. Position indicator on quarter-turn valves.

e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.

2. Exposed Operator:

a. Galvanized and painted handwheel.

b. Cranks on gear type operator.

c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.

d. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:

a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.

c. Buried valves shall have extension stems, bonnets, and valve boxes.

(B) Electric Motors Actuators, 480 Volts:

1. General:

a. Comply with latest version of AWWA C542.

b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.

c. Controls integral with actuator and fully equipped as specified in AWWA C542.

d. Stem protection for rising stem valves.

2. Actuator Operation—General:

a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.

b. Manual override handwheel.

c. Valve position indication.

d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.

e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.

3. Open-Close (O/C)/Service:

a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.

b. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:

1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.

2) Remote OPEN-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands.

3) Auxiliary contact that closes in REMOTE position.

c. OPEN and CLOSED indicating lights.

d. Integral reversing motor starter with built-in overload protection.

4. Limit Switch

a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.

b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN, one for valve 5% OPEN and one for valve FULL CLOSED.

c. Housed in actuator control enclosure.

5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.

6. Manufacturers and Products:

a. Rotork Controls.

b. Flowserve Limitorque.

c. AUMA.

3. Add the following to 511S.3 D)

A. Type V744 Air Release Valve 1/2 Inch to 2 Inches:

a. Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.

b. Rated 300 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512. Operating pressure is 70 psi.

c. Manufacturers and Products:

1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.

2) Val-Matic Valve; Series 15A to 45.6.

B. Type V748 Rolling Seal Combination Air Valve 2 Inches to 8 Inches:

a. Suitable for water service, combines operating features of air and vacuum valve and air release valve. Air and vacuum portion to automatically exhaust air at a high rate during filling of system and allow air to re-enter during draining or when vacuum occurs. Air release portion to automatically exhaust entrained air that accumulates in system. Air release uses rolling seal mechanism.

b. High flow air/vacuum valve, cast-iron body with stainless steel float and seat, EPDM seal, ASME B16.1 Class 125 flanged inlet, 230-psi working pressure nonslam feature.

c. Air release valve with foamed polypropylene float, EPDM rubber rolling seal mechanism with reinforced nylon plug, plug cover, and clamping stem, Buna-N O-ring.

d. Manufacturer and Product:

A.R.I. FLOW CONTROL
C/O McCain Waterworks Marketing
Suite 1202
18975 Marbach Lane
San Antonio, TX 78266
D-021-P

END

SPECIAL PROVISION
To Standard Specification Item No. 772S
Protective Coatings

For this project, Item 772S, Protective Coatings, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. **Delete** City Standard Technical Specification – 722S in its entirety and replace with Special Specifications 09900 Painting and Coating.

END

SPECIAL PROVISION
To Standard Specification Item No. 16110S
Raceway, Fittings, and Supports

For this project, Item 16110S, Raceways, Fittings, and Supports, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. Subsection 3.02 A. (page 5 of 8), **replace** "…. or 16 pounds per cubic yard of concrete." with "…or 12 pounds per cubic yard of concrete."

END

SPECIAL PROVISION
To Standard Specification Item No. 16200
General Wiring Methods

For this project, Item 16200, General Wiring Methods, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. **Add** the following section to 16200, General Wiring Methods:

" 1.02 REFERENCES

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

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
   c. C12.1 Code for Electricity Metering.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 810, Standard for Capacitors.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.
   h. 1059, Standard for Terminal Blocks.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:

a. Control devices.

b. Control relays.

c. Circuit breakers.

d. Fused switches.

e. Nonfused switches.

f. Timers.

g. Fuses.

h. Magnetic contactors.

i. Enclosures: Include enclosure data for products having enclosures.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed."

"2.02 600-VOLT RATED CABLE

A. General;

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.

2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.

3. Suitable for installation in open air, in cable trays, or conduit.

4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.

5. Overall Outer Jacket: [PVC, flame-retardant, sunlight- and oil-resistant.] [Hypalon (chlorosulfonated polyethylene).]

B. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.

2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.

3. Dimension: 0.31-inch nominal OD.

4. Conductors:

a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.

b. 20 AWG, seven-strand tinned copper drain wire.

c. Insulation: 15-mil nominal PVC.

d. Jacket: 4-mil nominal nylon.

e. Color Code: Pair conductors, black and red.

5. Manufacturers:

a. Okonite Co.

b. Alpha Wire Corp.

c. Belden

C. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal.

2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.

3. Dimension: 0.32-inch nominal OD.

4. Conductors:

a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.

b. 20 AWG, seven-strand, tinned copper drain wire.

c. Insulation: 15-mil nominal PVC.

d. Jacket: 4-mil nylon.

e. Color Code: Triad conductors black, red, and blue.

5. Manufacturers:

a. Okonite Co.

b. Alpha Wire Corp.

c. Belden

2.03 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.

2. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.

3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.

4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.

5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.

6. Manufacturer and Product: Belden; 7852A.

2.04 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.

D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.

2. Lugs removable/replaceable.

3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.

2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.05 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Enclosures: See Article Enclosures.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.06 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.

2. Provide to fit mountings specified with switches.

3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.

2. Type: Dual element, with time delay.

3. Manufacturers and Products:

a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).

b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:

1. Class: L.
2. Double O-rings and silver links.
3. Manufacturers and Products:
   a. Bussmann; Type KRP-C.
   b. Littelfuse, Inc.; Type KLPC.

D. Cable Limiters:
1. 600V or less; crimp to copper cable, bolt to bus or terminal pad.
2. Manufacturer and Product: Bussmann; K Series.

E. Ferrule:
1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.
4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littlefuse, Inc.

2.07 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard or Gloved hand.

C. Indicating Light: Push-to-test, LED, full voltage.

D. Pushbutton Color:
1. ON or START: Red.
2. OFF or STOP: Green

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:
1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64-inch.

G. Manufacturers and Products:
1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P
   b. Square D Co.; Type T

c. Eaton/Cutler-Hammer; Type 10250T.

2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

a. Square D Co.; Type SK.

b. General Electric Co.; Type CR 104P.

c. Eaton/Cutler-Hammer; Type E34.

d. Crouse-Hinds; Type NCS.

2.08 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.

2. Capable of jumper installation with no loss of terminal or rail space.

3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.

2. Ideal.

3. Electrovert USA Corp.

2.09 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A600 (600 volts).

C. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable [from 0.2 second to 60 seconds (minimum)] [from 5 seconds to 200 seconds (minimum)] [as shown].

2. Field convertible from ON delay to OFF delay and vice versa.

D. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

E. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Type M-600.

2. Allen-Bradley, type 700-N.

2.10 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

C. Solid-state electronic, field convertible ON/OFF delay.

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from .1 second to 60 seconds, unless otherwise indicated on Drawings.

G. Manufacturers and Products:

1. Square D Co.; Type JCK70.
2. Eaton/Cutler-Hammer.
3. General Electric Co.

2.11 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 hour to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush panel.

D. Manufacturers and Products:

1. Eaton: Model 7-Y-41349-406-ME.
2. Eagle Signal Controls; Bulletin 705.

2.12 MAGNETIC CONTRACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated As shown.
4. Poles: As shown.

D. Control: As shown.

E. Auxiliary Contacts: Quantity as shown, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

G. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Class A201.
2. Square D Co.; Class 8910.

2.13 PHASE MONITOR RELAY

A. Features:

1. Voltage and phase monitor relay shall drop out on low voltage, voltage unbalance, loss of phase, or phase reversal.
2. Contacts: Single-pole, double-throw, 10 amperes, 120/240V ac. Where additional contacts are shown or required, provide magnetic control relays.
3. Adjustable trip and time delay settings.
4. Transient Protection: 1,000V ac.
5. Mounting: Multipin plug-in socket base.

B. Manufacturer and Product: Automatic Timing and Controls; SLD Series.

2.14 INDUSTRIAL CAPACITORS

A. UL 810, NEMA CP 1, IEEE 18, and NFPA 70, Article 460.

B. Enclosed, [indoor, dustproof,] [outdoor, weatherproof,] three-phase capacitor units containing internally mounted, indicating type, high interrupting-capacity, current-limiting fuses, and discharge resistors.

C. Units containing PCB dielectric fluid are unacceptable.

D. Kilovar Ratings:

1. Check motor nameplate and manufacturer's power factor and no-load current data for actual motor installed.
2. Reduce capacitor rating, if required, to not exceed motor manufacturer's recommended maximum size, and to not exceed value required to raise motor no-load power factor to 0.95.

E. Manufacturers:

1. Square D Co.

2.15 SUPPORT AND FRAMING CHANNELS

A. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.

B. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

C. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas."

END

SPECIAL PROVISION
To Standard Specification Item No. 16480
Motor Control Center

For this project, Item 16480, Motor Control Center, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. **Add** the following section to Section 16480, Motor Control Center:

1.10 COMBINATION REDUCED VOLTAGE, SOLID STATE STARTER:

A. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 16200, General Wiring Methods.

B. Construction:

1. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.
2. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
3. Readily interchangeable with starters of similar size.
4. Pull-apart unit control wiring terminal boards capable of accepting up to 2#14 AWG wires minimum on all units.
5. Rating: Horsepower rated at 600 volt, UL labeled for 100,000 amperes at 480 volts short circuit capacity with overload protection.

C. Control: As shown on Drawings.

1. Bypass contactor.
2. Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
3. Kick start, with adjustable torque and time settings.
4. Ramp start, selectable current or torque, and adjustable time.
5. Smooth stop ramp, adjustable time.
6. Phase loss unbalance and phase reversal protection.
7. LED display or LCD of fault, N.O. contact to communicate fault condition.

D. Communications: Ethernet between pump motor starters and Station control system.

1.11 INDUSTRIAL ETHERNET SWITCH, 10/100 MBPS:

A. General:

1. Functions: Interconnects Ethernet nodes in an industrial environment with advanced Ethernet communication management functions. Provides automatically negotiates for maximum speed and performance of the 16-10/100 BaseTX RJ-45 Ports.

B. Standards and Compliance:

1. Electrical Safety: UL508, CSA C22.2/14; EN61010-1, CE.
2. EMC: Dir 89/336/EEC, EN 50204, EN 55011 EN61000-4-2, 3, 4, 5, 6, 8,11, EN61000-6-2, 4.
3. Hazardous locations: UL1604, CSA C22.2/213 (Class I, Div. 2, Groups); EN60079-15 (Zone 2, Category 3), CE (ATEX).
4. IEEE 1613 for Electric Utility Substations.
5. Marine/maritime/offshore rated per ABS.
6. NEMA TS-1/TS-2 for traffic control systems.
7. RoHS compliant.
8. MTBF: >2Million hours.

C. Management:

1. Auto negotiating 10/100 Mbps copper ports.
2. Type: Managed, store and forward.
3. Operation: Wire-speed switching, non-blocking.
4. Devices Supported: All IEEE 802.3 compliant devices.
5. Protocols: SNMPv1/v2/v3, RMON, DHCP, SNTP, TFTP, STP, RSTP, QoS/CoS/ToS/DS, IGMPv1/v2, VLAN (tag and port based), HTTP, HTTPS (SSL and TSL), telnet and SSH.
6. Standards: IEEE 802.3, 802.3u, 802.3x, 802.1D/w, 802.1p, 802.1Q.
7. Management Interfaces: DB 9 connector COM Port.

D. Environmental:

1. Operating Temperature: Minus 40 to 85 degrees C.
2. Storage Temperature: Minus 40 to 85 degrees C.
3. Humidity: 10 to 95 percent relative humidity, non-condensing.
4. Electronic Protection: Conformal coating on all circuit boards.
5. Vibration and Shock: Compliance with IEC60068-2-6, -27 and -32.

E. Features:

1. Duplex:
   a. 16 10/100-Mbps copper ports, RJ-45.
   b. Half/full duplex auto negotiating.
2. Forwarding:
   a. Latency typical: 2.1 µs.
3. MAC Addresses: 4000.
4. Memory Bandwidth: 2.6 Gbps.
5. Mounting: DIN-rail.
6. Electrical Isolation Between Ports: 1,500 Vrms for 1 minute.

7. Transient Protection: 15 kW peak.
8. Port Polarity: RJ-45 auto-polarity for automatic correction of crossed TXD and RXD pairs.
9. Indicators:
    a. Bi-Color LEDs for Link, Speed, Activity & Duplex Status.
    b. One power.
10. Connectors: RJ-45.
11. 10/100 Mbps Ports: 16; unless otherwise noted.

F. Power: 10 to 30 VDC. Provide two 24VDC power supply for connection to 120 VAC control power from each side of the tie-breaker.

G. Nominal Dimensions (H by W by D, inches): 3.44 by 7.69 by 3.44.

H. Manufacturer and Product: N-Tron, 516TX-A.

END

SPECIAL PROVISION
To Standard Specification Item No. 16520
Site Lighting

For this project, Item 16520, Site Lighting, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. SP16520 Paragraph 2.1, **delete** in its entirety and **replace** with the following revision:
    a. "Site Lighting" – see Luminaire Schedule on Electrical Drawing.

END

SPECIAL PROVISION
To Standard Specification Item No. 16700
Common Control Panel Requirements for Equipment

For this project, Item 16700, Common Control Panel Requirements for Equipment, of the City of Austin Standard Technical Specifications is hereby amended with respect to the clauses cited below. No other clauses or requirements of this section of this City of Austin Standard Technical Specification are waived or changed.

1. 2.02.D **Replace** "Division 17" with "Special Specifications Division 13".
2. 2.02.K **Delete** paragraph.
3. 2.02.L **Replace** "Division 17" with "Special Specifications Division 13."

END

SECTION 02371
GEOTEXTILES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society for Testing and Materials (ASTM):
   a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
   b. D4355, Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
   c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   f. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using Constant Head.
   g. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   h. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   i. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
   j. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

C. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Shop Drawings:

1. Manufacturer material specifications and product literature.
2. Installation Drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
3. Description of proposed method of geotextile deployment, and provisions for holding geotextile temporarily in place until permanently secured.

B. Samples:

1. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.

C. Quality Control Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 201S, Subgrade Preparation, first.

B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

PART 2 PRODUCTS

2.01 NONWOVEN GEOTEXTILE FOR FILTRATION

A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Nominal Weight Per Square Yard: 8 oz.

E. Physical Properties: Conform to requirements in Table No. 1.

TABLE NO. 1
PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE

Property	Requirement	Test Method
Water Permittivity	1.0 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	70-100 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength	160 lb, MinARV	ASTM D4632
Grab Elongation	50-90 percent, MaxARV	ASTM D4632
Puncture Strength	90 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	75 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	80 percent strength retention, MinARV after 500 hours	ASTM D4355

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 JOINTS

A. Unseamed Joints: Overlapped; a minimum of 18 inches.

3.03 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sand bags or other means approved by Engineer.

3.04 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.05 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way that will completely envelope granular drain gravel to be placed with specified overlap at joints. Overlap geotextile in direction of flow.

B. After granular drain gravel is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying Structural Fill is placed.

3.06 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

END OF SECTION

SECTION 02375
UNDERDRAIN SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the material and work necessary for installation of the underdrain systems.

1.02 REFERENCES

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only:

1. American Association of Highway and Traffic Organizations (AASHTO): AASHTO M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
2. American Society for Testing and Materials (ASTM):
   a. F449, Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing and Agricultural Drainage of Water Table Control.
   b. F405, Specification for Corrugated Polyethylene Tubing and Fittings.

1.03 SUBMITTALS

A. The following shall be submitted to the Engineer for approval.

1. Certificate of compliance of underdrain line with the requirements specified, prior to delivery.
2. Certificate of compliance of underdrain line fittings with the requirements specified, prior to delivery.

PART 2 PRODUCTS

2.01 PERFORATED UNDERDRAIN PIPING

A. The perforated underdrain pipe used for the underdrain piping will be four-inch diameter corrugated perforated HDPE pipe as manufactured by Advanced Drainage Systems (N-12LF), pipe or approval equal. The underdrain piping shall meet USDA Soil Conservation's Service Engineering Standard Code Material Specification 606 for subsurface drains and conform to ANSI/ASTM F405.

B. The perforated polyethylene piping shall have a water inlet area of at least 1.0 square inch per foot of tubing length. The inlets shall be slot perforations approximately equally spaced along the length and circumference of the tubing in not less than three rows. Slotted perforations shall be no wider than

1/8 inch or longer than 1 1/4 inches and located in the middle of the corrugations so there is a shoulder on each side of the slot. The dimensions of the water inlet area shall be measured on a straight specimen with no external forces applied. All measurements shall be made with instruments accurate to 0.01 inch. Minimum pipe stiffness shall be 86 psi, tested per ASTM method D2412.

2.02 PERFORATED UNDERDRAIN LINE FITTINGS

A. All underdrain line fittings, including elbows, tees, branch connections, snap end caps, and reducing couplers, shall be polyethylene drainage fittings conforming to ANSI/ASTM F405. Fittings installed shall be the clamp type rather than the snap type.

2.03 NON-PERFORATED HDPE PIPE AND FITTINGS

A. The solid wall portion of the underdrain piping shall be four-inch diameter corrugated HDPE pipe as manufactured by Advanced Drainage Systems (N-12LF) or approval equal. Contractor is required to provide all fittings and make all field adjustments as required for installation and connection of the underdrain pipes and terrace underdrain pipes by these plans in accordance with and as recommended by the pipe manufacturer. Pipe couplings shall be split couplings with corrugations each side of pipe joint as shown on the Plans and recommended by the manufacturer. underdrain coupling shall be jointed with polyethylene or polypropylene ties (two ties per coupling) and wrapped with polypropylene geotextile. Two ties shall be used for securing filter fabric at pipe joint.

2.04 DRAINAGE LAYER MATERIAL

A. Drain gravel as specified in Section 401S, Structural Excavation and Backfill.

PART 3 EXECUTION

3.01 UNDERDRAIN LINE FITTING INSTALLATION

A. Use standard fitting specified under Paragraph 2.02 Perforated Underdrain Line Fittings, to complete connections where required and in conformance with ANSI/ASTM F449. For nonstandard connections, join underdrain lines using manufacturer’s recommended methods to complete the connection.

3.02 UNDERDRAIN PIPE BACKFILL

A. Place underdrain pipe with the drainage layer material specified in Paragraph 2.04 before placing structural backfill over the pipe envelope. Underdrain line backfill shall be placed in such a manner that displacement of the underdrain line will not occur and that the filter after backfilling shall meet the requirements of these Specifications. It is especially important that the first lift of backfill be placed with a minimum of disturbance of the underdrain

line. The first lift of backfill material shall be placed immediately following the placement of the underdrain line, drain gravel, and filtration geotextile. The remaining backfill shall be placed as soon as practical. In no event shall it be left open overnight.

END OF SECTION

SECTION 02821

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 REFERENCES

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

1. ASTM International (ASTM):
   - a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   - b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   - c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   - d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   - e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   - f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   - g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   - h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   - i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   - j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   - k. C150, Standard Specification for Portland Cement.
   - l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   - m. F552, Standard Terminology Relating to Chain Link Fencing.
   - n. F567, Standard Practice for Installation of Chain-Link Fence.
   - o. F626, Standard Specification for Fence Fittings.
   - p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   - q. F900, Standard Specification for Industrial and Commercial Swing Gates.
   - r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
   - s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
   - t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
w. F1379, Standard Terminology Relating to Barbed Tape.
x. F1911, Standard Practice for Installation of Barbed Tape.
y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.2 DEFINITIONS

A. Terms as defined in ASTM F552.

1.3 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:
a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
1) Fence, gate posts, rails, and fittings.
2) Chain link fabric.
3) Gates and hardware.
4) Accessories: Barbed wire.
2. Samples:
a. Chain Link Fabric: Approximately 6 inches square.
b. Posts, Rails, Braces, Wire, and Ties: Approximately 6 inches long.
c. Fittings: 1 each.
3. Test Reports: Field test result for compliance of installation of chain link fence, gates, and gate operators.

B. Informational Submittals:
1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.2 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 2, 2.0 ounces per square foot; galvanized after weaving.

B. Aluminum-coated fabric conforming to ASTM A491, Type I, 0.4 ounce per square foot may be substituted for galvanized fabric.

C. Aluminum-alloy fabric conforming to ASTM F1183, with mill finish, may be substituted for galvanized fabric.

D. Height: 96inches, unless otherwise shown.

E. Core Wire Gauge: No. 9.

F. Pattern:2-inch diamond-mesh.

G. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.

H. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.

I. Wires of Twisted Selvages:
   1. Twisted in a closed helix three full turns.
   2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.3 POSTS

A. General:
   1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section.
   2. Round Steel Pipe, Schedule 40: ASTM F1083.
   3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.

4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.

5. Protective Coatings:
   a. Zinc Coating: ASTM F1043, Type A external and internal coating.

6. Color Coating: ASTM F1043, minimum 10 mils thickness over zinc coating to match color of chain link fabric.

B. Line Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.375 inches.
      b. Weight: 3.65pounds per foot.
   2. Roll-Formed Steel C Shape:
      a. Outside Dimensions: 2.25 inches by 1.625 inches. Weight: 2.70] pounds per foot.

   3. Steel H-Section:
      a. Outside Dimensions: 2.25 inches by 1.70 inches.
      b. Weight: 3.26 pounds per foot.

C. End, Corner, Angle, and Pull Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.875 inches.
      b. Weight: 5.79 pounds per foot.

   2. Roll-Formed Steel Shape:
      a. Outside Dimensions: 3.5 inches by 3.5 inches.
      b. Weight: 5.10 pounds per foot.

D. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

E. Posts for Swing Gates 8 Feet High and Under:
   1. ASTM F900.
   2. Round Steel Pipe:
      a. Outside Diameter: 4 inches.
      b. Weight: 6.56 pounds per foot.

F. Posts for Swing Gates Over 8 Feet High: As recommended by fence manufacturer.

2.4 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:
   1. ASTM F1083.

2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Color Coating: ASTM F1043, minimum 10-mil thickness over zinc coating to match color of chain link fabric.

D. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.

2.5 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.Tension Bars:
1. One-piece .
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

D. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

E. Tie Wires, Clips, and Fasteners: According to ASTM F626.

F. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with V-shaped arms for supporting six strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.6 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade:

B. Aluminum-Coated Steel Barbed Wire: ASTM A121, Type I.

1. Line Wire: Two strands of No. 12-1/2 gauge.
2. Barbs:
   a. Number of Points: Four.
   b. Length: 3/8 inch minimum.
   c. Shape: Round.
   d. Diameter: No. 14 gauge.
   e. Spacing: 5 inches.

2.7 GATES

A. General:
   1. Gate Operation: Opened and closed easily by one person.
   2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
   3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
   4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
   5. Gate Fabric Height: Same as for adjacent fence height.
   6. Welded Steel Joints: Paint with zinc-based paint.
   7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
   8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
   9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for single and or double swing gate types.
   1. Leaf Width: As shown.
   2. Hinges: Offset type, malleable iron.
      a. Furnished with large bearing surfaces for clamping in position.
      b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
   3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
   4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
   5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.
   6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.

2.8 CONCRETE

A. Provide as specified in Section 403S, Concrete for Structures.

2.9 FENCE GROUNDING

A. Conductors: Bare, solid wire for 6 AWG and smaller; stranded wire for 4 AWG and larger.
   1. Material above Finished Grade: Copper.
   2. Material on or below Finished Grade: Copper.

3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.
1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.1 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.
1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.
2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.2 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 102S, Clearing and Grubbing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Embedment Coating: Coat portion of galvanized or aluminum-coated steel posts that will be embedded in concrete as specified in Section 09900, Painting and Coating. Extend coating 1 inch above top of concrete.

3.3 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:
   1. Minimum 3 feet below finished grade.
   2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.4 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.
   1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.5 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.6 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.7 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.8 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

E. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.
   1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.9 BARBED WIRE

A. Install barbed wire uniformly in configurations of six strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.10 GATES

A. Install gates according to manufacturer’s written instructions, level, plumb, and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.11 ELECTRICAL GROUNDING

A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.12 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:
   1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
   2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
   3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.13 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

SECTION 03315 PRESTRESSED CONCRETE TANK

PART 1 GENERAL

1.01 REFERENCES

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

1. American Concrete Institute (ACI):
   a. 305R, Hot Weather Concreting.
   b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   c. 372R, Design and Construction of Circular Wire and strand Wrapped Prestressed Concrete Structures.
   d. b. 506R, Guide to Shotcrete.
   e. c. 506.2, Specification for Shotcrete.

2. ASTM International (ASTM):
   a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   c. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   d. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   e. A1008, Standard Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled.
   f. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   g. C920, Standard Specification for Elastomeric Joint Sealants.
   h. D1056, Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
   i. D1752, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

3. American Water Works Association (AWWA), D110, Wire and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
4. International Code Council (ICC): International Building Code (IBC).
5. ASCE Standard 7 Minimum Design Loads for Buildings and Other Structures.

1.02 DEFINITIONS

A. Prestressed Tank System: Consists of a cast-in-place concrete floor slab, a core wall, and dome roof.

B. Shotcrete: Mortar projected jet directly upon intended surface.

1.03 DESIGN REQUIREMENTS

A. Obtain services of a qualified design engineer, as defined in Article QUALITY ASSURANCE, to design Prestressed Tank System conforming to attributes specified in this section.

B. Floor Slab: Cast-in-place concrete, minimum 6-inches thick with minimum reinforcing in slab equals 0.005 times concrete section.

C. Roof: Cast-in-place or precast concrete dome with minimum thickness of 4 inches and minimum reinforcing of 0.005 times concrete section.

D. Walls: Precast concrete core wall with steel diaphragm, vertical joint seals, and shotcrete coverings. Walls placed on elastomeric bearing pads, free to move radially, and plastic water stop connection between wall and footing. Satisfy allowable stress requirements when calculating wall thicknesses.

E. Openings and Penetrations: Except for the openings shown on the Drawings, other openings or penetrations through wall not permitted.

F. Design Loads and Foundation Criteria:

1. Storage Capacity: 4.0 million gallons.
2. Roof Live Load: 20 psf for dome roof.
3. Wind Load: in accordance with IBC Section 1609, with basic wind speed (3 second gust) of 90 mph, exposure C, and Wind Importance Factor Iw = 1.15.
4. Winter Temperature: Water 50 degrees F, and outside air 32 degrees F.
5. Summer Temperature: Water 60 degrees F, and outside air 100 degrees F.
6. Differential Drying Allowance: 10 degrees F shall be additive to temperature differential during winter.
7. Liquid Unit Weight: 62.4 pcf.
8. Design Overflow Rate for Overflow Weir: 5000 gpm.
9. Design Draw-down Rate for Vents: 63,000 gpm.
10. Maximum Foundation Bearing Pressure: 3,000 psf (bearing pressure includes weight of water).
11. Maximum Differential Settlement: 1/2 inch.
12. Seismic Zone Forces: In accordance with IBC, Section 1615, with foundation soils classified as Class C.

1.04 SUBMITTALS

A. Shop Drawings:

1. Design Data:
   a. Proposed details, concepts, stress calculations, and overflow pipe opening for prestressed tank walls.
   b. For design loads and foundation criteria, show calculations and details based on the seismic zone forces.
   c. Details for sealing vertical joints of steel diaphragm shell.
   d. Details of prestressed tank accessories.
   e. Calculations stamped by professional engineer registered in Texas.
   f. Design drawings stamped by a professional engineer registered in Texas.

      1) Curing methods for dome concrete.
      2) Description of construction method and materials.

B. B. Samples: Vertical joint of steel diaphragm shell to show evidence of satisfactory seal.

C. C. Information Submittals:

1. Manufacturer's Certificate of Compliance:
   a. Shotcrete sand.
   b. Concrete and shotcrete admixtures do not contain chlorides or other corrosive chemicals.

2. Manufacturer's Certificate of Proper Installation.
3. Statements of Qualification:
   a. Registered professional engineer.
   b. Prestressed tank installer.
4. Written Test Reports of Each Test and Inspection:
   a. Shotcrete.
   b. Test reports for prestressing steel components.
   c. Mill test data for circumferential prestressing material regardless of manufacture. Include chemical composition, physical properties, and dimensions of steel. Mill test data for at least three samples of final prestressing material taken from material delivered to site. Identify each roll that Samples were taken from. Identify packages or rolls of prestressing material with mill and heat number.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Qualified Design Engineer: Registered in Texas.
2. Prestressed Tank Installer:
   a. Company specializing in design and construction of prestressed tanks. Minimum 10 years' experience on tanks of similar size and type required for Project. Company has designed and built in its name or under one of its divisions no less than 20 AWWA D110 Prestressed Concrete Tanks with a Type III core wall now in use and are giving satisfactory service. Tanks shall have been constructed within the last 10 years. Include name and address of owners.
   b. All tank contractors are required to be prequalified. The bidder is required to state in his bid the name of the prequalified tank contractor that will be used on the Project.
   c. DN Tanks, Inc., Delaware (Natgun Corporation, Massachusetts, and DYK Incorporated, California, Divisions of DN Tanks) and Preload, LLC, Louisville, KY, are prequalified for precast, wire-wound prestressed, concrete tank construction. Additional tank contractors seeking prequalification shall make a complete submittal to the ENGINEER for review and approval no later than ten (10) days prior to the date set for receipt of bid. The submittal shall include detailed design drawings and calculations meeting the requirements of these specifications, and the company's record of previous experience in the design and construction of circular precast, wire-wound prestressed concrete tanks constructed in their own name, conforming to AWWA D110 Type III. Within five (5) days prior to the date of receiving bids, the ENGINEER will publish a list of additional prequalified tank contractors.
   d. Experience in the design and construction of AWWA D110 Type I, Type II, or Type IV tanks is not acceptable.
   e. All tank manufacturers not prequalified in accordance with Paragraph 1.5 will be rejected.
   f. The Tank Contractor shall have in its employ a design professional with a minimum of 10 years experience.

B. Shotcrete Panel Mockups:

1. When not using automated equipment, assemble test panel at least 30 inches by 30 inches for each mix being considered.
2. Assemble test panels to same thickness as structure, but not less than 3 inches.
3. Take minimum three cubes or cores from panels for strength testing of shotcrete.
4. Cut or broken surfaces shall be dense and free from laminations and sand pockets.

5. Retain and maintain test panels during construction to establish standards by which completed shotcrete Work will be judged.
6. Independent Testing Laboratory Services will:
   a. Test proposed materials, including water.
   b. Test proposed mix proportions.
   c. Test specimens.
   d. Secure production samples of materials at plants or stockpiles during construction and test.
   e. Test strength of shotcrete as Work progresses.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Materials delivered prior to time required, store in a dry, ventilated building, heat if necessary to prevent accumulation of moisture on materials or in wrapping. Do not store on ground or expose to weather.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Delay Work under the following conditions:

1. During high winds causing sand to separate at the nozzle.
2. When weather approaches freezing defined as below 40 degrees F when temperature is falling, or until temperature is 35 degrees F when temperature is rising.
3. During rains of high intensity to wash cement out of fresh material.

B. Cold Weather: Take precautions to avoid low temperatures detrimental to epoxy grout or the ability to pump. If grouting procedure cannot be postponed, keep wall temperatures within the required temperature range.

C. Hot Weather: When temperatures exceed 90 degrees F, obtain approval for method used to protect shotcrete from excessive heat and drying. Hot weather shotcreting shall be in accordance with ACI 305R.

D. Do not expose circumferential prestressing on walls to weather for more than 72 hours. Exercise precautions during adverse weather conditions.

1.08 SPECIAL GUARANTEE

A. The tank manufacturer shall supply a special guarantee that the circumferential prestressing and shotcrete are free from defects in workmanship and materials for a period of 5 (five) years after substantial completion of the Project. If within 5 (five) years, workmanship or materials are proved defective, the tank contractor shall repair such defects at his own expense.

PART 2 PRODUCTS

2.01 CONCRETE

A. In accordance with City Standard Technical Specifications Series 400, except that a 3/8-inch maximum size aggregate may be used for dome concrete if designed for strength and maximum density.

B. Minimum Design Strengths:

1. Dome Roof: 4,000 psi at 28 days.
2. Core Wall: 4,000 psi at 28 days.
3. Floor Slab: 4,000 psi at 28 days.

C. Admixtures: As specified in City Standard Technical Specifications Series 400.

2.02 SHOTCRETE

A. Fine Aggregates (Sand):

1. Saturated, surface dry, hard, dense, uncoated rock fragments free from injurious amounts of foreign or deleterious substances as specified in City Standard Technical Specifications Series 400.
2. Fineness Modulus for Sand: Range from 2.40 to 2.75 with maximum particle size of 1/4 inch.
3. Maintain sand at 3 to 6 percent moisture content; dampen or dry with sand dryers if necessary.
4. Gradation:
   Sieve Size Percent Passing by Weight
   3/8 inch 100 No. 4 97 - 100 No. 8 90 - 98
   No. 16 70 - 85 No. 30 35 - 55 No. 50 12 - 25
   No. 100 2 -8

B. Screen sand for finish coat to produce uniform dense surface in texture and appearance.

C. Water and Cement: As specified in City Standard Technical Specifications Series 400.

D. D. Admixtures: As specified in City Standard Technical Specifications Series 400.

E. E. Minimum design strength 4,000 psi at 28 days.

2.03 MORTAR FILL AND NON-SHRINK GROUT

A. Mortar fill and non-shrink grout shall have a minimum compressive strength of 4,000 psi at twenty-eight days, have a maximum water to cement ratio of 0.42 and meet all requirements for concrete contained in this specification.

B. Portland cement grout will not be accepted.

2.04 ELASTOMERIC MATERIALS

A. A 9 inch minimum waterstop with centerbulb shall be polyvinyl chloride meeting the requirements of the Corps of Engineers Specification CRD-C 572. Splices shall be made in accordance with the Manufacturer's recommendations subject to the approval of the Engineer. Waterstop shall be manufactured by Greenstreak Plastic Products Company, Inc., or equal.

B. Bearing pads shall be natural rubber or neoprene.

1. Natural rubber bearing pads shall contain only virgin natural polyisoprene as the raw polymer and the physical properties shall comply with ASTM D2000 Line Call-Out M 4 AA 414 A1 3.

2. Neoprene bearing pads shall have a hardness of 40 to 50 durometer, a minimum tensile strength of 1,500 psi, a minimum elongation of 500%, and a maximum compressive set of 50%. Pads shall meet the requirements of ASTM D2000 Line Call-Out M 2 BC 410 A1 4 B14 or M 2 BC 414 A14 C12 F17 for 40 durometer material.

C. Sponge filler shall be closed-cell neoprene or rubber conforming to ASTM D1056, Type 2, Class A, and Grade 1 or 3. Compression deflection limited to 25% at 2 to 5 psi.

D. Polysulfide or polyurethane sealant will be a two or three component elastomeric compound meeting the requirements of ASTM C920. Sealants shall have permanent characteristics of bond to metal surfaces, flexibility, and resistance to extrusion due to hydrostatic pressure. Air cured sealants shall not be used.

2.05 WELDED WIRE FABRIC

A. In accordance with ASTM A82 and ASTM A185.

2.06 MILD STEEL REINFORCING

A. Deformed Grade 60 bars with maximum service load design, allowable stress of 18,000 psi in accordance with ASTM A615.

2.07 CIRCUMFERENTIAL PRESTRESSING STEEL

A. High Tensile High Carbon Steel Wire:

1. Diameter Tolerance of Wire: Plus or minus 0.002 inch.
2. Tensile Strength: Minimum 210,000 psi.
3. Yield Strength at 1 Percent Extension: Minimum 170,000 psi.
4. Elongation in 10 Inches at Fracture: Minimum 4 percent.
5. Bending (R equals 5D): Minimum 6 bends per 90 degrees.
6. Meet requirements of ASTM A821.

B. Anchorage: Prestressing manufacturer's standard and capable of safely developing full strength of units, and not susceptible to galvanic action with prestressed steel.

C. Prestressing Steel Requirements:

1. Initial prestress force in circumferential prestressing units after anchoring shall not exceed 70 percent of guaranteed ultimate strength. Coordinate value with tolerance requirements and reflect values in calculations.
2. Final prestress force in circumferential prestressing units, when using nonelectronic or electronic wrapping machine, not capable of close stress tolerance, shall be determined by using stress loss of 25,000 psi for concrete shrinkage, plastic flow, and creep in steel plus 6 percent of initial wire stress system tolerances.
3. Calculate final circumferential prestress force and location on wall. Final prestress force shall provide for minimum residual compression in wall, above that required to resist internal water pressure of 200 psi. Maximum compression in core wall limited to 0.45 times design strength of core wall when using final prestress force after all losses. Maximum initial compression in core wall limited to 0.55 times design strength of core wall. Calculate wall thickness to comply with these requirements and bending requirements.

2.08 STEEL DIAPHRAGM SHELL

A. Tank diaphragm in accordance with ASTM A1008 for Commercial Quality cold-rolled steel sheet. Minimum of 26-gauge sheet and form corrugations of a pattern to form a continuous positive watertight seal and a strong mechanical key between shotcrete and steel. Furnish steel sheets in one continuous length to full height of wall. Vertical joints between sheets.

2.09 SHOTCRETE MIX PROPORTIONS

A. Adjacent to Steel Diaphragm and Over Wires: 1 part cement to 3 parts sand.

B. All Other: 1 part cement to 4 parts sand.

2.10 LADDERS AND HANDRAILS

A. Provide an aluminum exterior ladder as shown on the Drawings and in accordance with Section 05500, METAL FABRICATIONS.

B. Provide aluminum handrail as shown on the Drawings and in accordance with Section 05521, ALUMINUM RAILINGS.

PART 3 EXECUTION

3.01 GENERAL

A. Foundation:

1. Encase tank piping under foundations in concrete.

B. Welded Wire Fabric: Adequately support prior to placement of concrete.

3.02 CORE WALL

A. Do not begin prestressing until core wall has obtained a compressive field strength of 4,000 psi or higher as determined by tests.

3.03 CIRCUMFERENTIAL PRESTRESSING

A. Apply uniformed stressed steel wire to core wall using a wrapping machine to provide the final prestressing force per linear foot of wall height. Electronic servo controlled wrapping systems with automatic electronic recording may be used. Nonelectronic wrapping machines may also be used.

B. Stress Measurement and Recording:

1. Apparatus capable of measuring stress of circumferential prestressing units accurately.
2. Gauges or other stress measuring apparatus calibrated by a recognized gauge manufacturer or testing laboratory on wire samples taken from prestressing steel delivered to site to be used in the Work.
3. Perform calibration work performed within 15 days prior to prestressing.
4. Recalibrate stress measuring apparatus during progress of Work.
5. If stresses measured exceed values specified, discontinue operation and make satisfactory adjustments prior to proceeding with wrapping.
6. Apply additional wire to compensate for understressed wire.
7. Base measurements of wire stress on a continuous sensing of applied force on wire between tensioning drum and wall when, and as, wire is being wrapped and laid on wall.

C. Splicing of Wire:

1. Do not weld splice wire, except when terminating one complete coil or in event of a defect.
2. Join ends of wire with steel sleeves or splicing devices which will develop full strength of wire without slippage or loss of stress.
3. Anchor stressed prestressing steel, or tie off at frequent intervals as stressing proceeds to minimize loss of stress in event of breakage.
4. Remove from Work, coils of prestressing steel which have broken three or more times.
5. Stress prestressing steel only once.

D. Spacing:

1. Space at minimum five wires of 0.162 to 0.192 inch in diameter, per foot of wall height, and maximum 22 wires per foot.
2. Minimum clear spacing between units not less than 1.5 unit diameters or 3/8 inch, whichever is larger.
3. Spread or remove from Work prestressing steel wrapped closer together.
4. Space wire of other diameters.
5. Wires in contact with each other shall be rejected.

3.04 SHOTCRETING OF CIRCUMFERENTIAL PRESTRESSING STEEL

A. In accordance with ACI 506.2 and ACI 506R. Application of dry or wet mix is acceptable.

B. Cover each layer and outer layer of prestressing steel with a coating of shotcrete. Work from bottom to top of wall.

C. Completely embed the prestressing steel without voids. Maintain uniform flow of material from nozzle.

D. Cut out slugs, sand spots, or wet sloughs resulting from nonuniform material flow and repair as Work progresses.

E. Clear rebound away from Work before initial set occurs.

F. Time the intervals between successive applications to allow for initial set to develop. After initial set, stiff broom shotcrete layers receiving another coat to remove laitance and to provide a bond with succeeding applications.

G. Adjust amount of water in shotcrete placed on vertical surfaces. Thickness of shotcrete approximately 3/4 inch.

H. Remove deposits of loose sand before placing succeeding layers of shotcrete. Clear rebound away continuously from the Work, and do not reuse rebounded sand.

I. Slope construction joints or day’s work joints off to thin, clean, and to regular feathered slope edge. Thoroughly clean sloped portion and adjacent shotcrete

with mortar film coating. Wet and scour with air jet, or sandblast with silica sand before placing adjoining Work.

J. Where more than one layer of circumferential prestressing units are required, maintain minimum 1/4-inch cover over each underlayer. Shotcrete cover over outer layer shall be a minimum of 1-inch thickness applied in a minimum of three coats. Provide 1/4-inch minimum cover over prestressing unit for first coat. Apply finish coat approximately 1/4-inch thickness. Layers of shotcrete shall have a nozzle finish.

3.05 FINISHING OF SHOTCRETE

A. Underlayers or Exposed Surfaces:

1. On completing surfaces, bring shotcrete to an even plane and to well-formed corners by working up to ground wires or other thickness or alignment guides, using lower placing velocity than normal.

B. Finish Coat:

1. Apply coat to remove rough areas after ground wires have been removed.
2. Carefully screen sand for finish coat to remove oversize particles which rebound and mar surfaces.
3. Surface of finish coat shall be; of natural texture and coloration; free from spotting, cement or dust streaking, lap lines, uneven surfaces, and rebounded material.
4. Do not hand-patch.
5. Check coatings for bond by tapping lightly to test for hollow sounding spots.
6. Cut out areas where bond is not fully developed and repair.

C. Corrosion Protection:

1. Inspect core wall and patched surfaces.
2. Patch surfaces by building out in uniform circular area level with surface.
3. Sandblast patches and core wall surfaces prior to application of prestressing and shotcrete.

3.06 CURING

A. Dome Concrete:

1. Water cure dome concrete for 7 days by keeping surface continuously wet.
2. Schedule wire wrapping and application of shotcrete so curing shall not be interrupted, and water from curing shall not wash or damage shotcrete wire coats.
3. Begin curing after initial concrete set has occurred.

B. Shotcrete:

1. Keep shotcrete between layers of wire and cover damp by hand watering or fine mist spray.
2. Continuously water cure completed shotcrete surfaces for period of 7 days after application, or until subsequent shotcrete coats are applied prior to end of the 7-day curing period.
3. Remove laitance from wall by light sandblasting or pressure washing after curing period.
4. Do not use curing compounds.

3.07 DECORATIVE COATINGS

A. All exposed concrete shall be given a two-coat finish consisting of one coat of damp-proofing product such as “Tamoseal with AKKRO-71” or equal, and one coat of “Tammscoat” or equal. Work shall be performed by workmen skilled in the application of these types of products. The manufacturer’s application instructions shall be submitted to the ENGINEER for approval. The CONTRACTOR shall confer with the manufacturer’s representatives regarding application techniques and shall follow the manufacturer’s instructions implicitly.

B. The concrete surface to be coated must be clean, free of all laitance, dirt, grease, or other foreign materials. All defective surfaces shall be filled and/or repaired. Application shall be in full accordance with the manufacturer’s instructions or as amended by the ENGINEER.

C. The OWNER shall select the color.

3.08 TESTS

A. Shotcrete Panel Field Tests:

1. When length of core is less than twice diameter, apply correction factors in accordance with ASTM C42 to obtain compressive strength of individual cores.
2. Average compressive strength of three cores taken from test panel equal or exceed 0.85 f’c with no individual core less than 0.75 f’c. Average of three cubes taken from a panel equal or exceed f’c with no individual cube less than 0.88 f’c.
3. Shotcrete will be based on results obtained from cores or sawed cubes.
4. Use of data obtained from impact hammers, ultrasonic equipment, or nondestructive testing devices is not permitted. However, these devices may be used for determining uniformity of shotcrete.
5. Remove and replace shotcrete found not meeting tests, or cut cores and further test shotcrete, or repair and replace as approved by ENGINEER.

B. Perform water leakage test on tank as specified in City Standard Technical Specifications Series 400.

END OF SECTION

SECTION 03600

NONSHRINK GROUTING

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. ASTM International (ASTM):
      a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
      b. C621, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable).
      c. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
      d. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.2 SUBMITTALS

A. Action Submittals:
   1. Product data of grouts.
   2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
   3. Forming method for fluid grout placements.
   4. Curing method for grout.

B. Informational Submittals:
   1. Manufacturer's Written Instructions:
      a. Adding fiber reinforcing to batching.
      b. Cement-water ratio of grout topping.
      c. Mixing of grout.
   2. Manufacturer's proposed training schedule for grout work.
   3. Manufacturer's Certificate of Compliance, in accordance with Section 01740 Common Product Requirements:
      a. Grout free from chlorides and other corrosion-causing chemicals.
      b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
   4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01670, Manufacturers' Field Services and Training.
   5. Statements of Qualification: Nonshrink grout manufacturer's representative.
   6. Test Reports:
      a. Test report for 24-hour evaluation of nonshrink grout.

b. Test results and service report from demonstration and training session.
c. Field test reports and laboratory test results for field-drawn Samples.

1.3 QUALIFICATIONS

A. Nonshrink Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Independent testing laboratory to certify that testing was conducted within last 18 months.

1.4 GUARANTEE

A. Manufacturer's guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.

B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective as a result of faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.1 NONSHRINK GROUT SCHEDULE

A. Furnish nonshrink grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Filling tie holes	I	I	I
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Precast base joints higher than one story	II	II	II
Through-bolt openings	II	II	II
Machine bases 26 hp and up	III	III	III
Baseplates and/or soleplates with vibration, thermal movement, etc.	III	III	III

2.2 NONSHRINK GROUT

A. Category I:
1. Nonmetallic and nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107/C1107M:
   a. Grout shall have flowable consistency.
   b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
   a. BASF Building Systems, Inc., Shakopee, MN; Construction Grout.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Kansas City, KS; 1107 Advantage Grout.
   d. US MIX Co., Denver, CO; US Spec MP Grout.
   e. L & M Construction Chemicals, Inc., Omaha, NE; Duragrout.

B. Category II:
1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. BASF Building Systems, Inc., Shakopee, MN; Master Flow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.

c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
d. Dayton Superior Corp., Kansas City, KS; Sure Grip High Performance Grout.
e. L & M Construction Chemicals, Inc., Omaha, NE; Crystex.

C. Category III:
1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
b. Temperatures of 40 degrees F and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 to 9 yard loads in ready-mix truck.
8. Manufacturer and Product:
a. BASF Building Systems, Inc., Shakopee, MN; EMBECO 885.
b. L & M Construction Chemicals, Inc., Omaha, NE; Ferrogrout.

PART 3 EXECUTION

3.1 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative's training instructions.

B. Form Tie or Through-Bolt Holes: Provide nonshrink grout, Category I and Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in as described in Concrete Forming specifications, and bonding agent in Cast-in-Place Concrete specifications.

C. Grouting Machinery Foundations:
1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material.
2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.
3. Form with watertight forms at least 2 inches higher than bottom of plate.
4. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

3.2 FIELD QUALITY CONTROL

A. Evaluation and Acceptance of Nonshrink Grout:

1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
2. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
3. For large grout applications make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
4. Consistency: As specified in Article Nonshrink Grout. Grout with consistencies outside range requirements shall be rejected.
5. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
6. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
7. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
8. Perform bleeding test to demonstrate grout will not bleed.
9. Store cubes at 70 degrees F.

10. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.

3.3 MANUFACTURER'S SERVICES

A. General:
1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of nonshrink grout.
3. Necessary equipment and materials shall be available for demonstration.

B. Training:
1. Training is required for all Type III grout installations.
2. Grout manufacturer's representative shall train Contractor to perform grout work.
3. Establish location at Site and schedule time for grout manufacturer's demonstration and training session of proposed nonshrink grouts. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and tie holes to provide actual on-the-job training.
4. Use minimum of five bags for each Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Training shall include methods for curing grout.
6. Mix and demonstrate patching through-bolt holes and blockouts for gate guides, and similar items.
7. Transport test cubes to independent test laboratory and obtain test reports.

3.4 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain five bags of each type of grout.

1. From intended grout supplier for Project.
2. Five bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____ No_____
B.	Literature and bag information meet specified requirements?	Yes_____ No_____
C.	Manufacturer guarantees grout as specified in Article Guarantee?	Yes_____ No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____ No_____
E.	Water demands and limits printed on bag?	Yes_____ No_____
F.	Mixing information printed on the bag?	Yes_____ No_____
G.	Temperature restrictions printed on bag?	Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____

2. List expiration date. _____

3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of five bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10 gallon pail.

2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).

3. Use maximum water allowed per water requirements listed in bag instructions.

4. Mix grout to maximum time listed on bag instructions.

5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds.

6. Add water to attain 20 to 30 second flow in accordance with ASTM C939.

7. Record time of grout through cone at new water demand. _____ seconds

8. Record total water needed to attain 20 to 30 second flow. _____ pounds

9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.

2. Place one can of grout in tub of ice water and leave one can at ambient temperature.

3. Cover top of both cans with glass or plastic plate preventing evaporation.

4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.

6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3 gallon cans. Place the cans into the 40-degree F and 100-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4-inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 100 degrees F.

   a. 20 min _____, sec. @ 40 degrees F.

   b. 40 min _____, sec. @ 40 degrees F.

   c. 60 min _____, sec. @ 40 degrees F.

   d. 20 min _____, sec. @ 100 degrees F.

   e. 40 min _____, sec. @ 100 degrees F.

   f. 60 min _____, sec. @ 100 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____
Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

Signature of Independent Testing Laboratory	Date Test Conducted

SECTION 04230

CONCRETE UNIT MASONRY

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. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Miscellaneous masonry accessories.
8. Masonry-cell insulation.

B. Related Sections:

1. Section 07100 "Waterproofing, Damproofing and Water Repellents" for water repellents applied to concrete unit masonry.
2. Section 07620 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.

2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength.

3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties.

2. Cementitious materials. Include brand, type, and name of manufacturer.

3. Pre-blended, dry mortar mixes. Include description of type and proportions of ingredients.

4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.

6. Joint reinforcement.

7. Anchors, ties, and metal accessories.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store pre-blended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1500 psi.

2. Density Classification: Normal weight.

3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Size (Width): Manufactured to the following dimensions:

a. 8 inch nominal; 7 5/8 inch actual.

5. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

6. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

C. Masonry Cement: ASTM C 91.

D. Mortar Cement: ASTM C 1329.

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.

3. White-Mortar Aggregates: Natural white sand or crushed white stone.

4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

F. Aggregate for Grout: ASTM C 404.

G. Cold-Weather Admixture: Non-chloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

H. Water: Potable.

2.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.

2. Exterior Walls: Hot-dip galvanized, carbon steel.

3. Wire Size for Side Rods: 0.148-inch diameter.

4. Wire Size for Cross Rods: 0.148-inch diameter.

5. Wire Size for Veneer Ties: 0.148-inch diameter.

6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.

7. Provide in lengths of not less than 10 feet.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.

2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.

3. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.

4. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.

5. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

6. Stainless-Steel Sheet: ASTM A 666, Type 304.

7. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

8. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel.

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch-diameter, hot-dip galvanized steel wire.

C. Partition Top anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

D. Rigid Anchors: Fabricate from steel bars [1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.6 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

C. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

D. Post-installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 07620 "Sheet Metal Flashing and Trim" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.

2. Copper: ASTM B 370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick or ASTM B 370, Temper H01, high-yield copper sheet, 12-oz./sq. ft. weight or 0.0162 inch thick.

3. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.

4. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.

5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counter-flashing.

6. Fabricate through-wall flashing with drip edge where indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees.

7. Fabricate through-wall flashing with sealant stop where indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

8. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.

9. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees.

10. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.

11. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. or 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

2. Asphalt-Coated Copper Flashing: 5-oz./sq. ft. or 7-oz./sq. ft. copper sheet coated with flexible asphalt. Use only where flashing is fully concealed in masonry.

3. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch.

   a. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

4. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

   a. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch thick.

   b. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of adhesive.

   c. Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches from edge.

      1) Color: Gray.

   d. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

5. EPDM Flashing: Sheet flashing product made from ethylene-propylene-diene terpolymer, complying with ASTM D 4637, 0.040 inch thick.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counter-flashing, use metal flashing.

2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.

3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge, with a sealant stop, or flexible flashing with a metal drip edge, or elastomeric thermoplastic flashing with drip edge, or flexible flashing with a metal sealant stop.

4. Where flashing is fully concealed, use metal flashing or flexible flashing.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

E. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

3. Elastomeric Sealant: ASTM C 920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime, masonry cement, or mortar cement mortar unless otherwise indicated.

3. For exterior masonry, use portland cement-lime, masonry cement, or mortar cement mortar.

4. For reinforced masonry, use portland cement-lime, masonry cement, or mortar cement mortar.

5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Pre-blended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M or Type S.

2. For reinforced masonry, use Type M or Type S.

3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type M or Type S.

4. For interior non-load-bearing partitions, Type O may be used instead of Type N.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.

3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

2. Verify that foundations are within tolerances specified.

3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.

2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns,

and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07800 "Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.

2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.

4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.

2. Allow cleaned surfaces to dry before setting.

3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to one story high, but not more than 20 feet.

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.

2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 2 inches wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install preformed control-joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.

4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.10 FLASHING

A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 07920 "Joint Sealants" for application indicated.

4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 07920 "Joint Sealants" for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.

2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than 60 inches.

3.12 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: Level 1 special inspections according to the "International Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

I. .

3.13 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel un-cleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.

3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.

2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 401S, “Structural Excavation and Backfill."

3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes structural steel.

B. Related Sections:

1.2 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.3 PERFORMANCE REQUIREMENTS

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

C. Qualification Data: For qualified Installer, and fabricator.

D. Welding certificates.

E. Mill test reports for structural steel, including chemical and physical properties.

F. Source quality-control reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 360.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at Project site.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992.

B. Channels, Angles: ASTM A 36.

C. Plate and Bar: ASTM A 36 or Stainless steel Type 304 as indicated in the drawings.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53, Type E or S, Grade B.

F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.

1. Finish: Hot-dip or mechanically deposited zinc coating.

C. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.

1. Finish: Hot-dip zinc coating, ASTM A 153, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

D. Threaded Rods: ASTM A 36.

1. Finish: Plain, Hot-dip zinc coating, ASTM A 153, Class C, or Mechanically deposited zinc coating, ASTM B 695, Class 50.

E. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

2.3 PRIMER

A. Primer: Comply with Division 09 painting Sections.

B.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness

of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION

SECTION 05310

STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Roof deck.

1.2 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Product certificates.

D. Welding certificates.

E. Field quality-control test and inspection reports.

F. Research/Evaluation Reports: For steel deck.

1.3 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.
2. Canam Steel Corp.;The Canam Manac Group.
3. Consolidated Systems, Inc.
4. DACS, Inc.
5. D-Mac Industries Inc.
6. Epic Metals Corporation.
7. Marlyn Steel Decks, Inc.
8. New Millennium Building Systems, LLC.
9. Nucor Corp.; Vulcraft Division.
10. Roof Deck, Inc.
11. United Steel Deck, Inc.
12. Valley Joist; Division of EBSCO Industries, Inc.
13. Verco Manufacturing Co.
14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008, Structural Steel (SS), Grade 33 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: Manufacturer's standard.

2. Galvanized Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33, G60 zinc coating.

3. Deck Profile: As indicated.

4. Profile Depth: As indicated.
5. Design Uncoated-Steel Thickness: As indicated.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, requirements in this Section, and as indicated.

B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

G. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

H. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches.

I. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds/mechanical fasteners not more than 12 inches apart with at least one weld/fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.

J. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.3 REPAIRS

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   k. A276, Standard Specification for Stainless Steel Bars and Shapes.

l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A489, Standard Specification for Carbon Steel Lifting Eyes.
s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
aa. A992/A992M, Standard Specification for Structural Steel Shapes.
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.

ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

9. International Code Council Evaluation Service (ICC-ES):
   a. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   b. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   e. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
10. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910.27, Fixed Ladders.
   b. 29 CFR 1926.105, Safety Nets.
   c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
11. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.2 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Concrete Anchor: Post-installed concrete anchors listed in this specification.

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

D. Exterior Area: Location not protected from weather by building or other enclosed structure.

E. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

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

G. Masonry Anchor: Post-installed masonry anchors listed in this specification.

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

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Metal fabrications, including welding and fastener information.
      b. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.
   2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:
   1. Concrete and Masonry Post-Installed Anchors:
      a. Manufacturer's product description and printed installation instructions.
      b. Current ICC-ES Report for each type of post-installed anchor to be used.
      c. Adhesive Anchor Installer Certification.
   2. U-Channel Concrete Inserts:
      a. Manufacturer's product description.
      b. Allowable load tables.
   3. Ladders: Letter of certification that ladder meets OSHA 29 CFR 1910.27 requirements.
   4. Passivation method for stainless steel members.
   5. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Adhesive Anchor Installer: Trained to install adhesive anchors in accordance with manufacturer's printed installation instructions.
   2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Assemblies, because of necessity, have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

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

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

E. Store adhesives anchors at service temperature ranges recommended by manufacturer.

1.6 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors and floor hatches found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

1.7 EXTRA MATERIALS

A. Delivery: In accordance with Section 01740, Common Product Requirements.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 55, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M

Item	ASTM Reference
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Plates and Structural Shapes	B209 and B308/B308M, Alloy 6061-T6
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.2 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:
1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:
1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
   d. Manufacturer: Sinco Products, Inc., Middletown, CT, (800) 243-6753.
2. Fabricated Steel: ASTM A36/A36M.

2.3 POST-INSTALLED CONCRETE ANCHORS

A. General:
1. AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Current ICC-ES Report indicating acceptance per IBC 2006 and IBC 2009 for anchors at structural applications in cracked concrete.
3. Anchors shall be suitable for long-term loads, as well as for wind and seismic loads.
4. Torque-Controlled Expansion Anchors (Wedge Anchors):
   a. Wedge anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.

b. Manufacturers and Products:
   1) ITW Ramset/Red Head, Addison, IL; Trubolt+ Wedge Anchor (ESR-2427).
   2) Hilti, Inc., Tulsa, OK; Kwik-Bolt–TZ (KB-TZ) Anchors (ESR-1917).
   3) Powers Fasteners, Brewster , NY; Power-Stud +SD2 or +SD1 Anchors (ESR-2502 and ESR-2818).
   4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt Anchors (ESR-1771).
   5) Wej-It Corp., Tulsa, OK; ANKRtite CCAT Wedge Anchor (ESR-2777).

5. Displacement-Controlled Expansion Anchors (Drop-in Anchors):
   a. Self-drilling anchors, snap-off or flush type, zinc-plated.
   b. Nondrilling Anchors: Flush type for use with zinc-plated or stainless steel bolt, or stud type with projecting threaded stud.
   c. Manufacturers and Products:
      1) ITW Ramset/Red Head, Addison, IL; Multi-Set II Drop-In and Self Drill Anchor.
      2) Hilti, Inc., Tulsa, OK; Hilti HDI Drop-In Anchor.
      3) Powers Fasteners, Brewster, NY; Steel Drop-In Anchor.
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Drop-In Anchor.

6. Undercut Anchors:
   a. When used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.
   b. Manufacturers and Products:
      1) USP Structural Connectors, Burnsville, MN; DUC Undercut Anchor (ESR-1970).
      2) Hilti, Inc., Tulsa, OK; HDA Undercut Anchor (ESR-1546).
      3) Powers Fasteners, Brewster, NY; Atomic+ Undercut (ESR-3067).
      4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Torq-Cut (ESR pending).
7. Self-Tapping Concrete Screw Anchors:
   a. When used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.
   b. Manufacturers and Products:
      1) Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
      2) Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
      3) Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
      4) Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
      5) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).
8. Light-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):

a. Manufacturers and Products:
1) ITW Ramset/Red Head, Addison, IL; Dynabolt Hex Nut Sleeve Anchor.
2) Powers Fasteners, Brewster, NY; Lok-Bolt AS.
3) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Sleeve-All Hex Head Anchor.
4) Wej-It Corp., Tulsa, OK; Wej-It Sleeve Anchor.

9. Heavy-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
a. Manufacturers and Products:
1) Powers Fasteners, Brewster, NY; Power-Bolt+ Anchor.
2) Hilti, Inc., Tulsa, OK; HSL-3 Heavy Duty Sleeve Anchor.

B. Adhesive Anchors (Epoxy Anchors):
1. If approved by Engineer, adhesive anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC308 for cracked concrete.
2. Threaded Rod:
a. ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
b. Length as required, to provide minimum depth of embedment.
c. Clean and free of grease, oil, or other deleterious material.
d. For hollow-unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.
3. Adhesive:
a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
c. Mixed Adhesive: Nonsag light paste consistency with ability to remain in 1-inch diameter overhead drilled hole without runout.
d. Meet requirements of ASTM C881/C881M.
4. Packaging and Storage:
a. Disposable, self-contained cartridge system capable of dispensing both components in proper mixing ratio and fitting into manually or pneumatically operated caulking gun.
b. Store adhesive cartridges and adhesive components on pallets or shelving in covered storage area.
c. Container Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
d. Dispose of when:
1) Shelf life has expired.
2) Stored other than in accordance with manufacturer’s instructions.
5. Manufacturers and Products:
a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 SD (ESR-2322).
b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors(ESR-2508).

c. Powers Fasteners, Brewster NY, PE1000+ Adhesive anchoring system (ESR-2583).

C. Adhesive Threaded Inserts:
1. Stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-SD adhesive.

2.4 POST-INSTALLED MASONRY ANCHORS

A. General: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of this section.

B. Current ICC Evaluation Report indicating acceptance per IBC 2006 for anchors at structural applications in masonry.

C. Manufacturers and Products:
1. Hilti, Inc., Tulsa, OK;Kwik-Bolt-3 (KB-3) (ESR-1385), for grout-filled masonry.
2. Powers Fasteners, Brewster NY, T308+ Epoxy Adhesive Anchoring System in Unreinforced Masonry (ESR-3149), Power-Stud+ SD1 (ESR-2966) for grout-filled masonry, Wedgebolt+ (ESR-1678) for grout-filled masonry.

2.5 STUD SHEAR CONNECTORS

A. Headed anchor studs (HAS), or threaded anchor studs (TAS),or stud shear connectors, as indicated on Drawings.
1. Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.
2. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.

B. Manufacturers:
1. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
2. Stud Welding Associates, Inc., Elyria, OH.

2.6 PIPE SLEEVES

A. ASTM A53/A53M, Schedule 40 steel pipe sleeves with continuously welded 3/16-inch-thick seep ring with outside diameter 3 inches greater than sleeve outside diameter. Hot-dip galvanize in accordance with ASTM A123/A123M.

2.7 STEEL LINTELS AND SHELF ANGLES

A. ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

2.8 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.9 U-CHANNEL CONCRETE INSERTS

A. Rolled ASTM A240/A240M, AISI Type 316 stainless steel, 0.105-inch-thick, 1-5/8 inches wide by 1-3/8 inches deep, with stainless steel anchors at 10-inch maximum spacing, styrofoam fillers, and end caps.

B. Nut and Bolt Hardware: Type 316 stainless steel, 5/8-inch minimum diameter, unless indicated otherwise. Manufacturer's standard to match insert.

C. Manufacturers and Products:
   1. Power-Strut, Wayne, MI; PS 349 Series.
   2. B-Line Systems, Inc., Highland, IL; B32 Series.
   3. Halfen Anchoring Systems, Converse, TX; Channel Type 4141HTA.

2.10 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:
   1. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.
   2. Epoxy abrasive shall extend over and form curved front edge of nosing.
   3. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.

C. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.

D. Size: 3 inches wide by 1/4 inch to 3/8 inch thick by length as shown.

E. Color: Selected by Engineer from manufacturer's standard color range.

F. Manufacturers and Products:

   1. Wooster Products, Inc., Wooster, OH; Spectra Type WP3C.
   2. American Safety Tread Co., Inc., Helena, AL; Type FA-311D.

2.11 FLOOR PLATE

A. Material:
   1. Galvanized Steel: Carbon steel, ASTM A786/A786M, commercial grade, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.

2. Stainless Steel: ASTM A793, AISI Type 304.
3. Aluminum: ASTM B632/B632M, Alloy 6061-T6.

B. Minimum Thickness:
1. Steel: 1/4 inch, unless shown otherwise on Drawings.
2. Aluminum: 3/8 inch, unless shown otherwise on Drawings.

C. Surface shall be raised-lug pattern or diamond tread, unless shown otherwise on Drawings.

D. Slip-Resistant Surface:
1. Provide where indicated on Drawings.
2. Manufacturers and Products:
a. IKG/Borden, Clark, NJ; MEBAC 2.
b. W.S. Molnar Co., Detroit, MI; SLIPNOT Grade 2–Medium.

2.12 EXTRUDED FLOOR PLATE

A. Extruded Deck Plate:

1. Minimum Section Height: As shown on Drawings.
2. Minimum Section Width: 12 inches.
3. Accessories: Dovetail interlock strips.
4. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

B. Extruded Tread Plate:
1. Minimum Section Height: 0.360 inch, plus serrations.
2. Section Width: 12 inches.
3. Accessories: Edgebands, tongue-and-groove attachment.
4. Manufacturer and Product: Alcoa Building Products, Inc., Sidney, OH; Standard Diamondback.

2.13 SIDEWALK DOORS

A. Load Capacity: 300 psf with maximum deflection of 1/150th of span. Provide H-20 wheel loading capacity where indicated on Drawings.

B. Component Fabrication:
1. Access Door Leaf(s): 1/4-inch aluminum diamond pattern plate. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.
2. Channel Frame: 1/4-inch-thick extruded aluminum trough frame with continuous anchor flange around perimeter. Weld 1-1/2-inch diameter drain coupling, and drain pipe, to frame trough at front right corner, unless indicated otherwise on Drawings.

C. Door Hardware:

1. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
2. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
3. Hold-Open Arm:
   a. Locks automatically in open position.
   b. Disengages with slight pull on vinyl grip with one hand.
   c. Door can be easily closed with one hand by pulling forward and down on vinyl grip.
4. Snap Lock:
   a. Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
   b. Threaded plug for flush outside surface with key wrench removed.

D. Aluminum shall be mill finished with protective coating applied to surfaces to be in contact with concrete, as specified in Section 09900, Painting and Coating.

E. Manufacturers and Products:
1. Bilco Co., New Haven, CT; J Series.
2. Nystrom Products Co., Minneapolis, MN; FG Series.
3. U.S.F. Fabrication, Hialeah, FL; T Series.
4. ITT Flygt Corporation, Trumbull, CT; FDRN Series.
5. Thompson Fabricating Co., Birmingham, AL; TE Series.
6. Halliday Products, Orlando, FL; WS Series.

2.14 LADDERS

A. Fabricate ladders with rails, rungs, landings, and cages to meet applicable requirements of OSHA, CFR Part 1910.27, and ALI A14.3.
1. Concentrated load of 200 pounds loads imposed by persons occupying ladder shall be considered to be concentrated at such points as will cause maximum stress in structural member being considered.
2. Weight of ladder and attached appurtenances together with live load shall be considered in design of rails and fastenings.
3. Self-closing gates at landings.

B. Aluminum Flat Bar Ladder:
1. Punch rails, pass rungs through rails, and weld on outside.
2. Weld brackets to ladder for fastening ladder to wall.

C. Aluminum Pre-engineered Pipe Ladder:
1. Rungs:
   a. Aluminum extrusions of Alloy 6063-T6.
   b. Nonslip grip surface, 1-inch wide flat top, and semicircular bottom with mill finish.
   c. Diamondback, finish to match rails, as manufactured by Alcoa Building Products, Inc., Sidney, OH.

2. Side Rails: ASTM B429/B429M, Alloy 6063-T6, 1-1/2 inches, Schedule 40 pipe with anodized finish, AA M32-C22-A41.
3. Ladder Attachments and Cage Assembly Fasteners: Stainless steel.
4. Welded, pop riveted, or glued construction is not acceptable.
5. Fabricate to longest length as practical but not to exceed 24 feet.
6. Furnish support attachments to side rails at 6 feet maximum spacing.
7. Manufacturer: Thompson Fabricating Co. Inc., Tarrant, AL.

D. Ladder Safety Post:
1. Telescoping tubular, spring balanced and automatically locking in raised position, with release lever for unlocking.
2. Post: Stainless steel, AISI Type 316.
3. Spring Mechanism: Stainless steel.
4. Furnish dissimilar metal protective coatings at connections.
5. Manufacturer and Product: Bilco Co., New Haven, CT; “Ladder Up” to fit ladder rungs.

2.15 SAFETY CLIMB DEVICE

A. General:
1. Conforms to ALI A14.3 and OSHA CFR Part 1910.27.
2. Belt and harness shall withstand minimum drop test of 250 pounds in 6-foot free fall.
3. Fall Prevention System Material: Stainless steel, AISI Type 316.

B. Components and Accessories:
1. Main Components: Sleeve or trolley, safety harness, and carrier or climbing rail.
2. Ladder rung clamps with stainless steel, AISI Type 316, mounting brackets and hardware.
3. Removable extension kit with tiedown rod or trolley gate, mandrel, and carrier rail for ladders under manholes and hatches.
4. One (1) North/Miller Saf-T-Grip Sleeve PN: 602-100-003.
5. Harnesses
   a. Comfort Fit Saf-T-Climb Harness - Medium size – PN: 733-201-001.
   b. Comfort Fit Saf-T-Climb Harness - Large size – PN: 733-201-002.
   c. Comfort Fit Saf-T-Climb Harness - X-Large size – PN: 733-201-002.

C. Manufacturers and Products:
1. SAF-T-Climb by North.

2.16 HOIST DAVIT ARM SYSTEM

Provide the Following:

A. One (1) lower mast (PN: DH – 22/45), 45” tall.

B. One (1) upper mast (PN: DH – 23), with 48” horizontal reach.

C. One (1) 8442 man-rated Winch with sufficient wire rope to reached the bottom of the tank and the bottom of the exterior ladder,(PN: 8442SS/65) = 65ft of stainless steel rope.

D. One (1) Mighty EVAC self retracting lifeline (SRL) with enough rope to reach the bottom of ladders (PN: MR50SB/50ft) = 50ft of stainless steel rope.

E. Two (2) Miller hoist/Winch mounting brackets (PN: DH – 19 – Miller) allows winches to mate with tubing of Davit Arm System.

F. One (1) base for the Miller dura–hoist to mounted to the upper landing and within 48” of center of hatch.

2.17 LADDER CLIMB PREVENTION SHIELD

A. Eight feet long with angled sides to within 2 inches of wall when closed.

B. Furnish dissimilar metals protective coatings at bolted connections.

C. Manufacturer and Product: North Safety Products, Specialty Products Division, Toronto, Ontario, Canada; Ladder Gate 770-000-001.

2.18 FALL ARREST ANCHORS

A. General:
   1. Conforms to OSHA CFR Part 1926.502.
   2. Minimum Breaking Strength: 5,000 pounds.
   3. Material: Stainless steel, AISI Type 304.

B. Components and Accessories:
   1. Forged combination eye and base assembly with headed anchor bolt, backer plate lock washer, and nut.
   2. Suitable for embedment in concrete wall or slab.

C. Manufacturers and Products:
   1. Thaler Metal Industries, Buffalo, NY; FARA Wall Anchor.
   2. Rose Manufacturing Company, Pittsburgh, PA; Anchorage Connector.

2.19 ALTERNATING STAIR TREADS

A. Material:
   1. Landings, Treads, and Foot Castings: Cast aluminum alloy F356F.
   2. Handrails: Aluminum alloy 6063-T4, 1-1/2-inch by 1/8-inch tube.
   3. Central Stringer: Aluminum alloy 6063-T52, 1-3/4-inch by 4-inch by 1/8-inch tube with rubber bumper strip.

B. Treads: Skid-resistant with upturned integrally cast skid barriers.

C. Risers: Equally spaced to within 3/16 inch for adjacent risers and to within 3/8 inch for nonadjacent risers.

D. Handrails: Contoured for body guidance and underarm support, with supports positioned to allow free sliding of hands along rails.

E. Foot Divider: Cast aluminum integral part of landing, which provides support for rubber bumper strip attached to central stringer.

F. Stair Angle: 68 degrees from horizontal.

G. Vertical Drop: As shown on Drawings.

H. Finish: Natural aluminum finish.

I. Manufacturer and Product: Lapeyre Stair, Inc., Harahan, LA; 68-Degree Alternating Tread Aluminum Stair.

2.20 FABRICATION – BIRD SCREENS

A. Bird screen panels and doors shall be McNichols ¾ inch stainless steel .105 gage intercrimp, woven mesh with M-2 style hook strip frame and mounting hardware as required for the installation and as shown on the Drawings.

2.21 FABRICATED UNITS

A. Shell Manhole:
   1. Flanged and bolted type with confined rubber gasket.
   2. Manhole Unit: Capable of withstanding pressure of full tank of water with no leakage.
   3. Minimum clear opening of 24 inches.
   4. Cover: Hinged to tank.
   5. Grind welds and sheared edges smooth.

B. Overflow Pipe and Accessories:
   1. Use steel pipe and fabricate flared section at top of overflow of steel plate, weld seams, and grind smooth.
   2. Flange at Base:
      a. Standard 125-pound steel ring flange drilled 125-pound ANSI Standard.
      b. Flange: Parallel to upper edge of fitting so lip can be installed in horizontal plane with pipe vertical.
      c. Grind upper lip smooth.
   3. Fabricate supporting brackets of structural shapes and flat bar stock, as shown.
   4. Bolts: Hot-dip galvanized steel machine bolts with hexagon nuts in accordance with ASTM A153/A153M.
   5. Hot-dip galvanize assembly after fabrication in accordance with ASTM A123/A123M.

6. Coat interior with coal-tar enamel as specified in Section 09900, Painting and Coating.

C. Float Pipe:
1. Standard weight steel pipe.
2. Furnish flanges of 1/2-inch steel plate for mid-height connection.
3. Furnish steel angle braces and all accessories.
4. Hot-dip galvanize float pipe after fabrication in accordance with ASTM A123/A123M.

D. Vortex Breaker: Use aluminum shapes and plate.
1. Plate Pattern: Approved nonslip pattern.
2. Supporting Frame: Aluminum, furnished with anchors for embedment in concrete.
3. Make connections with welds, bolts, or machine screws.
4. Grind smooth sheared edges of structural shapes and plates.
5. Hardware: Aluminum.
6. Apply protective coating of bituminous paint to aluminum surfaces in contact with concrete.

E. T-Handled Operating Wrenches: Galvanized operating wrenches, 4-foot total length, No. A-2461 as manufactured by Mueller.

F. Valve Operator Access Box: Cast iron, 8 inches by 4 inches, as manufactured by Zurn; No. ZN-1930-K.

G. Wire Mesh Screen:
1. Fabricate frame of aluminum shapes and flat bar stock.
2. Wire Mesh: Woven of 14-gauge aluminum wire, three openings per inch, stretched taut over frame before bolts are tightened down.

2.22 CASTINGS

A. Frame and Cover for Electrical Manholes and Handholes: Olympic Foundry.

B. Floor Boxes:
1. Cast iron, except as otherwise shown.
2. Depth: Equal to slab thickness where installed.
3. Diameter: As shown.
4. Manufacturers and Products:
   a. Neenah Foundry, Neenah, WI; R 7506.
   b. Mueller, Decatur, IL; No. A-27010.
   c. Olympic Foundry Co., Seattle, WA; No. 5680.

2.23 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

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

B. Neoprene Gasket:
1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

2.24 FABRICATION

A. General:
1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:
1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:
1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer’s instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09900, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:
1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for intended use. Cover full bearing surfaces.

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

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

2.25 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.
1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.1 INSTALLATION OF METAL FABRICATIONS

A. General:
1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

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

C. Pipe Sleeves:
1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on Drawings.

3.2 CAST-IN-PLACE ANCHOR BOLTS

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

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

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

3.3 CONCRETE AND MASONRY POST-INSTALLED ANCHORS

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

B. Install in accordance with manufacturer's instructions.

C. Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Minimum Embedment (Bolt Diameters)	Minimum Edge Distance (Bolt Diameters)	Minimum Spacing (Bolt Diameters)
Expansion	9	6	12
Undercut	9	12	16
Adhesive	9	9	13.5

D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air per manufacturer's printed installation instructions.

E. For undercut anchors, use special undercutting drill bit and rotary hammer drill and apply final torque as recommended by anchor manufacturer.

F. When embedded steel or rebar is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than 10 degrees to clear obstruction, notify Engineer for direction on how to proceed.

G. Adhesive Anchors:
1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F, unless cold temperature adhesives, compliant with ACI 308 are used. Refer to the respective ICC-ES report and manufacturer's printed installation instructions.
2. Remove water from hole with oil-free compressed air. Damp or water filled holes may be allowed only if approved in manufacturer's printed installation instructions and ICC-ES report.
3. For hollow-unit masonry, install screen tube in accordance with manufacturer's printed installation instructions.
4. Do not disturb anchor during recommended curing time.
5. Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

H. Prestressed Concrete: Do not use post-installed anchors in prestressed or post-tensioned concrete members without Engineer's prior approval, unless specifically shown on Drawings. If Engineer approves anchor installation all prestressed tendons in vicinity of anchors must be located prior to drilling.

3.4 U-CHANNEL CONCRETE INSERTS

A. Provide as indicated for pipe supports and where otherwise shown on Drawings.

B. Except for interior dry areas, use plastic clips or similar dielectric material to isolate channel anchors from concrete reinforcing steel.

3.5 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

3.6 ACCESS COVERS

A. Install access covers, including sidewalk doors, floor hatches, and hinged manhole covers in accordance with manufacturer's instructions.

B. Accurately position prior to placing concrete, such that covers are flush with floor surface.

C. Protect from damage resulting from concrete placement. Thoroughly clean exposed surfaces of concrete spillage to obtain a clean, uniform appearance.

D. Route drain pipe to exterior face of concrete or as shown on Drawings.

3.7 SAFETY CLIMB DEVICE SYSTEM

A. Provide for each ladder where unbroken height between levels exceeds 20 feet, or at lesser height where indicated on Drawings.

B. Install in accordance with manufacturer's instructions.

C. Furnish additional accessories required to complete system for each ladder.

D. Furnish harnesses for each ladder equipped with safety climb device.

E. Furnish pivot section at platforms, landings, and roofs.

F. When installed to required height, fall prevention system shall be rigid and an integral part of the structure.

3.8 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:
   1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09900, Painting and Coating, unless indicated otherwise.
   2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
   3. Allow coating to dry before installation of the material.
   4. Protect coated surfaces during installation.
   5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:
   1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
   2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.

3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.9 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09900, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:
1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09900, Painting and Coating.

3.10 FIELD QUALITY CONTROL

A. Owner-Furnished Quality Assurance:
1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings.

B. Contractor-Furnished Quality Control:
1. Inspection and testing required in Section 01400, Quality Control Services.
2. Manufacturer’s Certificate of Compliance per Section 01740, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01740, Common Product Requirements.

C. Concrete and Masonry Drilled Anchors: Special inspection and testing will be provided by Owner where indicated on Drawings.

3.11 MANUFACTURER’S SERVICES

A. Anchor Installation: Conduct site training of installation personnel for proper installation, handling, and storage of mechanical and adhesive anchor systems. Notify Engineer of time and place for sessions.

3.12 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09900, Painting and Coating
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09900, Painting and Coating
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Zinc-plated or stainless steel wedge or expansion anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
4. Anchors in Grout-Filled Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Hot-dip galvanized steel headed anchor bolts, zinc-plated or stainless steel sleeve anchors, or stainless steel adhesive anchors	
5. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Zinc-plated or stainless steel sleeve anchors, or stainless steel adhesive anchors with screen tube	
6. Connections for Structural Steel Framing		

Service Use and Location	Product	Remarks
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
7. Connections for Steel Fabrications and Wood Components		
Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections	
8. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
9. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

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

END OF SECTION

SECTION 05521

ALUMINUM RAILINGS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
   2. American Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
   3. American Iron and Steel Institute (AISI).
   4. ASTM International (ASTM):
      a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
      b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
      c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
      d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
      e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
   5. International Code Council (ICC): International Building Code (IBC).
   6. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.2 DEFINITIONS

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

B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.

C. Special Inspection: As defined by the ICC IBC.

D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.3 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or

allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Top Rail: Capable of withstanding the following load cases applied:
    a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC and OSHA.
    b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
    c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. In-Fill Area of Railing Systems:
    a. Capable of withstanding a horizontally applied normal load of 50 pounds applied to 1 square foot at any point in system including panels, intermediate rails, balusters, and openings and space between railings.
    b. Horizontal concentrated load need not be assumed to act concurrently with loads on top rails of railings.

1.4 SUBMITTALS

A. Action Submittals:
1. Shop Drawings:
    a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
    b. Manufacturer's literature and catalog data of railing and components.
    c. Design Data: Calculations or test data using specified design performance loads and including the following:
        1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
        2) Design of post base connection.
        3) Documentation that concrete anchors have been designed in accordance with one of the following:
            a) ACI 318, Appendix D.
            b) ICC Evaluation Services Report for selected anchor.
2. Samples:
    a. Rail sections, 6 inches long showing each type of proposed connection, proposed finish, and workmanship.
    b. Each fitting including wall brackets, castings, toeboard, and rail expansion joints.

B. Informational Submittals:
1. Manufacturer's assembly and installation instructions.
2. Special Inspection: Manufacturer's instructions for Special Inspection of post-installed anchors.
3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
    a. Test data for railing and components showing load and deflection because of load, in enough detail to prove railing is strong enough and satisfies national, state, local

standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:

1) Railing and post connections.
2) Railing wall connections.
3) Railing expansion joint connections.
4) Railing system gate assembly, including latch, gate stop, and hinges. Both gate latch and stop to support required loads applied independent of each other.
5) [Railing picket panel clamps and connections.]

b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with ICC IBC.

c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.

d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.

4. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.5 QUALITY ASSURANCE

A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.

B. Delivery:

1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
2. Deliver toeboards loose for field assembly.
3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.

1. Temperature Change Range: 70 degrees F, ambient; 110 degrees F, material surfaces.

PART 2 PRODUCTS

2.1 ALUMINUM RAILINGS

A. General:
   1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
   2. Railing systems using pop rivets or glued railing construction are not permitted.
   3. Sand cast accessories and components are not permitted.
   4. Fasteners shall be AISI Type 304 or Type 316 stainless steel, unless otherwise noted.

B. Rails, Posts, and Formed Elbows:
   1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
   2. Tensile Strength: 38,000 psi, minimum.
   3. Yield Strength: 35,000 psi, minimum.
   4. Wall Thickness: 0.145 inch, minimum.
   5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).

C. Accessories:

   1. Fittings and Accessories:
      a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
      b. Gauge metal components are not acceptable for load-resisting components.
      c. Fittings shall match color of pipe in railings.
   2. Miscellaneous Extruded Aluminum Parts: Alloys 6063-T6, 6061-T6, or 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.
   3. Castings for Railings:
      a. Cast Al-mag with sufficient strength to meet load and test requirements.
      b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
   4. Post Anchorages:
      a. Refer to standard details for types of post anchorages and minimum requirements.
      b. Bolts at anchorages shall be minimum 1/2-inch diameter.
   5. Wall Brackets: Adjustable wall fitting, with provision for minimum three 3/8-inch diameter AISI Type 304 or Type 316 stainless steel bolts or concrete anchors.
   6. Rail Terminals (including Wall Returns): Aluminum wall fitting with provision for three 3/8-inch Type 304 fasteners.
   7. Railing System Gate:
      a. Extruded aluminum rail components.
      b. Hardware Manufacturers and Products:
         1) Julius Blum & Co., Inc., Carlstadt, NJ; No. 782/3 gate hinges with springs, and No. 784 gate latch and stop.
         2) CraneVeyor Corp., South El Monte, CA; No. C4370b gate hinges with spring, No. C4369 gate latch, and No. C4368 gate stop.
         3) Moultrie Manufacturing Co., Moultrie, GA; Part No. W60006.

   8. Toeboards:

a. Molded or extruded Alloy 6063-T6 or 6061-T6 aluminum.
b. Provide slotted holes for expansion and contraction where required.

9. Fasteners: Stainless steel.

D. Finishes:
1. Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings and Toeboards: In accordance with AA DAF45, designation AA-M10-C22-A41.

2.2 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:
1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 304 or Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Bolts and Nuts for Bolting Railing to Metal Beams: ASTM A193/A193M and ASTM A194/A194M, Type 304 or Type 316 stainless steel.

C. Concrete Anchors:
1. Stainless steel, AISI Type 304 or Type 316.
2. Post-installed anchors in accordance with Section 05500, Metal Fabrications, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.3 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 6-foot horizontal spacing.
2. Railing Posts Bolted to Metal or Concrete:
a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:
1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:
1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.1 GENERAL

A. Field fabrication of aluminum railing systems is not permitted.

B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.

C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.

D. Modification to supporting structure is not permitted where railing is to be attached.

E. Mount railings only on completed walls. Do not support railings temporarily by means not satisfying structural performance requirements.

F. Protection from Entrapped Water:
   1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
   2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.2 RAILING INSTALLATION

A. Assembly and Installation: Perform in accordance with manufacturer’s written recommendations for installation.

B. Expansion Joints:
   1. Maximum intervals of 54 feet on center and at structural joints.
   2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
   3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
   4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

C. Posts and Rails:
   1. Surface Mounted Posts:
      a. Bolt post baseplate connectors firmly in place.
      b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.
   2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
   3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
   4. Install posts and rails in same plane.
   5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
   6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.

7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

D. Wall Brackets:
   1. Support wall rails on brackets spaced maximum 5 feet on centers as measured on the horizontal projection.
   2. Install wall anchor backplates on solid blocking in stud walls.

E. Toeboard:
   1. Provide at railings, except where 4-inch or higher concrete curbs are installed, at gates, or at stairways unless shown otherwise.
   2. Accurately measure in field for correct length; after railing post installation cut and secure to posts.
   3. Dimension between bottom of toeboard and walking surface not to exceed 1/4 inch.
   4. Install plumb and aligned to within 1/8 inch in 12 feet.

F. Railing System Gate: Install in accordance with manufacturer's installation instructions.

3.3 FIELD FINISHING

A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09900, Painting and Coating.

3.4 FIELD QUALITY CONTROL

A. Post-installed anchors supporting railing systems require special inspection.

B. Owner-Furnished Quality Assurance, in accordance with ICC IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings.

3.5 CLEANING

A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.

B. Do not use acid solution, steel wool, or other harsh abrasive.

C. If stain remains after washing, restore in accordance with railing manufacturer's recommendations or replace stained railings.

END OF SECTION

SECTION 05530

METAL GRATINGS

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
      c. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      d. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
      e. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. National Association of Architectural Metal Manufacturers (NAAMM):
      a. MBG 531, Metal Bar Grating Manual.
      b. MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.2 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
      b. Grating Anchorage: Show details of anchorage to supports to prevent displacement from traffic impact.
      c. Product data for grating, grating clips, anchors, accessories, and other manufactured products specified herein.
      d. Manufacturer’s specifications, including coatings, surface treatment, and finishes.

B. Informational Submittals:
   1. Special handling and storage requirements.
   2. Installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Insofar as is practical, factory assemble items.

B. Package and clearly tag parts and assemblies that are, due to necessity, shipped unassembled.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
   1. Alabama Metal Industries Corporation (AMICO), Birmingham, AL.
   2. IKG Industries, Houston, TX.
   3. Ohio Gratings, Inc., Canton, OH.
   4. Seidelhuber Metal Products, Inc., South San Francisco, CA.

2.2 GRATING MATERIALS

A. Aluminum: Provide alloy and temper as designated below.
   1. Bearing Bars and Banding: ASTM B221 alloy 6061-T6 or 6063-T6.
   2. Swaged Crossbar Rods: ASTM B221 alloy 6061 or 6063, or ASTM B210 alloy 3003.
   3. Finish: Mill.

B. Carbon Steel:
   1. Bearing Bars, Banding, and Rectangular Cross Bars: ASTM A1011/A1011M commercial steel Type II for hot rolled carbon steel sheet and strip, or ASTM A36/A36M.
   2. Cross Bars made from Wire Rods: Not Permitted.
   3. Finish: Galvanized after fabrication.

2.3 METAL BAR GRATING

A. General Requirements:
   1. Maximum Service Load:
      a. Light Duty (Type A): 200 psf uniformly distributed load.
      b. Medium Duty (Type B): 500 psf uniformly distributed load.
   2. Maximum Deflection: Span/240 or 1/4 inch, whichever is less.
   3. Bearing Bar Spacing:
      a. Light Duty: 1-3/16 inch maximum, center-to-center.
      b. Medium Duty: 15/16 inch maximum, center-to-center.

4. Bearing Bars, Cross Bars and Banding: Minimum thickness as specified in NAAMM MBG 531 or as shown on Drawings.

B. Grating Materials:
1. Aluminum, pressure-locked rectangular bar grating fabricated by pressing crossbars between rectangular bearing bars.
2. Galvanized steel pressure-locked rectangular bar grating fabricated by pressing rectangular crossbars into slots in rectangular bearing bars.

C. Surface:
1. Plain.

D. Stair Treads:
1. Material and Type: Same as grating material and grating type as furnished for connecting walkway or work surface.
2. Nosings: Integral ribbing and serrated edge on one long axis of tread, or nonslip abrasive on each tread along one long edge.
3. Carrier Plate or Angle: Furnish at each end for connection to stair stringers.

2.4 ACCESSORIES

A. Embedded Frames:
1. As indicated on Drawings and as specified in Section 05500, Metal Fabrications.

B. Grating Clamps:
1. Use at flanged beam and bolted angle frame supports.
2. Removable from above grating walkway surface.
3. Provide hat bracket, recessed bolt, and bottom clamp of same material as grating.
4. Manufacturers and Products:
   a. Direct Metals Company, LLC, Kennesaw, GA; Grating Clamp.
   b. Grating Fasteners, Inc., Harvey, LA; G-Clip.

C. Anchor Stud and Saddle Clip:
1. Use at embedded angle frame supports with stud anchor and nut recessed below top of grating surface.
2. Removable from above grating walkway surface.
3. Provide Type 316 stainless steel welded threaded stud anchor, nut, washer, and saddle clip.
4. Manufacturers and Products:
   a. Welded Stud Anchor:
      1) Nelson Stud Welding, Inc., Elyria, OH.
      2) Stud Welding Associates, Inc. Elyria, OH.
   b. Saddle Clip:
      1) Direct Metals Company, LLC, Kennesaw, GA; Saddle Clip.
      2) Grating Fasteners, Inc., Harvey, LA; Saddle Clip.

3) Struct-Fast, Inc., Baltimore, MD; Gratefast.

2.5 FABRICATION

A. General:
1. In accordance with NAAMM MBG 531 or NAAMM MBG 532.
2. Do not weld aluminum grating.
3. Conceal fastenings where practical.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Cutouts:
   a. Fabricate in grating sections for penetrations indicated.
   b. Arrange to permit grating removal without disturbing items penetrating grating.
   c. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
6. Do not notch bearing bars at supports to maintain elevation.
7. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
8. Section Length: Sufficient to prevent section from falling through clear opening when oriented in the span direction and one end is touching either the concrete or the vertical leg of grating support.
9. Minimum Bearing: 1 inch for grating depth up to 2-1/4 inches and 2 inches for grating depth greater than 2-1/4 inches.
10. Banding and Toe Plates: Same material as grating and welded to bearing bars in accordance with requirements of NAAMM MBG 531 and NAAMM MBG 532.

B. Metal Bar Grating: A single grating section shall be not less than 1.5 feet or greater than 3 feet in width, or weigh more than 150 pounds.

C. Supports:
1. Same material as grating, except that supports which are to be embedded in concrete shall be Type 316 stainless steel, unless part of an extruded aluminum system.
2. Coordinate dimensions and fabrication with grating to be supported.

PART 3 EXECUTION

3.1 PREPARATION

A. Electrolytic Protection:
1. Protect aluminum surfaces in contact with dissimilar metals, or embedded or in contact with masonry, grout, or concrete as specified in Section 09900, Painting and Coating.
2. Allow paint to dry before installation of material.

3.2 INSTALLATION

A. Until grating sections are securely fastened in place, area shall be appropriately barricaded or flagged to alert people working in the area of potential fall hazard.

B. Install manufactured products in accordance with manufacturer's recommendations.

C. Install supports such that grating sections have a solid bearing on both ends, and that grating sections will not rock or wobble under design loads.

D. Install grating supports plumb and level as applicable.

E. Install sections of welded frames with anchors to straight plane without offsets.

F. Field locate and install fasteners to fit grating layout.

G. Anchor grating securely to supports using minimum of four fastener clips and bolts per grating section.

H. Each grating or plank section shall be easily removable and replaceable.

I. Completed installation shall be rigid and neat in appearance.

J. Protect painted and galvanized surfaces during installation.

K. Repair damaged coatings as specified in Section 09900, Painting and Coating.

END OF SECTION

SECTION 06100 - ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and install all items of rough carpentry work complete as shown on the Drawings and as specified herein.

B. Set in place all pressed metal frames which are to be built into walls. Install pressed metal frames which are to be installed in concrete openings. Install hollow metal doors and finish hardware furnished under other Sections.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. The publications listed below form a part of this Specification to the extend referenced. The publications are referred to in the text by basic designations only.

AMERICA WOOD PRESERVERS ASSOCIATION (AWPA)

B. AWPA P5 Waterborne Preservatives AWWA C507

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

C. NEMA LD3 High-Pressure Decorative Laminates

1.04 – 1.10 (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS - ROUGH CARPENTRY

A. All lumber shall be of sound stock, delivered dry and shall be fully protected at all times from injury and dampness. Split, broken, or otherwise damaged pieces will not be allowed in the work.

B. Wood for blocking and nailers shall be seasoned, 19 percent maximum moisture content, Construction Grade quality and of Douglas Fir; Southern Pine or Ponderosa Pine species.

1. Wood members that will contact masonry or concrete shall be vacuum-pressure treated with 100 percent oxide pure chromated copper arsenate meeting AWPA P-5. Minimum net retention of solid preservative shall be 0.40 lbs/cu ft.
2. All treatment shall be performed in accordance with the requirements of AWPA for treating wood. Apply a heavy coat of the same preservative used in treating to all surfaces cut after treatment.

C. Nails, spikes, bolts, nuts and washers where sizes are not indicated or specified, shall be of suitable size and number as approved to securely fasten and hold members in place. Hot dip galvanize after fabrication.

2.02 – 2.04 (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. All rough carpentry shall be accurately cut, fitted and installed as detailed.

B. Anchors shall be installed, where indicated or required, to anchor carpentry or other items securely to masonry or concrete.

C. Forms for structural concrete work shall be as specified under Division 3. Provide all other miscellaneous wood formwork as may be required for the completion of the work.

D. Temporary wood doors and cloth or transparent plastic covered frames shall be provided for exterior wall openings during winter construction and to protect adjacent occupied, existing or finished spaces.

E. Installation of Hollow Metal Doors and Finish Hardware.

1. Doors and finish hardware will be furnished under Division 8 and shall be installed under the work of this Section, except where specifically designated otherwise herein.
2. As soon as the hardware is delivered to the job site, receive, verify and check each set and report to the Engineer any defect or shortage. Give notice to the hardware supplier for all such items that may be defective or missing. Provide a receipt to the hardware supplier for all such items as are found to be correct.
3. Finish hardware, after checking, shall be the responsibility of the Contractor until it is installed and the project is accepted in its entirety by the Owner.
4. Hardware shall be attached and placed by skilled mechanics in accordance with approved hardware templates provided with the hardware and shall be accurately fitted and adjusted. Lever handles shall be kept covered with heavy cloth and other hardware shall be protected from damage until final acceptance of the entire project by the Owner.
5. Set each edge and joint of threshold in a seal strip of polyurethane sealant. Grout remainder of threshold in mortar.
6. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with type lubrication recommended by manufacturer (graphite-type if no other recommended). Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made.
7. Wherever hardware installation is made more than 1 month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy and make a final check and adjustment of all hardware items in such space or area. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

3.02 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 06100

SECTION 07100 - WATERPROOFING, DAMPPROOFING AND WATER REPELLANTS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all materials, labor, equipment and incidentals required and install waterproofing, dampproofing and water repellants complete as shown on the Drawings, in the application schedule and as specified herein.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. ASTM C366 – Standard Test Methods for Measurement of Thickness of Sandwich Cores.
2. ASTM C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
3. ASTM D412 – Standard Test Methods for Measurement of Thickness of Sandwich cores.
4. ASTM D449 – Standard Specification for Asphalt Used in Damproofing and Waterproofing.
5. ASTM D570 – Standard Test for Water Absorption of Plastics.
6. ASTM D882 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
7. ASTM D903 – Standard Test Method for Peel or Stripping of Adhesive Bonds.
8. ASTM D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
9. ASTM D1876 – Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
10. ASTM D3767 Method A – Standard Practice for Rubber-Measurement of Dimensions.
11. ASTM D3776 – Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
12. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
13. ASTM D5385 – Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes.
14. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.
15. ASTM E154 – Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

B. National Roofing Contractors Association:
1. NRCA – The NRCA Waterproofing and Damproofing Manual.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Waterproofing System: Capable of resisting water head of 231 feet at horizontal applications and 231 feet at vertical applications for blindside (pre-applied) applications and 200 feet at horizontal and 200 feet at vertical applications for positive (post-applied) applications and preventing moisture migration to interior.

B. Damproofing: Factory applied sacrificial coating of clear, unpigmented surface applied coating to provide damproofing properties preventing moisture migration to interior.

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
   1. Rubberized asphalt/polyethylene sheet membrane waterproofing.
   2. Protection boards.
   3. Dampproofing.
   4. Sealants.
   5. Sealant primers.
   6. Backer rods.
   7. Accessories including surface conditioners, adhesives, tape, thinners and cleaners.
   8. Water repellants.

C. Samples
   1. Submit two representative samples of proposed materials required for the work when requested by the Engineer.

1.07 QUALITY ASSURANCE

A. Qualifications:
   1. Membrane Manufacturer: Company specializing in waterproofing sheet membranes with minimum three years documented experience.
   2. Applicator: Company specializing in performing work of this section with minimum three years documented experience approved and certified by the manufacturer.

B. Services of Manufacturer's Representative:
   1. Inspect and provide report of pre-application conditions with corrective items required noted, if any, prior to start of the work.
   2. Inspect work in progress and assist applicator in identifying and correcting deficiencies.
   3. Provide final inspection report with punch list items and corrective measures taken for final acceptance of work.

1.08 DELIVERY, STORAGE AND HANDLING

A. Comply with Manufacturer’s recommendations.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 01600 – Product Requirements.

B. Maintain ambient temperatures above 40 degrees F for 24 hours before and during application and until liquid or mastic accessories have cured and as required by Manufacturer

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty for waterproofing failing to resist penetration of water.

C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Membrane Waterproofing
   1. Post-applied Sheet Waterproofing Membrane "Positive Side" horizontal and vertical applications equal to Bithuthene 3000 by Grace Construction products, a factory made composite product with a thickness of 1.4 mm. It consists of rubberized asphalt and a cross-laminated, high density polyethylene film.
   2. Pre-applied Sheet Waterproofing Membrane for "Blindside" applications equal to Preprufe 160R (vertical) 1.1 mm and Preprufe 300R (horizontal) 1.4 mm membrane by Grace Construction Products. A three layer composite sheet membrane consisting of high density polyethylene film, specially formulated synthetic adhesive and protective coating with compatible seam tape and termination bar; conforming to Manufacturer's criteria.

B. Capillary waterproofing shall be a cementitious capillary acting type that is capable by extensive chemical penetration to produce crystalline growth that closes the natural concrete capillaries, providing dense, in depth protection against moisture, chemical attack, and liquid pressure. Capillary waterproofing shall be Krystol T1 & T2 Waterproofing System by Kryston International, Inc., 1645 East Kent Ave, Vancouver, BC or approved equal.

C. Drainage Panel for vertical application: High impact polystyrene embossed with filter cover sheet, Hydroduct 220 manufactured by W.R. Grace for use in conjunction with Bithuthene products.

D. Seaming Materials: As recommended by membrane manufacturer.

E. Surface Conditioner: Type as recommended by Manufacturer for the application and compatible with membrane.

F. Adhesives: As recommended by membrane manufacturer.

G. Tape: Preprufe Tape and Preprufe CJ Tape.

H. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

I. Sealant: As recommended by membrane manufacturer.

J. Liquid Membrane: As required by manufacturer's standard details.

K. Dampproofing
   1. Troweled dampproofing shall be an asphalt emulsion reinforced with fibers conforming to ASTM D1227, Type II, Class 1. The dampproofing shall be Hydrocide 700 by Sonneborn Building Products, Division of ChemRex Inc., Minneapolis, MN; Karnak 920 Asphalt Emulsion by Karnak Corporation, Clark, NJ or equal.
   2. Brushed dampproofing shall be an asphalt emulsion reinforced with fibers conforming to ASTM D1227, Type II, Class 1. The dampproofing shall be Hydrocide 700B by Sonneborn Building Products, Division of ChemRex Inc.,

Minneapolis, MN; Karnak 220 Asphalt Emulsion by Karnak Corporation, Clark, NJ or equal.

L. Water Repellant: Alkaline stable, Solvent-free blend of silane and oligomeric alkoxysiloxanes to be diluted with water to produce a penetrating water repellant. The water repellant shall be PROSOCO, Inc. Sure Klean Weather Seal Siloxane WB Concentrate.

PART 3 EXECUTION

3.01 INSTALLATION

A. Preparation
   1. Protect adjacent surfaces not designated to receive waterproofing. Clean and prepare surfaces to receive waterproofing, Vacuum substrate clean. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator. Seal cracks and joints with compatible sealant materials using depth to width ratio as recommended by sealant manufacturer. Apply surface conditioner at rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

B. Installation of Pre-Applied Sheet Membrane Waterproofing
   1. Refer to manufacturer's literature for complete pre-applied blindside waterproofing installation instructions including, but not limited to, the following:
      a. Roll out membrane. Minimize wrinkles and bubbles
      b. Apply membrane with HDPE film facing the prepared substrate. Remove the release liner during application.
      c. Apply succeeding sheets by overlapping the previous sheet 3 inches along the uncoated edge of the membrane. Roll firmly to assure a tight seal.
      d. Overlap the ends of the membrane a minimum of 3 inches and apply Preprufe tape centered over the lap. Roll firmly to assure a tight seal. Remove the release liner from Preprufe tape.

C. Installation of Post-Applied Sheet Membrane Waterproofing

D. Refer to manufacturer's literature for complete post-applied positive waterproofing installation instructions including, but not limited to, the following:
   1. Roll out membrane. Minimize wrinkles and bubbles
   2. Apply membrane to the primed surface starting at the low point. Successive sheets of membrane should overlap preceding ones by 3 inches.
   3. Apply succeeding sheets by overlapping the previous sheet 3 inches along the uncoated edge of the membrane. Roll all of the membrane firmly to assure a tight seal.
   4. For vertical surfaces, the membrane is applied in sections of 8 ft in length or less. On walls over 8 ft. high, the membrane should be applied in two or more sections with the upper section overlapping the lower section by at least 3 inches.

E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic per manufacturer's standard details. Verify waterstop by others is acceptable to waterproofing manufacturer.

F. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.

G. Install flexible flashings. Seal watertight to membrane.

H. Seal membrane and flashings to adjoining surfaces.

I. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 8 inches above horizontal surface for first ply and 8 inches at subsequent plies laid in shingle fashion.

J. Seal items protruding from or penetrating through membrane and install counterflashing membrane material per manufacturer's standard details.

K. Installation of Drainage Panels.
   1. For "positive side" installations place drainage board directly against waterproofing membrane and structure, butt joints, overlap the flanges of the drainage composite in shingle fashion in the direction of the water flow. Overlap the fabric of the drainage composite over the perimeter drain if required.
   2. Adhere protection board panel and drainage panel to substrate with adhesive acceptable to manufacturer. Scribe and cut boards around projections, penetrations and interruptions.

L. Installation of Dampproofing
   1. Surface to be treated shall be free from oil and dirt and shall be in the proper condition as indicated by the manufacturer prior to the application of the dampproofing material. The concrete shall have been completely cured and the surface shall be dry and free from frost at the time of application.
   2. Surfaces to be troweled dampproofed shall receive one heavy coat carefully applied so that "holidays" or air-bubble depressions in the surface are completely filled and a thickness of 1/16-in is obtained from the high points of the surfaces providing a 100 percent coating of the surface. Surfaces to be brushed dampproofed shall receive two coats carefully applied so that no "holidays" are visible. Carry coating over exposed top and outside edge of footing.
   3. Particular care shall be given to the application of dampproofing at all construction joints which are encountered.
   4. The coat or coats specified is in addition to primer coats as recommended by the manufacturer.
   5. Do not place backfill before cure time recommended by manufacturer and before the wall has been inspected by Engineer. The backfill shall be placed promptly after inspection by Engineer within time limits recommended by manufacturer.

M. Installation of Capillary Waterproofing
   1. A manufacturer's technical representative shall be present on site during installation to inspect surface preparation, provide detailed instructions on application procedures and to inspect and consult on the actual application.
   2. Surface preparation, including concrete finishing, routing out existing cracks and patching, mixing, application and curing shall be in accordance with the manufacturer's instructions as reviewed. Do not apply in rain or when frost or temperatures below that recommended by the manufacturer may occur.
   3. Clean concrete substrates to remove all laitance, dust, dirt, loose particles, grease, oil and foreign materials that might affect bond of material to concrete substrate.
   4. Saturate substrate with water. Remove all standing water before applying capillary waterproofing.
   5. Application thicknesses
      a. Base coat, 1.5 lbs/sq yd - 1 coat.
      b. Final coat, 1.5 lbs/sq yd - 1 coat.
      c. All vertical or horizontal intersections and construction joints, 2 lbs/sq yd - 1 coat.
   6. Curing
      a. Protect surface from sunlight, precipitation and frost during the curing period.
      b. A misty fog spray of water or other methods recommended by the manufacturer must be used for curing. Cure for the length of time recommended by the manufacturer. Concrete basins shall not be filled for at least 2 weeks after the completion of the curing period.

N. Application of Water Repellant:
   1. Dilute with clean, potable water only.
   2. Apply within 8 hours of dilution.

3. Apply as per Manufacturer's product instructions and in dilution ratios as recommended by Manufacturer for substrate application.

3.02 APPLICATION SCHEDULE

A. Pre-applied sheet membrane waterproofing shall be applied to surfaces noted on the Drawings.

B. Post-applied sheet membrane waterproofing shall be applied to surfaces noted on the Drawings.

C. Capillary waterproofing shall be applied to surfaces (unless otherwise noted) of concrete indicated on the Drawings.

D. Damp proof the surfaces of all poured in place concrete walls not scheduled to receive waterproofing membranes which are in contact with soil from the top of the footings up to 6-in below finished grade or to bottom of slab.

E. Water repellants shall be applied to brick, burnished CMU, CMU, precast concrete and cast in place concrete surfaces as indicated on the Drawings at the following locations:
   1. Brick: all new exterior brick applications.
   2. Concrete: all new exterior concrete applications.

3.03 CLEANUP

A. At all times keep the premises free from accumulation of waste materials and rubbish. At the completion of the installation, remove all tools, scaffolding and surplus materials and remove rubbish from the area.

B. Remove all waterproofing, dampproofing, water repellant and sealant materials from all surfaces where materials are not required to produce a clean, neat, workmanlike job. Use cleaning material recommended by the manufacturer of the compound.

3.04 - 3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 07100

SECTION 07210 - BOARD INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and construct all masonry work as shown on the Drawings and as specified herein.

B. This Section include, but is not necessarily limited to, the following:
   1. Cavity wall insulation.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Product Data for each type of insulation product specified.

B. Product test reports from and based on tests performed by a qualified independent testing agency evidencing compliance of insulation products with specified requirements including those for thermal resistance, fire-test-response characteristics, water-vapor transmission, water absorption, and other properties, based on comprehensive testing of current products.

C. Research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence compliance of foam-plastic insulations with building code in effect for Project.

1.07 QUALITY ASSURANCE

A. Single-Source Responsibility for Insulation Products: Obtain each type of building insulation from a single source with resources to provide products complying with requirements indicated without delaying the Work.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
   3. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering insulation products that may be incorporated in the work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide insulation products by one of the following:
   1. Extruded-Polystyrene Board Insulation:
      a. Amoco Foam Products Company.
      c. Dow Chemical Co.
      d. UC Industries, Inc.; Owens-Corning Co.

2.02 INSULATING MATERIALS

A. General: Provide insulating materials that comply with requirements and with referenced standards.
   1. Preformed Units: 2" (R-10). Board size 16" x 96".

B. Extruded-Polystyrene Board Insulation: Rigid, cellular polystyrene thermal insulation formed from polystyrene base resin by an extrusion process using hydrochlorofluorocarbons as blowing agent to comply with ASTM C 578 for type and with other requirements indicated below:
   1. Type X, 1.30-lb/cu. ft minimum density.
   2. Surface-Burning Characteristics: Maximum flame-spread and smoke-developed indices of 75 and 450, respectively.
   3. Recycled Content: Not less than 50 percent blend of postconsumer and recovered polystyrene resins.

2.03 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of substances harmful to insulations or vapor retarders, including removing projections capable of puncturing vapor retarders or that interfere with insulation attachment.

B. Close off openings in cavities receiving poured-in-place insulation to prevent escape of insulation. Provide bronze or stainless-steel screens (inside) where openings must be maintained for drainage or ventilation.

3.03 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, unsoiled, and has not been exposed at any time to ice and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Apply single layer of insulation to produce thickness indicated.

E. Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise shown or required to make up total thickness.

3.04 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between closed-cell (nonbreathing) insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

3.05 PROTECTION

A. General: Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.06 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 07210

SECTION 07610 - STANDING SEAM METAL ROOF AND SOFFIT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes manufactured roof panels of the following type:
   1. Standing seam roof panels and underlayment.
   2. Roof insulation.
   3. Roof underlayment.

B. Exposed Surfaces: It is a requirement that the exposed surfaces of the Work of "Manufactured Roof Panels, and "Sheet Metal Flashing and Trim" be consistent. Coordinate the finishes of this section with the other two sections to assure minimal differences between the appearance of various elements.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Provide certified test results by a recognized testing laboratory or agency in accordance with specified test methods for each system.

B. Air Infiltration: Provide roof panel systems with no air leakage when tested in accordance with ASTM E 283 at a static air pressure differential of 1.57 psf.

C. Water Penetration: Provide panel systems with no water penetration as defined in the test method when tested in accordance with ASTM E 331 at an inward static air pressure differential of not less than 6.24 psf and not more than 12.0 psf.

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Product data including manufacturer's product specifications, standard details, certified product test results, installation instructions and general recommendations, as applicable to materials and finishes for each component and for total panel system.

C. Samples for verification purposes of roof panels. Provide sample panels 12 inches long by actual panel width, in the profile, style, color, and texture indicated. Include clips, battens, fasteners, closures, and other panel accessories.

D. Shop Drawings showing layouts of panels on roofs, details of edge conditions, joints, corners, panel profiles, supports, anchorages, trim, flashings, closures, and special details. Distinguish between factory and field assembly work.

1.07 QUALITY ASSURANCE

A. Wind Uplift: Provide roof panel system including supports meeting requirements of Underwriters Laboratories, Inc. for Class 30 wind uplift resistance.

B. Field Measurements: Where possible, prior to fabrication of prefabricated panels, take field measurements of structure or substrates to receive panel system. Allow for trimming panel units where final dimensions cannot be established prior to fabrication.

C. Design roof system to conform to applicable requirements of ANSI A 58.1.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver panels and other components so they will not be damaged or deformed. Package roof panels for protection against transportation damage.

B. Handling: Exercise care in unloading, storing, and erecting roof covering panels to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering. Store metal roof panels so that they will not accumulate water. Do not store panels in contact with other materials that might cause staining, denting, or other surface damage.

1.09 NOT USED

1.10 WARRANTY

A. Finish Warranty
1. Submit a written warranty, signed by the manufacturer, for a period of twenty (20) years. This warranty states that the paint finish will not peel, check, crack in excess of a numerical rating of 8, or fade/change colors in excess of 5 E units (Hunter Color Units).
2. Galvalume steel sheet will not be subject to substrate failure or coating, cracking, peeling, or flaking and will not erode through or become perforated within a period of twenty (20) years after shipment from the manufacturer's plant.

B. Weather-tightness Warranty
1. Submit a written warranty executed by the manufacturer, guarantying installer's performance for a period of twenty years. The manufacturer endures that the installer will correct any roof leaks identified within the building beyond normal wear and tear. Liability is limited to the actual cost of the repair.

PART 2 PRODUCTS

2.01 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
2. Roof panels to be similar to Berridge Model CL-21 Portable Roll Former in continuous lengths from ridge to eave or factory formed to 40' max. Seam spacing shall be 16" when used for Batten Seam on center, Rib height 1-1/2".
3. Attachment shall be though the flat area adjacent to the overlapping rib with #8 x 3/4" color-matched fasteners, including a combination washer of metal and neoprene.

B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels : Formed with vertical ribs at panel edges and between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and snapping panels together.

1. Basis-of-Design Product: Provide "Cee-Lock" Standing Seam Roof System as manufactured by Berridge Manufacturing Co., or equal standing seam metal roof system by one of the following:
2. Manufacturers:
   a. Berridge Manufacturing Company.
   b. CENTRIA Architectural Systems.
   c. MBCI; Div. of NCI Building Systems.
   d. Peterson Aluminum Corporation.
3. Material: Aluminum-zinc alloy-coated steel sheet, 0.0209 inch thick.
   a. Color: “Aged Bronze” finish.
4. Clips: Fixed.
   a. Material: 0.0625-inch-thick, stainless-steel sheet.
5. Panel Height: 1.5 inches.
6. Uplift Rating: UL 90.

2.02 SOFFIT PANELS

A. A. Basis-of-Design Soffit Panel: Vee-Panel as manufactured by Berridge Manufacturing Company or equal metal soffit panel system .
   1. Panels shall be factory formed to 40' max and shall have no exposed fasteners.
   2. Panel shall have 12 3/4" exposure, two 3/8" deep vee grooves at 4 1/4" on center, with concealed fasteners and interlocking sidelap.
   3. Attachment to metal supports with #8 x 1/2" TEKS screws at maximum spacing of 2'-0" on center per local code requirement.
   4. Panels shall have a smooth surface texture.

2.03 SHEET MATERIALS

A. Structural Quality Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip aluminum-zinc-coated steel sheet complying with ASTM A 792 with class AZ-50 coating; Grade 40 or to suit manufacturer's standards.

2.04 METAL FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.05 ROOF PANELS

A. Panel Face Sheets: Fabricate to the profile or configuration indicated from 24-gage (0.0239-inch) aluminum-zinc-coated steel sheets.

B. Standing Seam Roof Panels: Manufacturer's standard factory-formed, standing-seam roof panel system with striations designed for mechanical attachment of panels to roof purlin using a concealed clip. Form panels of 24-gage (0.0239-inch) aluminum-zinc-coated steel sheets.
   1. Clips: Provide 16-gage (0.0598-inch) panel clips designed to meet negative load requirements. Provide space at purlins.
   2. Cleats: Factory-calked, mechanically seamed cleats formed from 24-gage (0.0239-inch), Grade C, zinc-coated steel sheets.

2.06 SELF ADHERING MEMBRANE UNDERLAYMENT

A. Self Adhering Membrane: A flexible high temperature, skid resistant sheet flashing specially formulated from plasticizers and other modifiers to remain flexible and waterproof in concealed application and approved by the metal roofing system manufacturer.
   1. Grace Ultra as manufactured by W.R grace & Co.
   2. Other pre-approved products.

2.07 MISCELLANEOUS METAL FRAMING

A. General: Comply with ASTM C 754 for conditions indicated.
   1. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653/A 653M, G60, hot-dip galvanized zinc coating.
   2. Configurations: Special shapes, including curved components, as indicated on the drawings.

2.08 MISCELLANEOUS MATERIALS

A. Polyisocyanurate Roof Insulation – Two layers of thickness shown on the drawings with maximum board size of 4' x4', faced on both sides. 2.0lb./cu.ft. density when measured in accordance ASTM D 1621, as manufactured by the approved roofing materials manufacturer.

B. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets, self-locking bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
   1. Use aluminum, corrosion-resistant steel, or stainless steel fasteners for exterior application and galvanized or cadmium-plated fasteners for interior applications.
   2. Provide metal-backed neoprene washers under heads of exposed fasteners bearing on weather side of panels.
      a. Atomseal by Fry, 7/8" diameter, Neoprene-stainless steel.
      b. Sealing washers by Rawl, 1 1/8" diameter, type 304 stainless, cat. no. 2896.
   3. Locate and space exposed fasteners in true vertical and horizontal alignment. Use proper tools to obtain controlled uniform compression for positive seal without rupture of neoprene washer.

C. Accessories: Provide components required for a complete roof panel system, including trim, fascias, corner units, clips, seam covers, flashings, sealants, gaskets, fillers, closure strips and similar items. Match materials and finishes of panels.
   1. Closure Strips: Closed-cell, self-extinguishing, expanded cellular rubber or cross-linked polyolefin foam flexible closure strips. Cut or premold to match configuration of roof panels. Provide closure strips where indicated or necessary to ensure weathertight construction.
   2. Sealing Tape: Pressure-sensitive 100 percent solids polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
   3. Joint Sealant: One-part elastomeric polyurethane, polysulfide, or silicone rubber sealant as recommended by the panel manufacturer.
   4. Separation Tape: Closed cell neoprene tape ¼-inch thick in width matching framing member. Use to eliminate "flutter" between panels and supporting members (purlins).

D. Soffit Panel Installation Accessories:
   1. Carrying Channels: 1-1/2 inches deep, 475 lb/1000 feet .
   2. Furring Channels: 7/8 inch deep, 300 lb/1000 feet .
   3. Non-Load-Bearing Studs and Runners: ASTM C 645 and complying with the following requirements for minimum thickness of base (uncoated) metal and other characteristics: Depth: 1 5/8 inches,2 1/2 inches, 3-5/8 inches, 4 inches.

2.09 PANEL FABRICATION

A. General: Fabricate and finish panels and accessories at the factory by manufacturer's standard procedures and processes, and as required to fulfill indicated performance requirements which have been demonstrated by factory testing. Comply with indicated profiles and dimensional requirements, and with structural requirements.

B. Apply bituminous coating or other permanent separation materials on concealed panel surfaces where panels would otherwise be in direct contact with substrate materials which are incompatible or could result in corrosion or deterioration of either material or finishes.

C. Fabricate panel joints with captive gaskets or separator strips, which provide a tight seal and prevent metal-to-metal contact in a manner which will minimize noise from movements within panel system.

PART 3 EXECUTION

3.01 PANEL SUPPORTS AND ANCHORAGE

A. Purlin, angles, channels, and other secondary structural panel support members and anchorage shall be installed in accordance with AISC Manual of Steel Construction "Code of Standard Practice."

B. Secure all clip angles to purlins only. Use stainless steel self-tapping screws and center on purlins to ensure that no fastener will be exposed to view from the underside of the panels.

3.02 PANEL INSTALLATION

A. General: Comply with manufacturers' instructions and recommendations for installation, as applicable to project conditions and supporting substrates. Anchor panels and other components of the work securely in place, with provisions for thermal and structural movement.
   1. Field cutting of exterior panels by torch is not permitted.
   2. Install panels with concealed fasteners.

B. Accessories: Install components required for a complete roof panel system, including trim, fascias, corner units, clips, seam covers, battens, flashings, sealants, gaskets, fillers, closure strips, and similar items.

C. Joint Sealers: Install gaskets, joint fillers and sealants where indicated and where required for weatherproof performance of panel systems. Provide types of gaskets, sealants, and fillers indicated or, if not otherwise indicated, types recommended by panel manufacturer.
   1. Refer to other sections of these specifications for product and installation requirements applicable to indicated joint sealers.

D. Standing Seam Roof Panel System: Fasten roof panels to supports with concealed clip in accordance with the manufacturer's instructions.
   1. Install clips at each support with self-drilling/self-tapping fasteners.
   2. Install separation tape on purlins and other supporting framing members with adhesive to eliminate "flutter" between panels and supporting framing.
   3. At end laps of panels, install tape caulk between panels.
   4. Install factory-calked cleats at standing-seam joints. Apply snap-on batten to the panels to provide a weathertight joint.

E. Installation Tolerances: Shim and align panel units within installed tolerance of inch in 20'-0" on level/plumb/slope and location/line as indicated, and within inch offset of adjoining faces and of alignment of matching profiles.

3.03 CLEANING AND PROTECTION

A. Damaged Units: Replace panels and other components of the work which have been damaged or have deteriorated beyond successful repair by means of finish touch-up or similar minor repair procedures.

B. Cleaning: Remove temporary protective coverings and strippable films (if any) as each panel is installed. Upon completion of panel installation, clean finished surfaces as recommended by panel manufacturer, and maintain in a clean condition during construction.

3.04 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 07610

SECTION 07620 - SHEET METAL FLASHING AND TRIM

GENERAL

1.01 SUMMARY

A. This section includes:
   1. Metal counter flashing
   2. Metal wall flashing.
   3. Gutters
      Downspouts
   4. Sheet metal coping.
   5. Exposed metal trim units
   6. Miscellaneous sheet metal accessories
   7. Composition flashing.

B. Integral masonry flashings are specified as masonry work in sections of Division 4.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data, Flashing, Sheet Metal, and Accessories: Manufacturer's technical product data, installation instructions and general recommendations for each specified sheet material and fabricated product.

C. Samples of the following flashing, sheet metal, and accessory items:
   1. 12" long samples of factory-fabricated products exposed as finished work. Provide complete with specified factory finish.
   2. Construct mockups for the following type of sheet metal flashing and trim:
      a. Exposed trim and fascia.

D. Shop Drawings showing layout, methods of joining, profiles, and anchorage details, including major counter-flashings, trim/fascia units and expansion joint systems; layouts at 1/4" scale, details at 3" scale.

1.07 NOT USED

1.08 NOT USED

1.09 JOB CONDITIONS

A. Coordinate work of this section with interfacing and adjoining work for proper sequencing of each installation. Ensure best possible weather resistance and durability of work and protection of materials and finishes.

PRODUCTS

1.10 FLASHING AND SHEET METAL MATERIALS

A. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ-50 coating, Grade 40 (ASTM A 792M, Class AZ-150 coating, Grade 275) or to suit project conditions, with 55 percent aluminum, not less than 0.0396 inch (1.0 mm) thick, unless otherwise indicated.

B. Coil-Coated, Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792, Class AZ-50 coating, Grade 40 (ASTM A 792M, Class AZ-150 coating, Grade 275) or to suit project conditions, with 55 percent aluminum, not less than 0.0396 inch (1.0 mm) thick, coil coated with high-performance fluoropolymer coating as specified in "Coil-Coated Galvanized Steel Sheet Finish" Article; not less than 0.0336 inch (0.85 mm) thick, unless otherwise indicated.

C. Fasteners: Same metal as flashing/sheet metal or, other non- corrosive metal as recommended by sheet manufacturer. Match finish of exposed heads with material being fastened.

D. Bituminous Coating: FS TT-C-494 or SSPC - Paint 12, solvent type bituminous mastic, nominally free of sulfur, compounded for 15- mil dry film thickness per coat.

E. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, non- drying, nonmigrating sealant.

F. Elastomeric Sealant: Generic type recommended by manufacturer of metal and fabricator of components being sealed and complying with requirements for joint sealants complying with the requirements specified in Division 7 Section "Joint Sealants".

G. Epoxy Seam Sealer: 2-part noncorrosive metal seam cementing compound, recommended by metal manufacturer for exterior/interior non-moving joints including riveted joints.

H. Adhesives: Type recommended by flashing sheet manufacturer for waterproof/weather-resistant seaming and adhesive application of flashing sheet.

I. Paper Slip Sheet: 5-lb. rosin-sized building paper.

J. Polyethylene Underlayment: Minimum 6-mil carbonated polyethylene film resistant to decay when tested in accordance with ASTM E154.

K. Reglets: Metal units of type and profile indicated, compatible with flashing indicated, noncorrosive.

L. Metal Accessories: Provide sheet metal clips, straps, anchoring devices and similar accessory units as required for installation of work, matching or compatible with material being installed, noncorrosive, size and gage required for performance.

M. Roofing Cement: ASTM D 2822, asphaltic.

N. Copings: Fabricate from the following material:
   1. Coil-Coated Galvanized Steel: 0.0299 inch thick.

O. Endcaps: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.027 inch (0.69 mm).

P. Inside and Outside Mitres: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.027 inch (0.69 mm).

Q. Gutter Hangers and Anchors: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.063 inch (1.60 mm). Provide types required to suit project requirements.

R. Downspout Anchors: Aluminum. Provide types required to suit project requirements

1.11 FABRICATED UNITS

A. General Metal Fabrication: Shop-fabricate work to greatest extent possible. Comply with requirements of SMACNA "Architectural Sheet Metal Manual". Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, damage or deterioration of the work. Form work to fit substrates. Comply with material manufacturer instructions and recommendations for forming material. Form exposed sheet metal work without excessive oil-canning, buckling and tool marks, true to line and levels indicated, with exposed edges folded back to form hems.

1.12 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Downspouts: Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Manufactured Hanger Style: Recommended by manufacturer
   2. Fabricate downspouts from the following material:
      b. Prepainted, Metallic-Coated Steel: 0.0217 inch thick.

B. Gutters: Fabricate gutter of aluminum sheet, ASTM B209, Alloy 3105-H24. Minimum tensile strength 26, 000 psi or equivalent. Continuous and seamless sheet aluminum, roll formed.
   1. Fabricate gutter from the following material:
      a. Prepainted, Metallic-Coated Steel: 0.027 inch thick.

1.13 REGLETS

A. General: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces and compatible with flashing indicated.

B. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

C. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.

D. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.

E. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of the counterflashing lower edge.
   1. Material: Stainless steel, 0.0187 inch (0.5 mm) thick.
   2. Material: Copper, 16 oz./sq. ft. (0.55 mm thick).
   3. Material: Aluminum, 0.024 inch (0.6 mm) thick.
   4. Material: Galvanized steel, 0.0217 inch (0.55 mm) thick.

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

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fry Reglet Corporation.
   2. Hickman: W.P. Hickman Co.
   3. Keystone Flashing Company.

1.14 COIL-COATED GALVANIZED STEEL SHEET FINISH

A. High-Performance Organic Coating Finish: Apply the following system by coil-coating process on galvanized steel sheet as recommended by coating manufacturers and applicator.
   1. Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and

fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.

a. Color and Gloss: Match Berridge "Aged Bronze."

b. Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:

1) Ausimont USA, Inc. (Hylar 5000)

2) Elf Atochem North America, Inc. (Kynar 500)

EXECUTION

1.15 INSTALLATION REQUIREMENTS

A. General: Except as otherwise indicated, comply with manufacturer's installation instructions and recommendations, and with SMACNA "Architectural Sheet Metal Manual". Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints and seams which will be permanently watertight and weatherproof.

B. Underlayment: Where stainless steel or aluminum is to be installed directly on cementitious or wood substrates, install a slip sheet of red rosin paper and a course of polyethylene underlayment.

C. Bed flanges of work in a thick coat of bituminous roofing cement where required for waterproof performance.

D. Install reglets to receive counter-flashing in manner and by methods indicated. Where shown in concrete, furnish reglets to trades of concrete work for installation as work of Division-3 sections. Where shown in masonry, furnish reglets to trades of masonry work, for installation as work of Division-4 sections.

E. Install counter-flashing in reglets, either by snap-in seal arrangement, or by wedging in place for anchorage and filling reglets with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.

1.16 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes.

B. Protection: Installer shall advise Contractor of required procedures for surveillance and protection of flashings and sheet metal work during construction, to ensure that work will be without damage or deterioration, other than natural weathering, at time of substantial completion.

3.03 –3.10 (NOT USED)

1.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION – 07620

SECTION 07800 - FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and install firestopping and firesafing, including:
   1. Through-penetration firestops and smokestops for fire-rated partition and floor assemblies, both blank (empty) and those accommodating penetrating items, such as, but not necessarily limited to cable trays, electrical signal cables, conduit, pipes, and ducts.
   2. Membrane penetration protection for fire-rated partitions.
   3. Construction Gap Firestops:
      a. Construction joint firestops with partitions, floors, or the intersection of floors to exterior walls, or the intersection of top of partitions to ceilings.
      b. Top of partition firestopping in fire-rated partitions.
      c. Top of partition and construction joint smokestopping in smoke partitions.
   4. Intumescent compressible joint filler, designed to prevent the spread of fire through openings between building components.
   5. Accessories as required to provide a complete firestopping system.
   6. Specific conditions requiring firestopping may not be fully detailed on the Drawings. Where a specific firestop system is not indicated on Drawings, the subcontractor shall include proposed system designs in submittals.

B. Design and engineering judgements for nonstandard applications where fire tests and approved systems do not exist.
   1. Firestop design documentation for code official review.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Provide complete through-penetration firestopping systems which have been tested and approved by UL or FM, or third-party testing agency approved by the Architect, and are listed under their label service.

B. Firestopping Materials and Systems:
   1. Shall be capable of closing or filling through-penetrations created by the following:
      a. The burning or melting of combustible pipes, cable jacketing, or pipe insulation materials.
      b. Deflection of sheet metal electrical and mechanical ductwork due to thermal expansion.
   2. Shall be asbestos free and lead free and shall not incorporate nor require the use of hazardous solvents.
   3. Shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces.
   4. Shall be moisture resistant and may not dissolve in water after curing.

C. Construction Gap Firestops: Where movement across gap is anticipated, firestopping system shall comply with ASTM E119 or UL 2079.

D. Through-Penetration Firestop Ratings:
   1. Comply with F- and T-ratings as required by local building codes, code official, and as tested in accordance with ASTM E814 or UL 1479 fire tests in a configuration that is representative of project conditions.
   2. The F-rating shall not apply to all through-penetration firestops and shall not be less than the required fire-resistive rating of the assembly penetrated, except as specified.
   3. The T-rating shall apply to through-penetration firestop locations as specified and shall not be less than the required fire-resistance rating of the assembly penetrated.
      a. R-rating shall apply to floor penetration firestops that protect larger than 4-in nominal pipe or 15 square inches in overall cross-sectional areas that are not contained within a wall at the point where they penetrate the floor.
      b. T-rating shall apply to wall penetration firestops that protect larger than 4-in nominal pipe or 15 square inches in overall cross-sectional area, and are below any ceiling. T-rating shall also apply to penetration firestops above corridor ceilings where penetrations are larger than the size indicated herein.
   4. The F-rating and T-rating for penetrations through 4-hour fire-resistance rated walls shall be not less than 3 hours.

E. Surface Burning: Firestop materials shall be classified as Class A tested in accordance with ASTM E84, flamespread maximum 25, and smoke developed maximum 450.

F. Construction Gap Firestops: Gaps that may experience movement shall comply with ASTM E119 or UL 2079.

G. Membrane Penetrations: Comply with applicable Building Code.

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300 “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Submit a schedule of through-penetrations which indicates the firestop system to be utilized for each different firestopping applications.
   1. approval, prior to submitting the actual schedule.
   2. Schedule shall indicate construction of the wall or floor assembly; size, number, and material of penetrating items; firestop system designation; required F-rating and T-rating; UL-listed system number; remarks where applicable.

C. Submit complete list of all firestop systems to be utilized, corresponding to system designations (FSM-1…) specified herein.
   1. Include all of the individual materials required for each complete system.
   2. Approved Installer: Provide document from manufacturer that recognizes the installer as qualified and approved to install the manufacturer’s firestopping materials.
   3. Submit a sample of the firestopping schedule format for the Contractor’s and code officials’ approval prior to submitting the actual schedule.
      a. Schedule shall indicate construction of the wall or floor assembly; size, number, and material of penetrating items; firestop system designation; required F-rating and T-rating; UL-listed system number; remarks where applicable.
      b. Approved testing agency’s standard details of manufacturer’s tested firestopping systems in format acceptable to code official.

D. Provide the following within 2 weeks of contract award:
   1. Submit a firestopping schedule which indicates the firestop system to be utilized for each different firestopping application.

2. Submit documentation of UL or FM classification for each material and system to be utilized. Include certification that such listings are current and subject to follow-up service inspection by listing body.
3. Submit copies of manufacturer's product data, material safety data sheets, standard details, and installation instructions for fire-rated firestop assemblies.

E. Submit documentation of UL classification or approved third party testing for each material and system to be utilized. Include certification that such listings are current and subject to follow-up service inspection by listing body.

F. Submit copies of manufacturer's product data, specifications, recommendations, standard details and installation instructions for fire-rated firestop assemblies.

G. Shop Drawings: Submit detail drawings of any firestopping application for which there is no tested and rated system. Shop drawings shall give all pertinent information of installation method proposed, together with all required dimensions for the proper fitting around other work and materials, together with all special conditions as may be required to complete installation.

1.07 QUALITY ASSURANCE

A. Installer: Company specializing in installing of fire rated and classified firestopping systems with minimum of 3 years documented experience and approved by material manufacturer.

B. All materials and components shall be the approved products of one manufacturer.

C. Mockup: Provide mockup representative of finished work. Replace unsatisfactory work as directed. Approved mockup will be used as standard for judging acceptability of work on project. Mockup, if approved, may be incorporated as part of final construction.
1. Provide mockup for each firestop system.
2. Install sample installation in the present of the materials manufacturer and by Owner's representative, not less than one week in advance of start of work.
3. Mockup shall be installed in accordance with the specifications and shall be representative of installations to be achieved throughout the project. Mockup not meeting the performance requirements shall be removed and replaced with one that does.
4. Installations not comparable to the mockup will be subject to rejection and shall be replaced at Subcontractor's expense.

D. Pre-installation Meeting: Prior to start of work that involves cutting penetrations, conduct a meeting with installers of such work to identify fire and smoke barriers and required configurations of penetrations. Discuss the proper procedures and time schedule for cutting, patching, and sealing penetrations in such assemblies, with emphasis on avoiding unnecessary cutting and patching.

1.08 DELIVERY, STORAGE AND HANDLING

A. Conspicuously mark "REJECTED" on materials which have been damaged and remove from site.

B. Store in accordance with manufacturer's recommendations.

C. Install firestop materials before expiration of material shelf life.

1.09 DEFINITIONS

A. "Through-Penetration Firestop" is a material, device, or construction installed to resist, for a prescribed time period, the passage of flame, heat, and hot gases through openings which penetrate the entire fire-resistive assembly in order to accommodate cables, cable trays, conduit, tubing, pipes, or similar items.

B. “F Rating” is the time period that a through-penetration fire block limits the spread of fire, flame, and hot gases through the fire-block assembly, including penetrating elements, when tested in accordance with the time-temperature curve defined in ASTM E119, fire tests of building construction and materials.

C. “T Rating” is the time period that a through-penetration fire block limits temperature rise through the fire-block assembly, including penetrating elements, when tested in accordance with the time-temperature curve defined in ASTM E119, fire tests of building construction and materials.

D. Membrane Penetration: Penetrations in a fire-rated partition or floor that breaches only one side of the barrier.

E. Construction Gaps: Continuous joint or opening, whether static or dynamic, such as where the top of a wall meets underside of a floor, wall-to-wall joints, floor-edge-to-floor-edge joints, floor-edge-to-exterior-wall joints, or other linear breach in a rated barrier.

1.10 WARRANTY

A. Submit manufacturer’s standard written warranty agreeing to repair or replace components which appear to have failed in general durability or any other form of apparent deterioration (excluding inherent qualities and limitations clearly specified in the manufacturer’s data which was submitted).

B. Complete installation shall be warranted jointly and severally, on a single document, by the materials manufacturer and the Contractor, against defects of materials and workmanship, as defined on the warranty.

1.11 REGULATORY REQUIREMENTS

A. Comply with local codes and regulations, where such codes and regulations are more stringent than requirements indicated on the Drawings and specified in these specifications.

B. The firestopping subcontractor shall provide firestopping and smokestopping design documentation for fire-resistance tested assemblies, as well as for nonstandard conditions for which no approved tests exist for code official review.

1.12 ENVIRONMENTAL

A. Apply firestopping materials only when the temperature of surfaces to be filled and surrounding air temperatures comply with the manufacturer’s printed instructions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. 3M Corporation, St. Paul, MN, USA.

B. Grace Construction Products.

C. Isolatek International.

D. Owens-Corning.

E. United States Gypsum.

F. Hilti.

G. Specified Technologies, Inc.

H. Tremco.

2.02 MATERIALS

A. Firestop Material Type 1: Mortar type seal.
   1. Water-based mortar capable of expanding a minimum of 3 percent by volume.
      a. Density: 35 to 38 pounds per cubic foot.
      b. Thickness: Minimum of 4-in, or as indicated on the Drawings, or if not indicated, as required for specified fire rating.
   2. Noncombustible to ASTM E814.
   3. Flame spread less than or equal to 25 per ASTM E84.
   4. Fire-Resistance Rating: 2 and 3 hours as required tested in accordance with UL 1479.
   5. Product Standard: KBS Mortar Seal MS 50; International Protective Coatings Corporation.
   6. Accessory Materials:
      a. Wall Penetration: On-side shuttered using styrofoam panel flush with damming material to be removed after drying.
      b. Floor Penetration – Retainers: Galvanized steel securing clips, holding damming board as recommended by manufacturer.

B. Firestop Material Type 2:
   1. Mineral wool safing insulation.
   2. Regular color unfaced with galvanized steel safing clips.
   3. FS HH-I-521F, Type I.
   4. Manufacturers:
      a. Certainteed.
      b. Manville.
      c. Owens-Corning.
      d. United States Gypsum.

C. Firestop Material Type 3: Firestop compound.
   1. Water-based compound, pourable, trowelable, fusible ceramic fire break materials.
      a. Thickness: 4-in minimum, or if not indicated, as required for specified fire rating.
   2. Noncombustible to ASTM E814.
   3. Flame spread and smoke developed less than or equal to 25 per ASTM E84.
   4. Fire-Resistance Rating: 2 and 3 hours as required tested in accordance with UL 1479.
   5. Products: Flamesafe FS500 and FS600; International Protective Coatings Corporation.
   6. Accessory Materials:
      a. Damming Panel: Use damming board as recommended by manufacturer or Type X gypsum board.
      b. Retainers: Galvanized steel securing clips, holding damming board as recommended by manufacturer.
      c. Bulk Ceramic Fiber: Ceramic fiber to dam smaller openings; resists fire and heat up to 3,000 degrees F.

D. Firestop Material Type 4: Intumescent bands or wrap.
   1. Wrap strip nominal 1/4-in thick intumescent material faced on one side with aluminum foil supplied in 2-1/2-in wide strips.
   2. Noncombustible to ASTM E814.
   3. Flame spread less than or equal to 25 per ASTM E84.
   4. Fire-Resistance Rating: 2 to 4 hours, as required, tested in accordance with UL 1479.
   5. Products: FS 195; 3M fire protection products.
   6. Accessory Materials: Aluminum tape, 28-gauge galvanized steel restricting collar.

E. Firestop Material Type 5: Firestop putty.
1. Moldable putty with one part, intumescent elastomer.
2. Noncombustible to ASTM E814.
3. Meets time and temperature exposure of ASTM E119.
4. Fire-Resistance Rating: 1 to 3 hours as required, tested in accordance with UL 1479.
5. Products:
   a. Fire barrier moldable putty, 3M Fire Protection Products.
   b. Flamesafe FSP1000 putty, International Protective Coatings Corporation.

F. Firestopping Material Type 6: Firestop caulking.
1. Water-based, single-component, endothermic caulk.
2. Noncombustible to ASTM E814.
3. Flame spread less than or equal to 25 per ASTM E84.
4. Fire-Resistance Rating: 1 to 3 hours as required.
5. Products: Fire Dam 150 Caulk; 3M Fire Protection Products.

G. Firestop Material Type 7: Heat expanding pillows:
1. Tightly woven dustfree fiberglass cloth bags, filled with a combination of mineral fiber incombustible components, water insoluble expansion agents, and special fire retardant activities.
2. Noncombustible to ASTM E814.
3. Flame spread less than or equal to 25 per ASTM E84.
4. Fire-Resistance Rating: 1 to 3 hours as required, tested in accordance with UL 1479.
5. Products: KBS sealbags; International Protective Coatings Corporation.
6. Accessory Materials: Wall and floor penetrations use wire mesh bolted to one side of wall or under side of floor.

H. Firestop Material Type 8:
1. Fire-resistant penetration seal.
2. Medium density, fire-resistant foam retaining stability of high temperatures.
3. ASTM E814, Underwriter's Laboratories, Inc., test No. R8196, series as appropriate for wall or floor fire rating indicated.
4. Products:
   a. Firestop Foam 2001, Dow Corning Corporation.
   b. CP 25WB, Fire Barrier Caulk.
   c. FS 195 wrap strips and putty 303, 3M Corporation.
   d. Metacaulk 950 Firestopping Penetration Sealant, The Rectorseal Company.

I. Firestop Material Type 9: Firestop sealant:
1. Silicon-based, single-component sealant.
2. Noncombustible to ASTM E814.
3. Flame spread 5 per ASTM E84.
4. Fire-resistant rating 1 to 3 hours as required.
5. Products: CLK N/S and CLK S/L, Nelson Firestop Products.

J. Firestop Material Type 10: Pipe Choke System:
1. Heavy gauge metal collar, with highly intumescent material.
2. Tested: UL 1429, ASTM E814, ASTM E199.
3. Products: PCS, Nelson Firestopping Products.

K. Fire Block for through penetration, multi penetrations, CMU and Concrete.
1. Ready-to-use, intumescent flexible block based on two-component polyurethane foam. Dimensions (2 in. x 5 in. x 8 in.)
2. Completely free from dust and fibers, Halogen, asbestos and solvent free.
3. Expansion Temperature - 149 degrees C
4. Surface Burning Flame Spread Index - 0 (ASTM E 84-96)

5. Surface Burning Smoke Development Index - 25 (ASTM E 84-96)
6. Products: Hilti FS 657 Fire Block

PART 3 EXECUTION

3.01 INSPECTION

A. Examine adjoining construction, and the conditions under which the work is to be installed, and do not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected.

3.02 PREPARATION

A. Verify adjacent materials are clean, dry and ready to receive installation.

B. Verify that openings and items passing through them are ready to receive the Work of this Section.

C. Verify that field dimensions are as shown on the Drawings and as recommended by the manufacturer.

D. Remove incompatible materials which may affect installation.

E. Beginning of installation means acceptance of existing conditions.

F. Protect elements surrounding the work of this Section from damage or disfiguration. Use masking tape where required to prevent contact of firestopping materials with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove smears. Remove tape immediately after installation without disturbing firestopping system.

3.03 INSTALLATION, GENERAL

A. Apply firestopping materials in accordance with manufacturer's instructions and in conformance with UL listing.

B. Apply firestopping material in sufficient thickness to achieve fire rating required.

3.04 THROUGH-PENETRATING

A. Inspect installation including firestopping materials and any damming or support materials to verify integrity of installation.

B. Where system design permits, remove damming or support materials only after it has been determined that firestopping materials have fully cured or dried.

C. Install any covering materials or finish as per design requirements and manufacturer's instructions.

D. All firestopping shall be inspected for proper installation, drying, curing, adhesion as appropriate for the materials and systems being used. Where necessary, repairs shall be made and repaired installations shall be reinspected.

3.05 FIRESAFING INSULATION

A. Size insulation strips to be 1/2-in to 3/4-in greater than the measured width of the void or cavity.

B. Impale steel securing clips in insulation approximately midway between top and bottom surface, approximately 8-in in from each end.

C. Push insulation strips into the void or cavity until the securing clips are in contact with the top of floor slab. Top of insulation shall be flush with the floor level.

D. Overlap and butt closely all end joints.

E. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

3.06 REPAIRS AND MODIFICATIONS

A. Identify damaged, improperly installed or reentered seals for repair or modification.

B. Modifications to penetrations shall be accomplished as per the firestop manufacturer's recommendations.

C. Only materials used in the original seal and designated by the manufacturer as suitable for a specific repair shall be used for this purpose.

3.07 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.08 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

B. Protect firestopping material throughout the construction period in a clean and properly protected condition so that each assembly will be without any indication of damage at the time of Substantial Completion.

3.09 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 07800

SECTION 07920 - JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all materials, labor, equipment and incidentals required and perform all sealants, joint fillers, gaskets and related work necessary for the proper completion of the project as shown on the Drawings and as specified herein.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)
1. ASTM C790 – Use of Latex Sealing Compounds.
2. ASTM C804 – Use of Solvent Release Type Sealants.
3. ASTM C834 – Standard Specification for Latex Sealants.
4. ASTM C920 – Standard Specification for Elastomeric Joint Sealants.
5. ASTM C1193 – Standard Guide for Use of Joint Sealants.
6. ASTM D395 - Standard Test Methods for Rubber Property - Compression Set.
7. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.
8. ASTM D573 - Standard Test Method for Rubber-Deterioration in an Air Oven.
9. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
10. 10. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
11. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal to Metal).
12. ASTM D1056 – Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
13. ASTM D1149 - Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber.
14. ASTM D1565 - Standard Specification for Flexible Cellular Materials – Vinyl Chloride Polymers and Copolymers (Open Cell Foam).
15. ASTM D1667 – Standard Specification for Flexible Cellular Materials – Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
16. ASTM D1708 - Standard Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
17. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
18. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
19. SWRI – (Sealant, Waterproofing, and Restoration Institute) – Sealant and Caulking Guide Specification.

B. Federal Specifications (FS)
1. FS HH-F-341 - Fillers, Expansion Joint; Bituminous (Asphalt and Tar) And Nonbituminous (Preformed For Concrete)

C. The Society for Protective Coatings (SSPC)

1. SSPC SP-10 - Surface Preparation Specification No. 10 Near-White Blast Cleaning.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Submit product data including detailed product information and colors on materials proposed and material installation methods. Submittals shall include the following:
1. Two sets of special colored sealant samples in representative quantities
2. Two sets of representative samples of any or all other proposed materials required for the work of this Section as requested by the Engineer.

1.07 QUALITY ASSURANCE

A. Perform work in accordance with sealant manufacturer’s requirements for preparation of surfaces and materials installation instructions.

1.08 NOT USED

1.09 NOT USED

1.10 WARRANTY

A. Submit manufacturer’s standard written warranty agreeing to repair or replace components which appear to have failed in general durability or any other form of apparent deterioration (excluding inherent qualities and limitations clearly specified in the manufacturer’s data which was submitted).

B. Complete installation shall be warranted jointly and severally, on a single document, by the materials manufacturer and the Contractor, against defects of materials and workmanship, as defined on the warranty.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.12 ENVIRONMENTAL REQUIREMENTS

A. Section 01600 – Products Requirements.

B. Maintain Temperature and humidity recommended by sealant manufacturer during and after installation.

1.13 APPLICATION SCHEDULE

A. Caulk all exterior wall joints, between adjacent materials, joints between frames or louvers and adjacent materials, copings, and all other joints shown on the Drawings or required for the completion of the work. Joints noted as "caulk", "caulking", or "sealant," shall be caulked as specified herein.

B. Caulk all interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete, floor joints in tile, joints in rooms to be airtight and all other joints shown on the Drawings or required for the completion of the work.

C. Compressible Filler at conditions indicated on the Drawings or requiring compressible filler for sealant or caulking installation.

D. Expansion Joint Seals at conditions indicated on the Drawings.

E. Waterproof Joint Filler at exterior conditions and at conditions with continuous water immersion.

PART 2 PRODUCTS

2.01 MATERIALS

A. Caulking and Sealants

1. All colors for caulking above grade in the superstructure of the building shall be selected by the Engineer.
2. Exterior and interior sealant for joints on the horizontal plane - **Type A** - shall be a two part, pour grade polyurethane base self-leveling Polytok sealant by Toch Brothers, Inc.; Tremco; Sonneborn or equal. Primer shall be as recommended by the manufacturer.
3. Exterior and interior sealant for joints on all other surfaces – **Type B** - shall be a one part, gun grade, polysulphide base non-sag Thiotok Sealant R.M. by Toch Brothers, Inc.; Pecora; Sonneborn or equal. Primer shall be as recommended by the manufacturer.
4. Exterior Metal Lap Joint Sealant: **Type C** - Butyl rubber and polyisobutylene blend, non-drying, non-skinning, non-curing. Use for concealed sealant bead in sheet metal work and concealed sealant bead in siding overlaps. Tremco Butyl Sealant.
5. Sealant for Continuous Water Immersion: **Type D** - Polyurethane; ASTM C920, Grade NS, Class 25, Uses M and A; approved by manufacturer for continuous water immersion; multi-component. Tremco Vulkem 922.
6. Silicone Sealant: **Type E** - ASTM C920, Grade NS, Class 25, Uses NT, A, M, G and O; single component, neutral curing, non-sagging, non-staining, mildew resistant, non-bleeding. Movement Capability; plus and minus 25 percent. Service Temperature Range: -65 to 180 degrees F. Tremco, Spectrem 3.
7. General Purpose Interior Sealant: **Type F** - Acrylic emulsion latex; ASTM C834, single component, paintable. Tremco, Tremflex 834.
8. Joint backing for joints in superstructure shall be approved closed cell polyethylene rods of diameters to suit joint conditions.

B. Compressible filler shall be foamed polyurethane strip saturated with polybutylene waterproofing material. When compressed to 50 percent of its original volume, filler shall hold a head of 6-ft of water, and a head of 10-ft of water when compressed 60 percent. Filler shall maintain its resiliency to allow for installation in temperatures as slow as 40 degrees F. Filler shall remain waterproof at 50 percent compression between temperatures of minus 40 and 200 degrees F. Elongation shall be at least 325 percent with a tensile strength of not less than 53 psi.

1. The polybutylene compound shall not migrate in the polyurethane strip. Compressible filler shall be Polytite by Sandell Manufacturing Company; Combriband by Secoa Corporation, Division of Phoenix Building Products, Inc. or equal.

C. Watertight Joint Filler

1. Joint Material - Closed-cell, cross linked ethylene vinyl acetate with a resistance to weather oxidation.

a. Compression and recovery: The load required to compress a specimen to 50 percent of its thickness before the test shall not be less than 10 or more than 60 psi. Upon removal of the test, the material shall recover at least 95 percent of its original thickness in 24 hours.
b. Extrusion - A specimen shall be compressed to 50 percent of its original thickness with three of its edges restrained. The amount of extrusion of the free edge shall not exceed 0.25-in.
c. Elongation - 25 degrees minimum at 0 degree F.
d. Density - 2.8 to 3.4 lbs/cu ft.
e. Water Absorption - A standard test specimen with four square cut edges, when submerged horizontally under 1-in of water at 70 degrees F plus 5 degrees shall absorb not more than 3.5 percent weight by volume of water in 24 hours.
f. Weather Test: FS HH-341a, Type 1 Standard Class A, No visible signs of deterioration.
g. Dimensional Variation:
1. 0 to 0.1181 thick plus 20 percent, minus 10 percent
2. 0.1181 to 0.2362 thick plus 15 percent, minus 5 percent
3. 0.2362 up plus 10 percent, minus 2 percent

2. Bonding agent - Two-component epoxy resin bonder that meets all requirements for bonding concrete to concrete, concrete to steel, concrete to wood and other materials as recommended by the manufacturer. Unmixed properties as follows:
a. Tensile: ASTM D1708, crosshead speed (0.05 ipm)
b. Age: C77 degrees F - 7 days
c. Tensile Strength: 3,900 psi
d. Elongation at break: 5.5 to 6.0 percent
e. Tensile Modulus: 1.4 x 10^5 psi
f. Flexural: ASTM D790, Procedure B, crosshead speed (0.015 ipm) 2-in span.
g. Mixed properties shall be as follows:
1) Compressive: ASTM D695, crosshead speed (0.05 ipm)
2) Compressive Strength, 7 day: 14,500 psi
3) Bond Strength, 24 hours: 650 psi
4) Adhesive (Tensile Shear), 7 days: ASTM D1002, 1,800 psi

3. Evasote Joint System by E-Poxy Industries, Inc. or equal.

D. Accessories: As recommended by the sealant and caulking manufacturer including, but not limited to the following;
1. Primer: Non-staining type to suit application.
2. Joint Cleaner: Non-Corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
3. Joint Backing: As indicated elsewhere in these specifications or round foam rod compatible with sealant; ASTM D1667, closed cell PVC; oversized 50 percent larger than joint width.
4. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of Caulking and Sealants
1. All joints to receive sealant shall be cleaned, primed, back filled and caulked in complete accordance with the manufacturer's instructions.
2. 2Sealant shall be applied generally to a square section configuration. Minimum depth of joint shall be 1/4-in and maximum 1/2-in. For joints greater than 1/2-in wide, provide sealant in a 2 to 1 width-to-depth ratio.

3. The surfaces of all materials adjoining caulked joints shall be cleaned free of all smears of sealant or other soiling due to caulking operations.
4. Perform installation in accordance with ASTM C1193.
5. Install bond breaker where joint backing is not used.
6. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
7. Tool joints slightly concave.
8. Clean adjacent soiled surfaces.

B. Installation of Expansion Joint Seals
1. Expansion joint seals shall be installed at the vertical expansion joints where detailed.
2. All surfaces to receive adhesive that are in contact with the seal shall be free from dirt, water, oil, rust, frost and loose debris.
3. Joint sides shall be constructed straight and parallel with no sharp edges.
4. Installation should not be done when temperatures are above 75 or below 40 degrees F.
5. The exterior of the joint shall be flush with the surrounding construction.

C. Installation of Compressible filler
1. Install compressible filler according to the manufacturer's written instructions for the situation where it is used.

D. Installation of Waterproof Joint Filler
1. Surface preparation
   a. Concrete
      1) Cleaned free of old existing coatings
      2) Cured 28 days minimum
      3) Dry preferred, moisture only if approved by the Engineer for difficult site conditions
      4) Cleaned of dirt
      5) Completely remove oil, grease and wax
      6) Acid etch surface only when surface pH is over 10
      7) Sandblast to clean and remove sharp edges or protrusions
   b. Steel
      1) Sandblast: SSPC SP-10
      2) Immediately apply bonder after sandblast cleaning
2. Bonder application
   a. Power caulking gun
   b. Trowel
   c. Hand application with rubber gloves
   d. Apply enough bonder so that it is squeezed out of the joint area when the filler is pressed together. Normally this will be 6 to 12 mils thick.
3. Environmental Conditions
   a. Apply at temperatures above minus 10 degrees F on dry surfaces only.
   b. Apply at temperatures above 32 degrees F on moist surfaces.

3.02 SCHEDULE

A. Schedule indicates only some of the major items requiring sealant and is not intended to be all inclusive.
1. Window Perimeter: Type E.
2. Door Frame to Walls Exterior: Type E.
3. Door Frame to Walls Interior: Type F.
4. Window Frames to Walls Interior: Type F.
5. Concrete Joints Vertical: Type B.
6. Concrete Joints Horizontal: Type A.
7. Water Immersion Joints: Type D.
8. Control and Expansion Joints in Paving: Type A.
9. Control and Expansion Joints in Masonry and between Masonry and Adjacent Work: Type E.

10. Lap Joints in Exterior Sheet Metal Work: Type C.
11. Butt Joints in Exterior Metal Work and Siding: Type C.
12. Under Exterior Door Thresholds: Type C.
13. Interior Joints for which no other Sealant is indicated: Type F.
14. Control and Expansion Joint in Interior Concrete Slabs and Floors: Type A.

3.03 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 07920

SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Extent of standard steel doors and frames is indicated and scheduled on drawings.

1. This work includes:
   a. Interior and exterior steel doors and frames.

2. Drawing and Scheduling Designations: This section applies to doors and frames referenced on the drawings and schedules using the terms "Hollow Metal Door", "Hollow Metal Frame", "Steel Door" and "Steel Frame".

B. Finish hardware is specified elsewhere in Division-8.

C. Glass and glazing in doors is specified elsewhere in Division-8.

D. Sealants used during installation of doors is specified in Division-7.

E. Building in of anchors and grouting of frames in masonry construction is specified in Division 4.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Shop Drawings: Submit for fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

C. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.

1. Indicate coordinate of glazing frames and stops with glass and glazing requirements.

1.07 QUALITY ASSURANCE

A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and as herein specified.

B. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated or required, provide fire-rated door and frame assemblies that comply with NFPA 80 "Standard for Fire Doors and Windows", and have been tested, listed, and labeled in accordance with ASTM E 152 "Standard Methods of Fire Tests of Door Assemblies" by a nationally recognized independent testing and inspection agency acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver hollow metal work cartoned or crated to provide protection during transit and job storage. Provide additional sealed plastic wrapping for factory-finished doors.

B. Inspect hollow metal work upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4" high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4" spaces between stacked doors to promote air circulation.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering steel doors and frames which may be incorporated in the work include; but are not limited to, the following:

1. Ceco Corp.
2. Curries Mfg., Inc.
3. Deansteel, Mfg., Inc.
4. Tex-Steel Corp.
5. Substitutions: See Section 01600 – Product Requirements .

2.02 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 569 and ASTM A 568.

B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.

C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, with ASTM A 525, G60 zinc coating, mill phosphatized.

D. Supports and Anchors: Fabricate of not less than 18-gage galvanized sheet steel.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D as applicable.

F. Shop Applied Paint:

1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as a base for specified finish paints.

2.03 FABRICATION, GENERAL

A. Fabricate steel door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site. Comply with SDI-100 requirements as follows:

1. Interior Doors: SDI-100, Type II, heavy-duty, Style 2, minimum 18-gage faces; and where indicated Type FG per SDI-106.
2. Exterior Doors: SDI-100, Type III, extra heavy-duty, Style 2, minimum 16-gage galvanized steel faces; and where indicated, Type FG per SDI-106.

B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel.

C. Fabricate frames, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot- rolled steel (at fabricator's option).

D. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat Phillips heads for exposed screws and bolts.

E. Thermal-Rated (Insulating) Assemblies:

1. At exterior locations and elsewhere as shown or scheduled, provide doors which have been fabricated as thermal insulating door and frame assemblies and tested in accordance with ASTM C 236.
2. Unless otherwise indicated, provide thermal-rated assemblies with U factor of 0.24 Btu/(hr x ft sq x deg.F) or better.

F. Finish Hardware Preparation: Prepare doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.

G. Frame Construction: Fabricate frames to shape shown.

1. Fabricate frames with mitered or coped and continuously welded corners and seamless face joints.
2. Provide welded frames with temporary spreader bars.
3. Interior Door Frames: 16 gage steel.
4. Exterior Door Frames: 14 gage galvanized steel, with prime coat for field painting.
5. Glazed Lights: Non-removable stops on non-secure side; size and configurations as indicated on the drawings.

H. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.

I. Locate finish hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.

J. Shop Painting:

1. Clean, treat, and paint exposed surfaces of steel door and frame units, including galvanized surfaces.
2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.
3. Apply shop coat of prime paint of even consistency to provide a uniformly finished surface ready to receive field-applied finish paint.

2.04 STANDARD STEEL DOORS

A. Provide metal doors of types and styles indicated on drawings or schedules.

B. Coordinate steel doors with adjacent work as required to assure proper installation.

2.05 STANDARD STEEL FRAMES

A. Provide metal frames for doors, borrowed lights, and other openings, of types and styles as shown on drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 16-gage cold-rolled furniture steel.

1. Fabricate frames with mitered and welded corners.
2. Form exterior frames of hot-dip galvanized steel.

B. Door Silencers: Except on weather-stripped frames, drill stops to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.

C. Plaster Guards: Provide 26-gage steel plaster guards or mortar boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

PART 3 EXECUTION

3.01 DOOR INSTALLATION

A. General: Install standard sheet doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

B. Placing Frames: Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames", unless otherwise indicated.

1. Except for frames located at in-place concrete or masonry and at drywall installations, place frames prior to construction of enclosing walls and ceilings. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
2. In masonry construction, locate 3 wall anchors per jamb at hinge and strike levels.
3. At in-place concrete or masonry construction, set frames and secure to adjacent construction with machine screws and masonry anchorage devices.
4. Install fire-rated frames in accordance with NFPA Std. No. 80.
5. In metal stud partitions, install 4 wall anchors in hinge jamb, and 3 wall anchors in strike jamb; two at top hinge level of hinge jamb, and one each at hinge and strike levels. In steel stud partitions, attach wall anchors to studs with tapping screws.

C. Door Installation:

1. Fit hollow metal doors accurately in frames, within clearances specified in SDI-100.
2. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.

3.02 ADJUST AND CLEAN

A. Prime Coat Touch-Up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

B. Clean surfaces promptly after installation of doors. Exercise care to avoid damage to the finish. Remove excess glazing and sealant compounds, dirt, and other substances.

C. Final Adjustments: Check and readjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and proper operating condition.

3.03 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08110

SECTION 08330 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and install service doors as shown on the Drawings and as specified herein.

B. The door types include the following:
   1. Roll-up type, overhead steel doors, insulated, and with motor and hand chain operation as scheduled.

C. Where required, all motors, starters, push button stations and power and control wiring from each disconnect switch shall be furnished and installed under this Section and in accordance with Division 16.

D. Provide Bracket Mounted Safety Accordion Strip Door for designated doors.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A153 - Standard Specification for Zinc-Coatings (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc- Iron, Alloy-Coated by the Hot-Dip Process.

B. National Electrical Manufacturers Association (NEMA)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”: complete shop drawing showing materials, construction, tracks, hardware, bracing, wiring diagrams, motor data and characteristics, hand crank operator specifications, door guides, appurtenances and installation details of doors proposed.

1.07 NOT USED

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original, undamaged protective coverings with labels legible and intact. Store materials in protective coverings in a manner to prevent damage from the environment and construction operations.
   1. Handle in accordance with the manufacturer's instructions.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 GENERAL

A. All exterior doors and components shall withstand 20 psf wind load and associated negative pressures.

B. Provide additional, non-standard door bracing, reinforcements, or heavier gauge materials required to conform to wind load.

2.02 OVERHEAD ROLL-UP DOOR

A. Exterior power operated roll-up doors shall be mounted on the inside wall, equal to Model 625 RG, thermal series interlocking slat, manufactured by Overhead Door Corporation, Dallas, Texas: 800-887-3667 or 972-233-6611/972-233-0367 fax, similar by Cookson; North American or equal. Curtain shall be of interlocking slats of galvanized steel. Slats shall give curtain adequate strength to safely resist wind load specified. Each slat shall be formed of two 22 gauge galvanized steel layers enclosing an 3/4-in foamed in placed layer of CFC-free foamed-in-place polyurethane insulation. Slats shall have endlocks locking each end of every slat and to act as wearing surface and maintain slat alignment.

B. The counterbalance, coil brackets, and hood shall be fabricated in accordance with the manufacturer's standard practice. The coil shall be housed in a 24 gauge galvanized steel sheet metal hood laterally reinforced. Guides shall be fabricated of structural steel of sufficient size, thickness and of depth to retain the curtains in the guides against the wind load specified. Guides shall be provided with anchors and continuous weld-on wind lock bars all galvanized after fabrication.

C. The door bottoms shall be provided with a combination safety device and weather seal. The safety device shall be an electrical device working in conjunction with the operator control. A compressible strip shall be mounted along the bottom of the rolling door curtain. In the event that the door in its downward travel comes in contact with any object in the opening, this strip shall compress, activating an electrical control that will automatically stop and reverse the curtain travel causing it to return to the fully raised position. The compressible strip shall also serve as a weatherstrip along the bottom of the door.

D. Power operated doors shall be provided with an electric operator with a minimum 1/2 Hp motor wired for operation on a 120 Volt, single phase, 60 Hz service. Control shall be wired for 120 Volts, single phase. A suitable control transformer shall be supplied. The operator shall be bracket mounted and provided with a protective sheet metal housing. Motor shall be high starting torque, hoist-type having sufficient power to operate the door at an average speed of one foot per second. Where called for to be explosion proof on the Drawings, operator and associated electrical control components shall be approved for use in Class 1, Division 1, Groups C and D Hazardous Areas.

E. Power operated doors shall be controlled by a maintained contact, NEMA 4, 2 unit push button station marked "OPEN" and "CLOSE" and an automatic rotary limit switch which will break the switch at termination of travel. High efficiency worm gearing, running in an oil bath, shall be furnished together with a spring-set solenoid-operated brake completely housed to protect against damage, dust and moisture and a magnetic reversing contactor

in NEMA Type 1 enclosure. Continuous hand crank emergency operator which will not affect the timing of the limit switch shall be provided to operate doors in case of power failure or removal of motor. Operators shall have mechanical advantage of 3:1.

F. Operator shall be designed to transmit motion to the door without shock and automatically release motor from driving unit prior to stalling so as to prevent damage to unit from any type of overload. An efficient overload protective device which will break the control circuit and eliminate any possible damage to motor winding shall be both heat and current sensing and shall be installed integrally with the unit.

G. Provide approved neoprene weatherstripping at interior on each guide and in hood.

H. Provide hand crank operators for manual override in case of power failure.

2.03 FINISH

A. All steel components and (where so noted) hardware shall be galvanized.

B. Galvanizing shall be of zinc applied by a hot-dipped process. For sheet steel, zinc shall be applied at not less than 0.90 oz/sq ft of steel and in a manner as to provide a ductile coating, tightly adherent to base metal and conforming to bend tests conducted in accordance with ASTM A653. Structural shapes and similar heavy steel shall be galvanized per ASTM A123 and A153 as applicable. Provide a phosphate coating for paint adhesion at the factory. The manufacturer's certificate shall be furnished to the Engineer stating that galvanizing has been done as specified herein.

C. Galvanized components shall be shipped with no additional surface treatment for priming and finishing in the field. Baked-on, prime painted surfaces which are compatible with the finished paint specified in Division 9 may be acceptable if approved.

PART 3 EXECUTION

3.01 INSTALLATION

A. All doors and components shall be installed and adjusted in accordance with the details shown and the approved shop drawings.

B. Doors shall be tested for full and effective operation by the Engineer. Electrically operated doors shall be tested in manual and electric operation.

C. Make required adjustments to provide operation as approved.

3.02 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08330

SECTION 08450 – FIBERGLASS-SANDWICH PANEL ASSEMBLIES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment, and incidentals required and install fiberglass sandwich panels as shown on the Drawings and as specified herein.
   1. All battens, perimeter closures, flashings, bent plate connectors under panels, fasteners, sealing tapes and sealants within the systems and all appurtenances required.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. A. American Society for Testing and Materials (ASTM)
   1. ASTM C236 - Standard Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
   2. ASTM C297 - Standard Test Method for Flatwise Tensile Strength of Sandwich Construction.
   3. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   4. ASTM D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal to Metal).
   5. ASTM D1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
   6. ASTM D1183 - Standard Test Methods for Resistance of Adhesives to Cyclic Laboratory Aging Conditions.
   7. ASTM D2244 - Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
   8. ASTM D3841 - Standard Specification for Glass-Fiber-Reinforced Polyester Plastic Panels.
   9. ASTM E72 - Standard Methods of Conducting Strength Tests of Panels for Building Construction.
   10. ASTM E84 - Standard Test Methods for Surface Burning Characteristics of Building Materials.

B. American Architectural Manufacturers Association (AAMA)
   1. AAMA 603.8 - Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED
1.05 NOT USED
1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”: shop drawings showing all panels,

flashing, connections and appurtenances and all proposed materials. Submittals shall include the following:

1. A notarized certification that the panel system, as detailed on the shop drawings, will perform satisfactorily when subjected to the wind loading requirements prescribed for the locality.
2. Test reports shall be furnished by the panel system manufacturer as provided above for shop drawings. The manufacturer shall submit certified test reports, made by an independent testing organization for each type and class of panel. Reports shall verify that the material will meet all performance requirements of this Section. Previously completed test reports will be acceptable if current and indicative of products used on this project. Test reports required are:
   a. Flame Spread and Smoke Development (ASTM E84)
   b. Burn Extent (ASTM D635)
   c. Color Difference (ASTM D2244)
   d. Impact Strength (SPI Method)
   e. Bond Strength (ASTM C297 and ASTM D1002)
   f. Accelerated Aging (ASTM D1037)
   g. Beam Bending Strength (ASTM E72)
   h. Insulated U Factor (ASTM C236)
   i. Class A Roof Covering Burning Brand (ASTM E108)
3. 12-in square minimum samples of each proposed panel showing overlapping joint where required, battens perimeter framing, fasteners and finished proposed.

1.07 NOT USED

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Store panels fully wrapped on long edge and on wood blocks above ground and other materials in unopened packages, all in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.
B. Furnish five year manufacturer warranty.
C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Facing panels shall be by Kalwall especially for architectural use and conforming to the following requirements.
   1. Flammability
      a. The interior face sheet shall have a flamespread rating no greater than 50 and smoke development no greater than 250 when tested in accordance with ASTM E84 for insulated panels. Burn extent by ASTM D635 shall be no greater than 1-inch. Faces shall not deform, deflect or drip when subjected to fire or flame or delaminate when exposed to 300 degrees F for 25 minutes per UBC.
   2. Weatherability
      a. Overall degradation factor shall be 10 or less according to ASTM D3841, Method B.

b. The exterior face shall not change color more than 3.0 Adams Units (DELTA E by ASTM D2244) after 5 years outdoor weathering in South Florida at 5 degrees facing South, determined by the average of at least three samples.
c. The face sheet of insulated panels shall not darken more than 0.2 (DELTA L by ASTM D2244) when exposed to 150 degrees for 2 weeks.
d. The exterior faces shall have a permanent glass erosion barrier integrally embedded for maximum resistance to erosion and weather, applied, in the factory under controlled temperature conditions. Sacrificial surface films or coatings are not acceptable erosion barriers. Exterior face surface loss shall not exceed .7 mils and 40 mgs when tested in accordance with ASTM D-4060-90 employing CS17 abrasive wheels at a head load of 500 grams for 1000 cycles.
e. Initial transmission of each face of solar panels shall be 35 percent; with less than 5 percent transmission loss after 300 hours exposure to 200 degrees F.

3. Appearance
   a. The face sheets shall be uniform in color to prevent splotchy appearance.
   b. Exterior face sheets shall be 0.070-in thick, crystal in color and interior face sheets shall be 0.045-in thick, white in color, all as approved for appearance and transmission properties. Faces shall not vary more than plus or minus 10 percent in thickness.
   c. The faces shall be completely free of ridges and wrinkles which prevent proper surface contact in bonding to the aluminum grid core. Clusters of air bubbles and pinholes which collect moisture and dirt will not be acceptable.
4. Strength
   a. The exterior face sheet shall be uniform in strength and repel an impact equal to 70 ft-lbs without fracture or tear when impacted by a 3 ¼" diameter, 5 lb. free-falling ball per UL 972.

B. Grid Core - Provide aluminum I-beams of 6063-T6 alloy with provision for mechanical interlocking of muntin-mullion and perimeter to prevent high and low intersections which do not allow full bonding surface to contact with face material. Width of I-beam shall be no less than 7/16-in. Aluminum I-beam for the grid shall be machined to tolerances of not greater than plus or minus 0.002-in. A welded or web interlocked grid core shall not be acceptable due to unevenness at muntin-mullion intersections.

C. Laminating adhesive shall be heat and pressure type engineered for structural sandwich panel use. Adhesive shall pass testing requirements specified by the International Conference of Building Officials Acceptance Criteria for Sandwich Panel Adhesive. Minimum strength shall be as follows:

1. 750 psi tensile strength by ASTM C297 before and after two exposures to six cycles each of the aging conditions prescribed by ASTM D1037.

2. Minimum shear strength average of all five separate exposures by ASTM D1002:
   a. 50 percent relative humidity at 73 degrees F: 540 PSI
   b. Accelerated Aging by ASTM D1037 at room temperature: 800 PSI
   c. Accelerated Aging by ASTM D1037 at 182 degrees F: 250 PSI
   d. 182 degrees F: 100 PSI
   e. 500 Hour Oxygen Bomb by ASTM D-572: 1400 PSI

D. Battens, Perimeter Closures and Flashing

1. Provide extruded 6063-T6 and 6063-T5 alloy aluminum screw clamp-tite batten and closure system with 6061 alloy sheet aluminum flashing, 0.040-in thick unless otherwise shown. Provide 6061 alloy bent plate connector members as shown under panels.
2. All battens and perimeter closures to be supplied with 300 series alloy stainless steel screws and sealing head washers of neoprene and stainless steel. Provide similar alloy screws bolts and nuts as required for securing to structure.
3. All exposed aluminum shall receive the corrosion resistant finish specified below.
4. Receiving channels for self-tapping stainless steel screws to be continuous the length of each member and extruded as part of the member. Threaded receiving channel will not be acceptable.

E. Sealing Tapes and Sealants
1. Flexible sealing tape at battens and perimeter closure framing shall be manufacturer's standard neoprene as approved, pre-applied to closure system at the factory under controlled conditions.
2. Foam tape where shown and required shall be manufacturer's standard as approved.
3. Sealant where shown and required shall be Dow Corning 795 Silicone Building Sealants, similar by General Electric or equal. Provide in approved color.

2.02 PANEL CONSTRUCTION

A. Panels shall have a thickness of 2-3/4-in. Panels shall have a "U" factor of .53, a light transmission of 35 percent, a wall solar heat gain coefficient of .39 and a shading coefficient of 0.45.
B. Panels and perimeter frame shall be pre-assembled where practical and sealed at the factory.
C. Panels shall be a true sandwich panel of flat fiberglass face sheet bonded to a grid core of mechanically interlocking aluminum I-beams and shall be laminated under a controlled process of heat and pressure.
D. Panel deflection shall not exceed 1.9-in at 30 lbs/sq ft loading in 10’ span and shall not exceed 0.10-in set deflection 5 minutes after load release per ASTM E72 with a 12-ft clearspan.

E. Grid pattern shall be nominal 12-in wide by 24-in high or as shown on the drawings and symmetrical about the horizontal center line of each panel.

F. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge. In order to insure bonding strength, white spots at intersections of muntins and mullions shall not exceed 4 for each 40 sq ft of panel, nor shall they be more than 3/64-in in width.

2.03 FINISH

A. The corrosion resistant finish for all exposed aluminum shall be made from acrylic copolymer which meets the performance requirements of Mil Spec L-1448A or the requirements of the AAMA 603.6 modified.
B. The corrosion resistant finish shall be factory applied under controlled conditions. All aluminum to be wash-primed per Mil Spec C-15328B. Finish shall be even over the entire exposed aluminum surface and have a minimum dry film thickness of 2 mils.
C. The corrosion resistant finish shall have sufficient adhesion to withstand 10 years outdoor exposure of 7 degrees to the horizontal, facing South in South Florida with no blistering or peeling. Provide test date as required.
D. The corrosion resistant finish shall be resistant to atmospheric acids, alkalies, gases, salt solutions and water as approved.

E. Color shall be mill aluminum selected from the manufacturer's standards by the Engineer. The color shall be uniform in appearance as approved.

PART 3 EXECUTION

3.01 3.01 PREPARATION

A. A. Provide isolation of dissimilar materials from aluminum system which may cause damage by electrolysis. Provide approved vinyl tape or other means for separation.

3.02 3.02 ERECTION

A. Install system, fasten and seal in accordance with details shown and approved shop drawings. All aluminum shall be cleaned before sealants are applied.

3.03 3.03 INSPECTION AND REPAIR

A. Immediately prior to substantial completion of project, carefully inspect panel installation and made adjustments necessary to insure proper installation and weather-tight conditions.

B. Repair or, if ordered, replace defective or damaged components.

3.04 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08450

SECTION 08510 - ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Prefinished aluminum window frames for exterior use.

B. Prefinished aluminum window frames for interior use

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITALS

A. Furnish the following in accordance with Specification Section 01300, "Submittals" and Section 01730, "Operation and Maintenance Data".

B. Product Data: Materials and details of design and construction hardware locations, reinforcement type and locations, anchorage and fastening methods and finishes.

C. Shop Drawings: Details of each opening, show elevations, glazing and frame profile.

D. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.07 NOT USED

1.08 DELIVERY, STORAGE AND HANDLING

A. Store in accordance with the manufacturer's recommendations.

B. Protect with resilient packaging; avoid humidity build-up under coverage.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Aluminum Frame Basis-of-Design for interior windows: The design for aluminum frames is based Series 7225, Non-thermal, 2 1/4" Deep frame, fixed as manufactured by Kawneer; height of system as indicated on Drawings.

1. Substitutions: See Section 012500 – Substitution Procedures.

2.02 ACCEPTABLE MANUFACTURERS

A. Aluminum Frame Basis-of-Design for exterior windows: The design for aluminum frames is, TRACO TR-9450 Fixed Thermal Aluminum Window as manufactured by Kawneer; height of system as indicated on Drawings.

1. Substitutions: See Section 012500 – Substitution Procedures.

2.03 MATERIALS

A. Aluminum: Meeting requirements of ASTM B221, 6063T5 alloy, and as otherwise required to assure compliance with dimensional tolerances and maintain color uniformity.

B. Anchorage Devices, Clips, and Fasteners: manufacturer's standard type, compatible with materials being secured.

C. Anchorage Devices, Clips, and Fasteners: manufacturer's standard type, compatible with materials being secured.

D. Accessories: As necessary for complete system.

2.04 FABRICATION

A. Frames: shall be machines, mechanically fastened and sealed to from a watertight joint.

B. Do not exceed maximum size of window to meet applicable code requirements.

C. Component forming: all aluminum components shall be formed, free of scratches and burrs, before application of finish.

2.05 FINISHED

A. Factory finish extruded frame components so that all parts exposed to view upon completion of installation are uniform in finish and color. Exposed surfaces shall be free of scratches and other serious blemishes.

B. Anodized: AA-M12C22A44, Architectural Class I Anodic Coating, color #40 Dark Bronze.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install standard frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

B. Install frames plumb and square, free from warp or twist, securely anchored to substrates with fasteners recommended by frame manufacturer. Maintain dimensional tolerances and alignment with adjacent work. Ensure joints are hairline tight and surfaces flush with adjacent components.

3.02 PROTECTION AND CLEANING

A. After installation, the Contractor shall adequately protect exposed portions of aluminum surfaces from damage by grinding and polishing compounds, plaster, lime, texture, acid, cement, or other contaminants. The contractor shall be responsible for final cleaning.

3.03 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08510

SECTION 08710 - DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and deliver to the project site all finish hardware as shown on the Drawings and as scheduled or as specified herein.

B. The schedule included herein designates the type and quality of the hardware desired. The brand of hardware furnished shall be equivalent to the brand scheduled.

C. Furnish and deliver to the door manufacturers all templates and schedules required by the manufacturers of the doors and frames to enable the manufacturers to make proper provision in their work to receive the finish hardware. All locks, lock strikes and flush bolts shall be made to ANSI standard dimensions.

D. Furnish padlocks as scheduled in the quantity specified.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. American National Standards Institute (ANSI)

B. Underwriters Laboratories (UL)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data: complete shop drawings and product data for all items furnished under this Section. Shop drawings shall include a detailed hardware schedule identifying for each door item of hardware the item name, manufacturer's name, product number and the location to be installed in the work. Hardware templates shall not be distributed until the hardware schedule has been reviewed and approved in accordance with Section 01300. Submittals shall include the following:

1. Samples of hardware items proposed for use may be requested prior to approval to confirm standards of quality, including materials and finishes. If requested, two representative samples of each hardware item shall be submitted for review within ten days after the request is made.
2. No hardware items for which samples have been requested may be installed until the samples are approved.

1.07 QUALITY ASSURANCE

A. The hardware supplier shall have in his employ one or more members of the American Society of Architectural Hardware Consultants, who shall be responsible for the selection of hardware items; preparation and submittal of shop drawings, product data and

samples and coordinating delivery of approved hardware items to the site of the work or to the door manufacturers as appropriate.

1.08 DELIVERY, STORAGE AND HANDLING

A. Packaging
   1. All hardware shall have the required screws, bolts and fastenings and instructions necessary for proper installation, wrapped in paper and packed in the same package as the hardware.
   2. Each package shall be legibly labeled, indicating that portion of the work for which it is intended.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MATERIALS

A. All hardware shall be entirely free from imperfections. Qualities, weights and sizes specified herein are the minimum that will be accepted. Provide hardware listed by UL for fire at labeled doors, except that hinges which are not UL approved shall have a melting point of greater than 2000 degrees F. Provide exit devices UL listed for panic situations.

B. Hardware Items
   1. Hinges
      a. Hager BB1191-NRP 4 1/2-inch by 4 1/2-inch.
   2. Locksets
      a. Best as approved by Owner's representative, stainless steel, with Broadway BRR Design, Cast lever handle and Wrought rose, six pin cylinders (operation as scheduled.).
   3. Closers
      a. (Door Closers) - Provide with cushion arm. LCN 4040 Series CUSH -TB stainless steel arms with aluminum polyurethane finish on all closer components by LCN or equal.
   4. Kick Plates - Stainless Steel, 8-inch high by 0.050-inch thick by 2-inch less width of door (LWOD), 1-inch LWOD, at double doors.
   5. Stops – Ives FS13, FS450, or FS452-4 (as required by floor condition).
   6. Door Bottoms Sound/Weather Seal – 360 F (rated for "A" label) 420_pkl automatic door bottom for HM doors, aluminum by Pemko or equal.
   7. Heads and Jambs Sound/Weather Seals - Hollow Metal Doors (Zero 770 provided with Aluminum Door Frames); Series 3000, by Pemko or 5050-BN or equal.
   8. Silencers - Glynn-Johnson GJ 64, similar by Baldwin or equal.
   9. Threshold
      a. Type A - Zero 565 A aluminum;
      b. Type B (handicapped) - Zero 655A - aluminum Pemko, similar by Reese or equal.
      c. Type C - Zero 105, Zero 268 A, and Zero 676A (roof access) (Three parts make one threshold); Pemko, similar by Reese or equal.
      d. Type D - National Guard 425

10. Overhead Stop and Holders - 90 Series with 110 degree hold open, unless noted otherwise Glynn-Johnson.
11. Padlocks – Best Cylinder Padlock
12. Exit Devices - Stainless steel, by Von Duprin with outside trim at doors as required, provide devices with center support brackets for crossbars. Brackets shall be designed as an integral part of the device. For single doors, exit devices shall be model 99-L typical, with model 99L-BE some locations (for "passage" type functions.) For double doors, exit devices shall be model 9927-L on active leaf, with model 9927-EO on inactive leaf.
13. Key Cabinet for fifty doors minimum. Telkee Regent by P.O. Moore; Lund; HPC Inc. or equal.
14. Coordinators with carry bar strike, 900 Series by Ives Inc. or equal. Finish to be chrome plated ANSI 626.
15. Flush Bolts – Trimco 3917-12", Ives 12-inch with 24-inch top bolts at 8-foot-6-inch doors No. 458 similar by Baldwin or equal.
16. Self Latching Flush Bolts - Ives 12-inch, No. 359, UL listed, similar by Baldwin or equal.
17. Chain Bolts - Stanley SP1055, 6-inch cases, 8-foot chains, ANSI 652.
18. Astragals – None or removable. 115 NA as scheduled.
19. Rain drip – 4" - 16A, National Guard
20. Door Sweep- 102V, National Guard

C. Closers and overhead stop and holders shall be sized as recommended by manufacturer and as approved for size and location of door served. The mounting of the closer and overhead stop and holder shall be coordinated for the operation of both items.

D. On exterior doors, provide hinges with pins not removable when door is closed. Provide 1/2 pair hinges for each 2-foot-6-inch or part thereof of door height. Provide thresholds as scheduled and full perimeter sound/weather seal system for threshold, head and jambs.

E. Provide full perimeter sound seals where required in acoustical areas as noted on the Drawings and in Door Schedule for exterior and interior doors and frames.

F. Provide type of threshold required by the Door Schedule for particular doors.

G. Provide three silencers in lock side jamb of single doors and four silencers in head of double doors. Silencers are not required at doors with sound/weather seals.

H. Closers shall be designed to clear weatherstripping. Brackets to hold closers are to be located inside the frame door stops where the weatherstripping is mounted. (Drop plate installation.)

I. Exit devices shall have stainless steel springs, and main arm pivots in addition to the stainless steel finish. Crossbars and arms shall be counter balanced. Crossbars shall have a minimum wall thickness of 0.62-inch or be reinforced.

2.02 FINISHES

A. Base metal for hardware shall be stainless steel for all items unless it is not available. Finish shall be ANSI 630. All hardware not available in stainless steel shall be bronze or brass with chrome finish ANSI 626.

B. For those items of hardware which are not able to be fabricated from stainless steel, the base metal shall be bronze or brass [steel]. Finish shall be ANSI 626, chrome plated.

C. Provide tactile warning on the door handles of hazardous locations. Door locations are as scheduled.

2.03 KEYING

A. All cylinder locks including padlocks shall be grand masterkeyed in one new set that is coordinated with the Owner's system. All cylinders shall be Construction Keyed for Contractor's use during construction period. Install permanent cylinders when directed. Keys and locks on any existing facilities shall remain as existing.

B. Provide one Grand Master and two Sub-masters (Administration and Plant Operations). The system division will be supplied by Engineer during construction.

C. Furnish
   1. Two Grand Master keys
   2. Three master keys
   3. Two Change keys with each lock
   4. Three Construction day keys

PART 3 EXECUTION

3.01 SCHEDULE OF HARDWARE SETS

A. The following general hardware sets represent hardware for one opening (single or pair of doors). Refer to Materials paragraphs above for additional items required under specified conditions. Quantities of each set supplied shall be sufficient to complete the work. Refer to Door Schedule for locations. The actual content of each set shall be determined by approved hardware sets.

1. HW 1 TBD

3.02 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08710

SECTION 08800 - GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Double insulated glass
   2. Glazing sealants.
   3. Glazing accessories.

B. Types of work in this section include work for:
   1. Exterior windows.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 REFERENCES

A. 16 CFR 1201 -- Safety Standard for Architectural Glazing Materials; Consumer Products Safety Commission; 1977 (with 1984 Revision).

B. AAMA 800-92 -- Voluntary Specifications and Test Methods for Sealants; American Architectural Manufacturers Association; 1992.

C. ANSI Z97.1-1984 -- American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 1984.

D. ASTM C 509-91 -- Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material; 1991.

E. ASTM C 864-90 -- Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 1990.

F. ASTM C 920-87 -- Standard Specification for Elastomeric Joint Sealants; 1987.

G. ASTM C 1036-91 -- Standard Specification for Flat Glass; 1991.

H. ASTM C 1048-91 -- Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; 1991.

I. ASTM E 163-84 -- Standard Methods of Fire Tests of Window Assemblies; 1984.

J. Glazing Manual; Flat Glass Marketing Association (FGMA); 1990.

K. Sealant Manual; Flat Glass Marketing Association (FGMA); 1990.

1.04 DEFINITIONS

A. Shading Coefficient: Fraction of total solar energy transmitted when compared to that transmitted by 3 mm clear glass.

B. Light Transmittance: Percent of visible daylight transmitted, unless otherwise indicated.

C. Reflectance: Percent of total daylight reflected, unless otherwise indicated.

D. Solar Heat Gain Coefficient: The ratio of total solar heat gain through the glass relative to the incident of solar radiation.

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Exterior Glazing: Provide glazing assemblies which will withstand normal conditions without failure, loss of weathertightness, or deterioration.
   1. Design to accommodate thermal movement resulting from:
      a. Air temperature range of 120 degrees F.
      b. Material temperature range of 180 degrees F.

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Product Data: Manufacturer's data, describing product characteristics, installation instructions and recommendations, and maintenance procedures.
   1. Sustainable Design Submittals:
      a. Submit manufacturer's product data for sealants. Indicate VOC limits of the product. Submit MSDS highlighting VOC limits.

C. Samples of Glass: 12-inch-square samples, of:
   1. Each type of glass.

D. Samples of Sealants Exposed to View: Cured samples of each type and each color, other than black.

E. Samples of Gaskets: 6-inch-long sample of each type and each color, other than black.

F. Certificates for each product, from manufacturer stating that product used on the project complies with specified requirements.

G. Sealant-Substrate Test Reports: For each exterior sealant.

H. Weathertight Warranty.

I. Mockups: Before glazing, build mockups for each glass product indicated below to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work:
   1. Build mockups of exterior applications to match glazing systems required for Project, including typical lite size, framing systems, and glazing methods:
   2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
   3. Obtain Architect's approval of mockups before starting fabrication.
   4. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.07 QUALITY ASSURANCE

A. Standard for Fire-Resistance Rated Glass: ASTM E 163; each piece labeled by:
   1. Underwriters Laboratories Inc. (UL).

B. Certified Safety Glazing: Provide Category II products which comply with test requirements of 16 CFR 1201 and ANSI Z97.1 and permanently marked with label of:
   1. Safety Glazing Certification Council (SGCC).

C. Sealant-Substrate Tests: Have manufacturer of sealant test glazing materials, glass, and substrates for proper adhesion and compatibility.
   1. Use sealant manufacturer's standard test methods.
   2. Provide as many samples as manufacturer requires.
   3. Allow adequate time for testing to prevent delay in the work.
   4. Submit sealant manufacturer's report on testing and recommendations for use of sealants and preparation of substrates.

D. Project Mockup Panels: Before beginning wall construction, participate in project mockup panels, using materials indicated for the completed Work, to verify selections made under mockup wall panel Submittals and to demonstrate aesthetic effects and construction techniques. Build mockup wall panels for each type of exposed unit masonry assembly in sizes shown on the Drawings.

E. Pre-installation Meeting: Have all installers whose work is related to glazing work meet to review installation procedures, sequencing, coordination, and methods of protection of completed work.
   1. Have on hand, and keep at the site for the duration of glazing operations, a copy of the following:
      a. Each referenced document which applies to installation.
      b. Installation instructions of each manufacturer of products.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect products in accordance with manufacturer's recommendations; specifically, avoid damage to glass edges; prevent damage due to temperature changes, sunlight, and moisture.

1.09 PROJECT CONDITIONS

A. Environmental Conditions: Do not install glazing when either air or substrate temperature exceeds the range recommended by manufacturer or when substrate is wet, damp, or covered with snow, ice, or frost.

B. Install bulk sealants only at air and substrate temperatures above 40 degrees F.

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Glass Manufacturers - General:
   1. Obtain materials from only one manufacturer or fabricator for each type; obtain tinted primary glass (if any) used for each type from only one manufacturer.
   2. Where product names are indicated, no substitutions are allowed.

B. Manufacturers:
   1. Primary float glass: Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
      a. AFG Industries, Inc.
      b. Ford Glass Division/Ford Motor Company.
      c. Guardian Industries Corporation.

d. Libbey-Owens-Ford Company.
e. Saint Gobain.

2. Heat-treated glass: Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
   a. AFG Industries, Inc.
   b. Guardian Industries Corporation.
   c. HGP Industries, Inc.
   d. Spectrum Glass Products, Inc.
   e. Tempglass Division/Indal Ltd.
   f. Viracon, Inc.

2.02 GLASS PRODUCTS

A. Clear Float Glass: Clear, fully tempered.
   1. Comply with ASTM C1036, Type I, transparent flat, Class 1 clear, Quality q3 glazing select.
   2. Comply with ASTM C1048, Condition A uncoated, type I, transparent flat, Class 1, Quality q3 glazing select.

B. Safety Glass: Clear; heat strengthened.
   1. Laminated with 0.015 inch thick plastic interlayer; comply with ASTM C1172, ¼" inch thick.

C. Coated Tinted Heat-Treated Float Glass: Provide Kind HS (heat-strengthened) coated float glass in place of coated annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in "Performance Requirements" Article. Provide Kind FT (fully tempered) where safety glass is indicated.
   1. Low E Glass (Type I): Float type, Low E pyrolytic surface on surface 2, ½" air space, clear glass on inside pane, heat strengthened; tempered; laminated; or annealed clear where indicated .
   2. Provide insulating glass units with the following performance values:
      a. Thickness: 1-inch.
      b. Outdoor Lite: Low-E sputter coated on second surface.
      c. Indoor Lite: clear float glass.
      d. Transmittance:
         1) Visible 54%
      e. Reflectance:
         1) Visible Out 36%
   3. Comply with ASTM C 1036, type I, transparent flat, Quality Q3 (glazing select).
   4. Comply with ASTM C 1048.

2.03 ELASTOMERIC GLAZING SEALANTS AND PREFORMED GLAZING TAPES

A. General: Provide products of type indicated and complying with the following requirements:
   1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials with which they will come into contact, including glass products, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
   2. Suitability: Comply with recommendations of sealant and glass manufacturers for selection of glazing sealants and tapes which have performance characteristics suitable for applications indicated and conditions at time of installation.
   3. Elastomeric Sealant Standard: Provide manufacturer's standard chemically curing, elastomeric sealant of base polymer indicated which complies with ASTM C 920 requirements, including those for Type, Grade, Class and Uses.
   4. Colors: Provide color of exposed sealants indicated or, if not otherwise indicated, as selected by Architect from manufacturer's standard colors.

B. One-Part Non-Acid-Curing Silicone Glazing Sealant: Type S; Grade NS, Class 25; Uses NT, G, A, and, as applicable to uses indicated, O; and complying with the following requirements for modulus and additional joint movement capability.
   1. Low Modulus: Tensile strength of 45 psi or less at 100 percent elongation when tested per ASTM D 412 after 14 days at 77 deg.F (20 deg.C) and 50 percent relative humidity.
   2. Additional capability, when tested per ASTM C 719 for adhesion and cohesion under maximum cyclic movement, to withstand the following percentage increase and decrease of joint width, as measured at time of application, and remain in compliance with other requirements of ASTM C 920.
      a. 40 percent.

C. Preformed Butyl-Polyisobutylene Glazing Tape: Provide manufacturer's standard solvent-free butyl-polyisobutylene formulation with a solids content of 100 percent; complying with AAMA A 804.1; in extruded tape form; non-staining and non-migrating in contact with nonporous surfaces; packaged on rolls with a release paper on one side; with or without continuous spacer rod as recommended by manufacturers of tape and glass for application indicated.

D. Available Products: Subject to compliance with requirements, glazing sealants which may be incorporated in the work include, but are not limited to, the following:
   1. One-Part Non-Acid Curing Low-Modulus Silicone Glazing Sealant:
      a. "Chem-Calk 1000"; Bostik Construction Products Div.
      b. "Dow Corning 790"; Dow Corning Corp.
      c. "864"; Pecora Corp.
      d. "Omniseal"; Sonneborn Building Products Div., Rexnord Chemical Products Inc.
      e. "Spectrum 1"; Tremco, Inc.
   2. Preformed Butyl-Polyisobutylene Glazing Tape Without Spacer Rod:
      a. "Chem-Tape 40"; Bostik Construction Products Div.
      b. "Extru-Seal"; Pecora Corp.
      c. "PTI 303" Glazing Tape; Protective Treatments, Inc.
      d. "Tremco 440 Tape"; Tremco Inc.
   3. Preformed Butyl-Polyisobutylene Glazing Tape With Spacer Rod:
      a. "Chem-Tape 60"; Bostik Construction Products Div.
      b. "Shim-Seal"; Pecora Corp.
      c. "PTI 303" Shim Tape; Protective Treatments, Inc.
      d. "Pre-shimmed Tremco 440 Tape"; Tremco Inc.

2.04 GLAZING GASKETS

A. Dense Elastomeric Compression Seal Gaskets: Molded or extruded gaskets of material indicated below, complying with ASTM C 864, of profile and hardness required to maintain watertight seal:
   1. Neoprene.
   2. EPDM.
   3. Thermoplastic polyolefin rubber.
   4. Any material indicated above.

B. Cellular Elastomeric Preformed Gaskets: Extruded or molded closed cell, integral-skinned neoprene of profile and hardness required to maintain watertight seal; complying with ASTM C 509, Type II; black.

C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
   1. Manufacturers of Preformed Gaskets:
      a. D. S. Brown Co.
      b. Maloney Precision Products Co.
      c. Tremco.

2.05 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide materials with proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers and Sealers: Type recommended by sealant or gasket manufacturer.

C. Setting Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A ,durometer hardness.

D. Spacers: Neoprene, EPDM or silicone blocks, or continuous extrusions, as required for compatibility with glazing sealant, of size, shape and hardness recommended by glass and sealant manufacturers for application indicated.

E. Edge Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

F. Compressible Filler Rods: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5-10 psi compression strength for 25 percent deflection.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine frames and rabbets in which glazing is to be installed for conditions that could be detrimental to the longevity of the glazing. In particular, check for conditions that would void the manufacturer's warranty.

B. Submit installer's report describing unacceptable conditions.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean surfaces to receive glazing just before installation of glazing.

3.03 INSTALLATION - GENERAL

A. Comply with recommendations for installation contained in the FGMA "Glazing Manual" and "Sealant Manual" except when specifically not recommended or prohibited by the glass or glazing material manufacturer; comply with manufacturer's recommendations.

B. Protect glazing from edge damage during handling and installation.

C. Do not install glass that has edge damage or defects that reduce glass strength or performance or diminish appearance.

D. Install glass so that visual characteristics, such as pattern, bow, and roll wave distortion, are uniform.

3.04 GLAZING IN FRAMES

A. Use continuous heel or toe bead at all exterior glazing.

B. Permanently adhere setting and edge blocks to frame.

C. Do not block weep holes.

D. Sealants:

1. Remove applied coatings from surfaces, unless such coatings have been tested to show acceptable adhesion and compatibility.
2. Use continuous spacers.
   a. Exception: For lights of less than 100 united inches, non-continuous spacers may be used, with backer rods to form proper sealant shape.
3. Use primer where required for proper adhesion as determined by sealant-substrate testing.
4. Tool sealant, eliminating air pockets, with a definite slope away from glazing.

E. Sealant Tape: Install tape continuously, located so that when compressed the exposed face will be flush with the face of the framing.
   1. Do not use joints in tape, except at corners.
   2. Seal joints with compatible sealant.

F. Compression Gaskets: Secure gaskets so they will not work out under normal movement.
   1. Install so they fit tightly at corners, allowing for stretch during installation.
   2. Do not use joints in gaskets, except at corners.
   3. Miter-cut corners and seal joint with sealant.
   4. Install gaskets so they protrude slightly past face of framing.

3.05 PROTECTION AND CLEANING

A. Immediately after installing glazing in frames, apply warning tape or bands across opening without touching glazing.

B. Do not apply tape or labels to glazing; remove temporary labels.

C. Protect glazing during subsequent construction operations; remove dirt, contaminants, staining agents and other deposits promptly using manufacturer's recommended procedures.
   1. Clean off excess sealants as work progresses using methods which will not damage glazing.

D. Replace glazing that is damaged.

E. Wash both sides of glazing, using manufacturer's recommended procedures not more than 10 days before inspection for substantial completion.

3.06 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 08800

SECTION 09200 – GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including Uniform General and Supplementary Conditions and Division-1 Specification sections, apply to this section.

1.2 SUMMARY

A. Extent of each type of gypsum board assemblies construction required is indicated on Drawings.

B. This Section includes the following types of gypsum board construction:

1. Steel framing members to receive gypsum board.
2. Gypsum board screw-attached to steel framing and furring members.

1.3 DEFINITIONS

A. Gypsum Board Construction Terminology: Refer to ASTM C 11 and GA 505 for definitions of terms for gypsum board construction not otherwise defined in this section or other referenced standards.

1.4 SUBMITTALS

A. Product data from manufacturers for each type of product specified.

1.5 QUALITY ASSURANCE

A. Fire-Resistance Ratings: Where indicated, provide materials and construction which are identical to those of assemblies whose fire resistance rating has been determined per ASTM E 119 by a testing and inspecting organization acceptable to authorities having jurisdiction.

1. Provide fire-resistance-rated assemblies identical to those indicated by reference to GA File No's. in GA-600 "Fire Resistance Design Manual" or to design designations in U.L. "Fire Resistance Directory" or in listing of other testing and agencies acceptable to authorities having jurisdiction.

B. Single Source Responsibility: Obtain each type of gypsum board and related joint treatment materials from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.

C. Handle gypsum boards to prevent damage to edges, ends, and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.7 PROJECT CONDITIONS

A. Environmental Conditions, General: Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C 840 and with gypsum board manufacturer's recommendations.

B. Minimum Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40 deg F (4 deg C). For adhesive attachment and finishing of gypsum board maintain not less than 50 deg F (10 deg C) for 48 hours prior to application and continuously thereafter until drying is complete.

C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Steel Framing and Furring:

   a. Dale/Incor Industries, Inc.
   b. Dietrich Industries, Inc.
   c. Gold Bond Building Products Div., National Gypsum Co.
   d. Marino Industries Corp.
   e. Unimast Inc.

2. Gypsum Boards and Related Products:

   a. Georgia-Pacific Corp.
   b. National Gypsum Company
   c. Temple-Inland Forest Products.
   d. United States Gypsum Co.

2.2 STEEL FRAMING FOR WALLS AND PARTITIONS

A. Steel Studs and Runners: ASTM C 645, with flange edges of studs bent back 90 deg and doubled over to form $^{3}/_{16}$" minimum lip (return) and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 22 gage.
2. Depth: 2½, 3⅝, 4 inches and 6 inch, except where otherwise indicated.

B. Steel Rigid Furring Channels: ASTM C 645, hat-shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Depth: ⅞ inch.
2. Thickness: 25 gage, unless otherwise indicated.

C. Furring Brackets: Serrated-arm type, adjustable, fabricated from corrosion-resistant steel sheet complying with ASTM C 645, minimum thickness of base (uncoated) metal of 0.0329 inch, designed for screw attachment to steel studs and steel rigid furring channels used for furring.

D. Z-Furring Members: Manufacturer's standard zee-shaped furring members with slotted or nonslotted web, fabricated from hot-dip galvanized steel sheet complying with ASTM A 525, Coating Designation G60; with a minimum base metal (uncoated) thickness of 0.0179 inch, face flange of 1⅝ inch, wall-attachment flange of 1⅝ inch, and of depth required to fit insulation thickness indicated.

E. Flat Sheet Bracing: Provide flat sheet metal bracing in sizes, configurations and thickness indicated to act as reinforcing and/or mounting plates/receptors within drywall construction where wall hung fixtures, railings and wall mounted items are shown to be secured to drywall surfaces.

F. Fasteners: Provide fasteners of type, material, size, corrosion resistance, holding power and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum drywall manufacturers for applications indicated.

2.3 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

A. Components, General: Comply with ASTM C 754 for conditions indicated.

B. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch diameter wire.

C. Hanger Attachments to Concrete: As follows:

1. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by a qualified independent testing agency.

D. Hangers: As follows:

1. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

E. Grid Suspension System for Interior Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Armstrong World Industries, Inc.; Furring Systems/Drywall.
b. Chicago Metallic Corporation; Drywall Furring 640 System.
c. USG Interiors, Inc.; Drywall Suspension System.

2.4 GYPSUM BOARD MANUFACTURERS

A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end joints.

1. Thickness: Provide gypsum board in ⅝ inch thickness to comply with ASTM C 840 for application system and support spacing indicated.

B. Acceptable Manufacturer: Gypsum Board as manufactured by Temple-Inland forest Products Corp. - Gypsum Products, 303 S. Temple Dr. P.O. Box N, Diboll, TX 75941: 1-800-231-6060, or, subject to compliance with requirements provide the named product or an Architect approved equal product by one of the following manufacturers.

1. G-P Gypsum
2. National Gypsum Company.
3. Temple-Inland forest Products
4. USG Corporation.

2.5 MATERIALS

A. General: Provide gypsum board of types indicated in maximum lengths available to minimize end-to-end joints.

1. Thickness: Provide gypsum board in ⅝ inch thickness to comply with ASTM C 840 for application system and support spacing indicated.

B. Gypsum Wallboard: ASTM C 36, and as follows:

1. Type: Regular, except use type X for fire-resistance-rated assemblies.
2. Edges: Tapered.
3. Thickness: ⅝ inch.
4. Available Products: Subject to compliance with requirements, products which may be incorporated in the Work where Type X gypsum wallboard is indicated include, but are not limited to, the following:

   a. "Gyprock Fireguard 'C' Gypsum Board" or "Gyprock Fireguard 'X' Gypsum Board" as required by the specific fire rating; Domtar Gypsum Co.
   b. "Fire-Shield G" or "Fire-Shield" as required by the specific fire rating; Gold Bond Building Products Div., National Gypsum Co.
   c. "SHEETROCK Brand FIRECODE or FIRECODE 'C' Gypsum Panels" as required by the specific fire rating; United States Gypsum Co.

C. Gypsum Backing Board for Multi-Layer Applications: ASTM C 442 or, where backing board is not available from manufacturer, gypsum wallboard, ASTM C 36, and as follows:

1. Type: Regular, except use type X for fire-resistance-rated assemblies.
2. Edges: Manufacturer's standard.
3. Thickness: ½ inch, unless indicated otherwise.

D. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178, at all Restroom ceilings and walls and all Janitor walls, and as follows:

1. Product: Subject to compliance with requirements, provide "Dens-Shield Tile Backer" manufactured by G-P Gypsum Corp.
2. Core: 5/8 inch, Type X.

2.6 TRIM ACCESSORIES

A. Cornerbead and Edge Trim for Interior Installation: Provide corner beads, edge trim and control joints which comply with ASTM C 1047 and requirements indicated below:

1. Material: Formed sheet steel zinc-coated by hot-dip process.
2. Edge trim shapes indicated below by reference to designations of Fig. 1 in ASTM C 1047:

   a. "Cornerbead", unless otherwise indicated.
   b. "LC" Bead, unless otherwise indicated.
   c. "LK" Bead with square nose for use with kerfed jambs.
   d. "L" Bead.
   e. "U" Bead.

3. One-Piece Control Joint: Formed with vee-shaped slot per Fig. 1 in ASTM C 1047, with slot opening covered with removable strip.

2.7 TREATMENT MATERIALS

A. General: Provide materials complying with ASTM C 475, ASTM C 840, and recommendations of manufacturer of both gypsum board and joint treatment materials for the application indicated.

B. Joint Tape: Alkali-resistant, polymer coated, glass-fiber mesh tape, unless otherwise indicated.

1. Use pressure sensitive or staple-attached open-weave glass-fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.

C. Setting-Type Joint Compounds: Factory-prepackaged, job-mixed, chemical-hardening powder products formulated for uses indicated.

1. Where setting-type joint compounds are indicated for use as taping and topping compounds, use formulation for each which develops greatest bond strength and crack resistance and is compatible with other joint compounds applied over it.
2. For filling joints and treating fasteners of water-resistant gypsum backing board behind base for ceramic tile, use formulation recommended by gypsum board manufacturer for this purpose.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat Water-Resistant Backing Board: As recommended by the manufacturer.

2.8 TEXTURE FINISH MATERIALS

A. Primer: Of type recommended by manufacturer of texture finish.

B. Texture Finish: Manufacturer's standard proprietary product formulated with aggregates for spray application, to achieve light "orange peel" texture, with surface burning characteristics of 25 per ASTM E 84.

C. Available Products: Subject to compliance with requirements, polystyrene aggregated finishes which may be incorporated in the Work include, but are not limited to, the following:

1. USG Texture II; United States Gypsum.
2. Wall Spray Texture; Gold Bond.
3. Gyptex Ready Mix Stucco; Domtar Gypsum.

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C 834 and the following requirements:

1. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, non-hardening, non-skinning, non-staining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce transmission of airborne sound.

C. Available Products: Subject to compliance with requirements, acoustical sealants that may be incorporated in the Work include, but are not limited to, the following:

1. Acoustical Sealant for Exposed and Concealed Joints:

a. PL Acoustical Sealant; ChemRex, Inc.; Contech Brands.
b. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
c. SHEETROCK Acoustical Sealant; United States Gypsum Co.

2. Acoustical Sealant for Concealed Joints:

a. BA-98; Pecora Corp.
b. Tremco Acoustical Sealant; Tremco, Inc.

2.11 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum drywall construction which comply with referenced standards and the recommendations of the manufacturer of the gypsum board.

B. Spot Grout: ASTM C 475, setting-type joint compound of type recommended for spot grouting hollow metal door frames.

C. Gypsum Board Screws: ASTM C 1002.

D. Asphalt Felt: ASTM D 226, Type I (No. 15).

E. Concealed Acoustical Sealant: Nondrying, non-hardening, non-skinning, non-staining, non-bleeding, gunnable sealant complying with requirement specified in Division-7 section "Joint Sealers."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which drywall construction attaches or abuts, preset hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF STEEL FRAMING, GENERAL

A. Steel Framing Installation Standard: Install steel framing to comply with ASTM C 754 and with ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking and bracing at terminations in the work and for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, and similar construction to comply with details indicated and with recommendations of gypsum board manufacturer, or if none available, with "Gypsum Construction Handbook" published by United States Gypsum Co.

C. Isolate steel framing from building structure to prevent transfer of loading imposed by structural movement, at locations indicated below to comply with details shown on Drawings:

2. Where edges of suspended ceilings abut building structure horizontally at ceiling perimeters or penetration of structural elements.
3. Where partition and wall framing abuts overhead structure.

a. Provide slip or cushioned type joints as detailed to attain lateral support and avoid axial loading.

D. Do not bridge building expansion and control joints with steel framing or furring members;

independently frame both sides of joints with framing or furring members or as indicated.

3.3 INSTALLING STEEL SUSPENDED CEILING AND SOFFIT FRAMING

A. Suspend ceiling hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.
4. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet measured lengthwise on each member and transversely between parallel members.

C. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

3.4 INSTALLATION OF STEEL FRAMING FOR WALLS AND PARTITIONS

A. Install runners (tracks) at floors, ceilings and structural walls and columns where gypsum drywall stud system abuts other construction.

1. Where studs are installed directly against exterior walls, install asphalt felt strips between studs and wall.

B. Installation Tolerances: Install each steel framing and furring member so that fastening surface do not vary more than c inch from plane of faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

D. Install steel studs and furring in sizes and at spacings indicated but not less than that required by referenced steel framing installation standard.

1. For single and double layer construction: As indicated on the drawings.

E. Install steel studs so that flanges point in the same direction and gypsum boards can be installed in the direction opposite to that of the flange.

F. Frame door openings to comply with details indicated, with GA-219 and with applicable published recommendations of gypsum board manufacturer. Attach vertical studs at jambs with screws either directly to frames or to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Extend vertical jamb studs through suspended ceilings and attach to underside of structure above.

G. Frame openings other than door openings to comply with details indicated, or if none indicated, in same manner as required for door openings; and install framing below sills of openings to match framing required above door heads.

3.5 APPLICATION AND FINISHING OF GYPSUM BOARD, GENERAL

A. Gypsum Board Application and Finishing Standard: Install and finish gypsum board to comply with ASTM C 840.

B. Install sound attenuation blankets where indicated, prior to gypsum board unless readily installed after board has been installed.

C. Locate exposed end-butt joints as far from center of walls and ceilings as possible, and stagger not less than 24 inches in alternate courses of board.

D. Install wall/partition boards in manner which minimizes the number of end-butt joints or avoids them entirely where possible. At high walls, install boards horizontally with end joints staggered over studs.

E. Install exposed gypsum board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than $^{1}/_{16}$ inch open space between boards. Do not force into place.

F. Locate either edge or end joints over supports, except in horizontal applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut or field-cut ends against mill-cut or field-cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions.

G. Attach gypsum board to steel studs so that leading edge or end of each board is attached to open (unsupported) edge of stud flange first.

H. Attach gypsum board to supplementary framing and blocking provided for additional support at openings and cutouts.

I. Spot grout hollow metal door frames at each jamb anchor clip just before inserting board into frame.

J. Form control joints at locations indicated, with space between edges of boards, prepared to receive trim accessories. Securely attach boards on each side of control joint.

K. Cover both faces of steel stud partition framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls which are braced internally.

1. Except where concealed application is indicated or required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. area, and may be limited to not less than 75 percent of full coverage.
2. Fit gypsum board around ducts, pipes, and conduits.

L. Isolate perimeter of non-load-bearing drywall partitions at structural abutments. Provide 3 inch to 2 inch space and trim edge with "U" bead edge trim. Seal joints with acoustical sealant.

M. Where sound-rated drywall construction is indicated, seal construction at perimeters, control and expansion joints, openings and penetrations with a continuous bead of acoustical sealant including a bead at both faces of partitions. Comply with ASTM C 919 and manufacturer's recommendations

for location of edge trim, and close off sound-flanking paths around or through construction, including sealing of partitions above acoustical ceilings.

N. Space fasteners in gypsum boards in accordance with referenced gypsum board application and finishing standard and manufacturer's recommendations.

O. Where fire-rated gypsum board construction is indicated, assemble in compliance with the UL assembly requirements using materials listed for the specific UL design assembly.

3.6 METHODS OF GYPSUM BOARD APPLICATION

A. Single-Layer Application: Install gypsum wallboard as follows:

1. Apply gypsum board vertically (parallel to framing), unless otherwise indicated, and provide sheet lengths which will minimize end joints.

B. Double-Layer Application: Install gypsum backing board for base layer and gypsum wallboard for face layer.

1. Apply base layer and face layers vertically (parallel to framing) with joints of base layer over supports and face layer joints offset at least 10 inches with base layer joints.

C. Single-Layer Fastening Methods: Apply gypsum boards to supports as follows:

1. Fasten with screws.

D. Double-Layer Fastening Methods: Apply base layer of gypsum board and face layer to base layer as follows:

1. Fasten both base layers and face layers separately to supports with screws.

3.7 INSTALLATION OF BACKING PANELS

A. Water-Resistant Gypsum Backing Board: Install at showers, tubs, and where indicated. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Glass-Mat, Water-Resistant Backing Panel: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

3.8 INSTALLATION OF DRYWALL TRIM ACCESSORIES

A. General: Use the same screw fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports.

B. Install corner beads at external corners with screws.

C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound except where "U" bead (semi-finishing type) is indicated.

1. Install "Cornerbead" at all exposed external corners in drywall construction.
2. Install "LC" bead where drywall construction is tightly abutted to other construction and back flange can be attached to framing or supporting substrate.
3. Install "LK" bead where substrate is kerfed to receive long flange of trim.
4. Install "L" bead where edge trim can only be installed after gypsum board is installed.
5. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).

D. Install control joints at locations indicated, at both sides of doors and windows, or if not indicated, at spacings and locations required by referenced gypsum board application and finish standard, and approved by the Owner's Representative for visual effect.

3.9 FINISHING OF DRYWALL

A. General: Apply joint treatment at gypsum board joints (both directions); flanges of corner bead, edge trim, and control joints; penetrations; fastener heads, surface defects and elsewhere as required to prepare work for decoration.

B. Prefill open joints and rounded or beveled edges, if any, using setting-type joint compound.

C. Apply joint tape at joints between gypsum boards, except where trim accessories are indicated.

D. Finish interior gypsum wallboard by applying the following joint compounds in 3 coats (not including pre-fill of openings in base), and sand between coats and after last coat:

1. Embedding and First Coat: Setting-Type Joint Compound.
2. Fill (Second) Coat: Setting-type joint compound.
3. Finish (Third) Coat: Ready-mix drying-type all-purpose or topping compound.

E. Finish gypsum board in each area to the level of finish indicated below:

1. All gypsum drywall surfaces scheduled to receive paint:

   a. Level 5: Embed tape in joint compound at all joints and interior angles. Provide three separate coats of compound at all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound or a special-purpose coating to the entire gypsum board surface. Provide smooth surfaces free of tool marks and ridges.

2. All gypsum drywall surfaces scheduled to receive wall covering:

   a. Level 4: Embed tape in joint compound at all joints and interior angles. Provide three separate coats of compound at all joints, angles, fastener heads, and accessories. Provide smooth surfaces free of tool marks and ridges.

3. Backing board of fire-rated partitions to be covered with another layer of gypsum wallboard:

   a. Level 1: Embed tape in joint compound at all joints and interior angles; provide accessories only as detailed. Provide surfaces free of excess joint compound; tool marks and ridges are acceptable.

4. Above ceiling surfaces of non-fire-rated gypsum drywall partitions:

   a. Level 0: No taping, finishing, or accessories are required.

5. Above ceiling surfaces of fire-rated gypsum drywall partitions:

   a. Level 3: Embed tape in joint compound at all joints and interior angles. Provide two separate coats of compound at all joints, angles, fastener heads, and accessories. Provide smooth surfaces free of tool marks and ridges.

F. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.10 APPLICATION OF TEXTURE FINISH

A. Surface Preparation and Primer: Prepare and prime drywall and other surfaces in strict accordance with texture finish manufacturer's instructions. Apply primer to all surfaces to achieve texture finish.

B. Finish Application: Mix and apply finish to drywall and other surfaces indicated to receive finish in strict accordance with manufacturer's instructions to produce a uniform "light orange peel" texture matching Owner Representative's sample without starved spots or other evidence of thin application,

and free of application patterns.

C. Remove any texture droppings or overspray from door frames, windows and other adjoining construction.

3.11 PROTECTION

A. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall construction being without damage or deterioration at time of Substantial Completion.

END OF SECTION 092116

SECTION 09900

PAINTING AND COATING

PART 1 GENERAL

1.1 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. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
   4. NSF International (NSF):
      a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
      b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
   5. Occupational Safety and Health Act (OSHA).
   6. The Society for Protective Coatings (SSPC):
      a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
      b. PA 3, Guide to Safety in Paint Applications.
      c. SP 1, Solvent Cleaning.
      d. SP 2, Hand Tool Cleaning.
      e. SP 3, Power Tool Cleaning.
      f. SP 5, White Metal Blast Cleaning.
      g. SP 6, Commercial Blast Cleaning.
      h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
      i. SP 10, Near-White Blast Cleaning.
      j. SP 11, Power Tool Cleaning to Bare Metal.
      k. SP 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
      l. SP 13, Surface Preparation of Concrete.
      m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.2 DEFINITIONS

A. Terms used in this section:
   1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
   2. FRP: Fiberglass Reinforced Plastic.
   3. HCl: Hydrochloric Acid.

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

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      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). The PSDS form is appended to the end of this section.
         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. Applicator's Qualification: List of references substantiating experience.
   2. Coating Manufacturer's Certificate of Compliance, in accordance with Section 01740, Common Product Requirements.

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.

1.4 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.

1.5 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. 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.

1.6 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.

PART 2 PRODUCTS

2.1 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
   1. Use or reuse of components and materials without a traceable certification is prohibited.

2.2 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. Ameron.
   2. Carboline.
   3. Endura Flex.
   4. PPG.
   5. Sherwin Williams.
   6. TNEMEC.

2.3 ABRASIVE MATERIALS

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

2.4 PAINT MATERIALS

A. General:
   1. Manufacturer's highest quality products suitable for intended service.
   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.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Alkyd Wood Primer	Flat alkyd
Bituminous Paint	Single-component, coal-tar pitch based
Block Filler	Primer-sealer designed for rough masonry surfaces, 100% acrylic emulsion
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF/ANSI 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately

Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
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	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
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
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF/ANSI 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Sanding Sealer	Co-polymer oil, clear, dull luster
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellant, penetrating stain
Stain, Wood	Satin luster, linseed oil, solid or transparent as required
Varnish	Nonpigmented vehicle based on a variety of resins (alkyd, phenolic, urethane) in gloss, semigloss, or flat finishes, as required
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

2.5 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. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.6 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:
   1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
   2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:
   1. Ductile Iron Pipe:
      a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
      b. The surface preparation and application of the primer shall be performed by pipe manufacturer.
      c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
      d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
      e. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.

PART 3 EXECUTION

3.1 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, 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.

3.2 EXAMINATION

A. Factory Finished Items:

1. Schedule 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.

3.3 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.

3.4 SURFACE PREPARATION

A. 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.

B. Metal Surface Preparation:
1. Where indicated, meet requirements of SSPC Specifications summarized below:

a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.

e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high-pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.

2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.
3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Preblast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

9. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

C. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:
1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

D. Concrete Surface Preparation:
1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.
5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

E. Plastic and FRP Surface Preparation:
1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

F. Masonry Surface Preparation:
1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.

2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
    a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    b. Brush-off blasting.
    c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

G. Wood Surface Preparation:
1. Replace damaged wood surfaces or repair in a manner acceptable to Engineer prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.
4. Filler:
    a. Synthetic-based wood putty approved by paint manufacturer for paint system.
    b. For natural finishes, color of wood putty shall match color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
    d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer’s recommendations.
    e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

H. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.
1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

3.5 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. Acid Etching:
1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
   a. Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
   d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. 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.

3.6 APPLICATION

A. General:
1. The intention of these Specifications is for new, interior and exterior [masonry, concrete, 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. Sand wood lightly between coats to achieve required finish.

6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. 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.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:
   1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
   2. Prepare surface and apply primer in accordance with System No. 10 specification.
   3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. 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.

D. 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.

3.7 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. Additional requirements are included in the Piping Schedule.

C. System No. 1 Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	NSF Epoxy	3 coats, 3 MDFTPC

1. Use on the following items or areas:
   a. Metal surfaces new below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete

D. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal-Tar Epoxy -OR- High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:
   b. Metal surfaces new below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel.

E. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:

a. Exposed metal surfaces located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as metal doors and frames, pipe galleries and similar areas.

F. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new located inside or outside of structures or exposed to weather, including vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim , and the following specific surfaces:
      1) Inside duct stack heads behind diffusers, registers, and grilles with flat black.
      2) Instrumentation and control systems exposed enclosures for process.
   b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

G. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   c. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles.

H. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

I. System No. 12 Skid-Resistant—Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

1. Use on the following items or areas:
   a. Steps and ladders.

J. System No. 13 Skid-Resistant—Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Aluminum: In accordance with Article Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation -OR- FRP: In accordance with Article Plastic and FRP Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

1. Use on the following items or areas:
   a. Steps and Ladders

K. System No. 21 Skid-Resistant—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG

1. Use on the following items or areas:
   a. Stairs and Steps.

L. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

M. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	

Surface Prep.	Paint Material	Min. Coats, Cover
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

N. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.

O. System No. 29A Fusion Bonded, Steel Dowel Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT
TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation	TFE Lube or Grease Lube	1 coat, as required

1. Use on steel expansion joint dowels as specified.

3.8 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. See Section 09910, Architectural Painting, and architectural finish schedules on the drawings for architectural paint systems and application schedules that will include but not limited to building metal trim and structural steel, masonry, building concrete flooring, and gypsum board.

B. In the event of discrepancies or omissions in the paint system listings, request clarification from Engineer before starting work in question.

3.9 COLORS

A. Provide as shown in Schedules for Finishes, shown for equipment and appurtenances and designated herein, shown in Piping Schedule, and as selected by Owner.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:
1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.

3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:

   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Radiation Hazards: OSHA Purple.
   d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:
   1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
   2. Pipe Color Coding: In accordance with Piping Schedule and as shown in table below.
   3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
   4. Pipe Supports: Painted light gray, as approved by Owner.
   5. Fiberglass reinforced plastic (FRP) pipe, polyvinylidene fluoride (PVDF), and polyvinyl chloride (PVC) pipe located inside of buildings and enclosed structures will not require painting, except as noted or scheduled.

E. Pipe System Color Code:

Pipe System	**Color**
Air, Process	Federal Safety Green
Air, Instrument	Federal Safety Purple
Ammonia, Liquid	Federal Safety Orange
Ammonia, Solution	Federal Safety Orange
Alum	Dark Green
Chlorine, Gas	Federal Safety Yellow
Chlorine, Liquid	Federal Safety Yellow
Chlorine, Residual Sampling	Silver/Gray
Chlorine Solution	Federal Safety Yellow
Chlorine Ejector Water	Silver/Gray
Chlorine Vent	Federal Safety Yellow
Compressed Air	Federal Safety Purple
Carbon	Black
Drains and Sludge	Light Brown
Decant	Light Brown
Dewatering	Black

Pipe System	Color
Drains	Black
Effluent, Final	Silver/Gray
Effluent, Primary	Silver/Gray
Effluent, Flushing Water, High Pressure	Dark Green
Effluent, Flushing	Dark Green
Fuel Oil Supply	Federal Safety Orange
Fuel Oil Return	Federal Safety Orange
Flocculation Basin Influent	Buff
Filter Backwash Supply	Medium Blue
Filter Surface Wash Supply	Medium Blue
Hot Flushing Loop	Federal Safety Blue
Headworks	Buff
Lime	White
Mixed Liquor	Silver/Gray
Overflow	Silver/Gray
Plant Service Water	Medium Blue
Potable Water	Light Blue
Polymer/Cationic	Buff
Polymer Nonionic or Anionic	Buff
Raw Sewage	Dark Gray
Rapid Mix Influent	Light Brown
Reclaimed Water	Purple
Scum	Light Brown
Sample	Medium Green
Seal Water	Federal Safety Blue
Sludge, Digested	Dark Brown
Sludge, Primary	Dark Brown
Sludge, Return Activated	Light Brown
Sludge, Thickened	Light Brown
Sludge, Waste Activated	Dark Brown
Sludge, Stored	Dark Brown
Sludge, Recirculated	Dark Brown
Sludge, Mixed	Light Brown
Thickener Dilution Water	Dark Green

3.10 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. Testing:
   1. Thickness and Continuity Testing:
      a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
      b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE RP0188.
      c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE RP0188.
      d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. 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.

D. 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.

E. 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.

3.11 MANUFACTURER'S SERVICES

A. In accordance with Section 01670, Manufacturers' Field Services and Training, 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 placed into immersion service.

3.12 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.

3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification:
   1. Paint System Data Sheet (PSDS)
   2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage

PAINT PRODUCT DATA SHEET

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:_____ max.:_____

Surface Temperature Limitations: min.:_____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

[Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.]

SECTION 09910 – ARCHITECTURAL PAINTING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes surface preparation, painting, and finishing of exposed interior items and surfaces.
   1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.
   1. Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
   1. Prefinished items not to be painted include the following factory-finished components:
      a. Acoustic materials.
      b. Architectural woodwork and casework.
      c. Finished mechanical and electrical equipment.
      d. Light fixtures.
      e. Switchgear.
   2. Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
      a. Foundation spaces.
      b. Furred areas.
      c. Utility tunnels.
      d. Pipe spaces.
      e. Duct shafts.
   3. Finished metal surfaces not to be painted include:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper.
      e. Bronze.
      f. Brass.
   4. Operating parts not to be painted include moving parts of operating equipment such as the following:
      a. Valve and damper operators.
      b. Linkages.
      c. Sensing devices.
      d. Motor and fan shafts.
   5. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Related Sections: The following sections contain requirements that relate to this section:

1. Division 5 Section "Metal Fabrications" for shop priming ferrous metal.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 DEFINITIONS

A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”.

B. Product Data: Manufacturer's technical information, label analysis, and application instructions for each material proposed for use.
   1. List each material and cross-reference the specific coating and finish system and application. Identify each material by the manufacturer's catalog number and general classification.

C. Samples for verification purposes: Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate. Define each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
   1. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.
   2. Submit samples on the following substrates for the Architect's review of color and texture only:
      e. Stained or Natural Wood: Provide two 4- by 8-inch samples of natural and stained wood finish on actual wood surfaces.
      f. Ferrous Metal: Provide two 4-inch-square samples of flat metal and two 8-inch-long samples of solid metal for each color and finish.

1.07 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify the Architect of problems anticipated using the materials specified.

C. Field Samples: On wall surfaces and other interior components, duplicate finishes of prepared samples. Provide full-coat finish samples on at least 100 sq. ft. of surface until required sheen, color and texture are obtained; simulate finished lighting conditions for review of in-place work.
   1. Final acceptance of colors will be from job-applied samples.

D. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.
   1. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Federal Specification number, if applicable.
   4. Manufacturer's stock number and date of manufacture.
   5. Contents by volume, for pigment and vehicle constituents.
   6. Thinning instructions.
   7. Application instructions.
   8. Color name and number.

B. Store materials not in use in tightly covered containers in a well- ventilated area at a minimum ambient temperature of 45ºF (7ºC). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
   1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.09 JOB CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50ºF (10ºC) and 90ºF (32ºC).

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45ºF (7ºC) and 95ºF (35ºC).

C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5ºF (3ºC) above the dew point, or to damp or wet surfaces.
   1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are not limited to the following:
   1. Devoe and Raynolds Co. (Devoe).
   2. The Glidden Company (Glidden).
   3. Benjamin Moore and Co. (Moore).
   4. PPG Industries, Pittsburgh Paints (Pittsburgh).
   5. Pratt and Lambert (P & L).

6. The Sherwin-Williams Company (S-W).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.
   1. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.02 PREPARATION

A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
   1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.
   2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
      a. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
      b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
      c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, and rinse; allow to dry and vacuum before painting.
   3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
      a. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended knot sealer before application of primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
      b. When transparent finish is required, back-prime with spar varnish.
      c. Seal tops, bottoms, and cutouts of wood doors with a heavy coat of varnish or sealer immediately upon delivery.

4. Ferrous Metals: Clean non-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.

   d. Blast steel surfaces clean as recommended by the paint system manufacturer and in accordance with requirements of SSPC specification SSPC-SP 10.

   e. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

5. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

C. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

D. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.03 APPLICATION

A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

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

C. Paint colors, surface treatments, and finishes are indicated in "schedules."

D. Provide finish coats that are compatible with primers used.

E. The number of coats and film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce an even smooth surface in accordance with the manufacturer's directions.

F. 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 ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.

G. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles, and similar components are in place. Extend coatings in these areas as required to maintain the system integrity and provide desired protection.

H. 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.

I. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint.

J. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

K. Sand lightly between each succeeding enamel or varnish coat.

L. Omit primer on metal surfaces that have been shop-primed and touch up painted.

M. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
   1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

N. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

O. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces.

P. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

Q. Prime Coats: Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to material that is required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.

R. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surface imperfections.

S. 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.

T. Transparent (Clear) Finishes: Use multiple coats to produce a 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.
   1. Provide satin finish for final coats.

U. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.04 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during the period when paint is being applied:
   1. The Owner will engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the

project will be taken, identified, sealed, and certified in the presence of the Contractor.

2. The testing laboratory will perform appropriate tests for the following characteristics as required by the Owner:

   a. Quantitative materials analysis.
   b. Abrasion resistance.
   c. Apparent reflectivity.
   d. Washability.
   e. Absorption.
   f. Accelerated weathering.
   g. Dry opacity.
   h. Accelerated yellowness.
   i. Recoating.
   j. Skinning.
   k. Color retention.
   l. Alkali and mildew resistance.

3. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove non-complying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are non-compatible.

3.05 CLEANING

A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

3.06 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Architect. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

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

3.07 PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates, as indicated.

B. Colors: Provide paint systems matching colors selected by Owner's Representative.

C. Ferrous Metal:

1. Semi-gloss Enamel Finish: 2 coats over primer with total dry film thickness not less than 2.5 mils.

   a. Primer: Quick-drying, rust-inhibiting primer for priming ferrous metal on the interior under semi-gloss latex enamel:
      1) S-W: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series.

   b. Finish Coat: Low-odor, semi-gloss, latex enamel for use over a primer on concrete, masonry (including concrete masonry block), plaster, wood, and hardboard and both ferrous and zinc-coated (galvanized) metal surfaces and over a primer on gypsum drywall:
      1) S-W: Pro-Green 200 Interiors, B31-600 Series.

D. Zinc-Coated Metal:

1. Semi-gloss Finish: 2 coats over primer, with total dry film thickness not less than 2.5 mils.

c. Primer: Quick-drying, rust-inhibiting primer for priming ferrous metal on the interior under semi-gloss latex enamel:

1) S-W: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series.

d. Finish Coat: Low-odor, semi-gloss, latex enamel for use over a primer on concrete, masonry (including concrete masonry block), plaster, wood, and hardboard and both ferrous and zinc-coated (galvanized) metal surfaces and over a primer on gypsum drywall:

1) S-W: Pro-Green 200 Interiors, B31-600 Series.

3.08 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 09910

SECTION 10200 - LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Fixed metal wall supply grille for dust collector.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.

1.3 DEFINITIONS

A. Louver Terminology: Refer to Air Movement and Control Association (AMCA) 501 for definitions of terms for metal louvers not otherwise defined in this Section or in referenced standards.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data: Include construction details, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

1.5 QUALITY ASSURANCE

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

B. SMACNA Standard: Comply with SMACNA "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures.

1.6 PROJECT CONDITIONS

A. Field Measurements: Check actual louver openings by accurate field measurements before fabrication, and show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Where field measurements cannot be made without delaying the Work, guarantee opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

a. Greenheck
b. METALAIRE, Inc
c. Price Industries.
d. Titus.
e. Krueger

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

2.3 DIFFUSERS, REGISTERS AND GRILLES

A. Air Outlet shall be round, single deflection supply register with 1" extruded aluminum airfoil shaped blades on 1" spacing. Border shall be constructed of heavy gauge aluminum. Deflector blades shall be individual adjustable:

1. Basis of Design: Provide Model MRDS as manufactured by Greenheck., or Architect approved equal manufactured by one of the above listed manufacturers.
2. Grille sized: refer to ME-3 for sizes.
3. Seal: foam gasket to seal the border and mounting surface

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 10200

SECTION 10400 – PANEL SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and install signage as specified and scheduled herein.

B. The types to be furnished are as follows:
   1. Room identification signs.
   2. Site signs, identification, restrictive and directional.
   3. Restrictive signs.

1.02 RELATED REQUIREMENTS

A. Other related work as called for on PLANS or specified elsewhere in this or other TECHNICAL SPECIFICATION Sections.

1.03 NOT USED

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”: Submittals shall include the following:
   1. Manufacturer's complete color range and type styles.
   2. Sign layout with shop drawings as follows:
      a. Scale layout of all site signs.
      b. Full size layout of typical Room Identification, Restrictive and Process Identification signs.
      c. Full size layout and text of Dedication Plaque.
   3. Submit two each of the following samples. Samples shall be resubmitted as required until approved.
      a. A 12-in minimum square sample of proposed encapsulated Site Sign with subsurface graphics and 12-in mounting post and spacer attached.
      b. A 12-in minimum square sample of each proposed plastic restrictive sign and proposed framing and mounting device.
      c. A 6-in minimum square sample of proposed plastic sign showing proposed framing and mounting device and/or pressure sensitive vinyl for Room Identification cut into letters in the colors proposed for the required color scheme.
   4. Cleaning and maintenance instructions for all signage components.

1.07 NOT USED

1.08 NOT USED

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty.

C. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Signs shall be manufactured by Architectural Signage Products, 5214 Burleson Rd., Suite 405-6, Austin, Texas; Austin Architectural Graphics, 516 Navasota, Austin, Texas; Innovative Graphics Systems, P.O. Box 33139, Austin, Texas 78764; Trinity Sign Graphics, 7802 Doncast, Austin, Texas 78745; The Southwell Company, P.O. Box 299, San Antonio, Texas 78291. All lettering shall be Optima Semi Bold upper and lower case and sized as specified or as shown on scale sign drawings. All exposed surfaces shall be matte finish as approved.

B. Interior Room Identification signs; 1/8" – thick Westinghouse Micarta raised graphics with domed braille, square corner and no borders applied as indicated on the Drawings and comply with ADA and ANSI A117.1 requirements. The adhesive and finish surface shall be protected with one piece removable liners. Colors shall be in contrasting colors as selected by Owner's representative from manufacturer's standard full color range.

C. Word and Picture Signs; 1/8" – thick Westinghouse Micarta raised graphics with domed braille, square corner and no borders applied as indicated on the Drawings and comply with ADA, ANSI A117.1 and OSHA. The adhesive and finish surface shall be protected with one piece removable liners. Colors shall be in contrasting colors as selected by Owners representative from manufacturer's standard full color range.

1. Word and Picture (WP) types shall include but not limited to the following (refer to signage schedule): WP236RB (Stairs), WP260RB (In Case of Fire Do not Use Elevator Use Stairs), WP237 (Exit), WP251 (Fire Extinguisher), WP284 (No Smoking in Elevator), WP278 (Emergency Shower), WP279 (Emergency Eye Wash), WP293 (Danger-High Voltage).

D. D. Site Signs

1. For bidding purposes text and composition of site signs shall be as shown on Drawings. Final text and composition shall be as shown on approved shop drawings. Signs shall be located as shown.
2. Signs shall be provided with galvanized U-channel posts. Handicapped parking signage shall be white lettering and symbol on blue background (#SS 53) and Alternative Fuel / Carpool Van parking signage shall be black lettering on white background (#SS 49 sim.).
3. Site signs shall be designed to withstand wind loading of 30 psf without damage or permanent deflection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Signage shall be installed at the locations detailed or as directed, in accordance with the manufacturer's recommendations, ADA, ANSI A117.1, OSHA and approved shop drawings.

B. Posts for site signs shall be shop mounted on base plates and installed on 12-in by 12-in by 4-ft deep footings constructed of 2500 psi concrete as specified in Section 03300 and secured with nuts on anchor bolts furnished under this Section and cast into the concrete. Peen-over bolt threads to prevent removal as directed. Set concrete to provide bottom of base plate at 6-in below grade.

C. Dedication plaque shall be installed into holes drilled in masonry with waterproof cement in accordance with the approved shop drawings. Plaque shall be flush with wall. Locate on interior as directed.

D. Damaged units or components shall be removed and replaced at no additional cost to the Owner.

E. Signage shall be cleaned to the satisfaction of the Engineer using the approved methods, upon completion of the installation and again, just prior to acceptance of the project.

3.02 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 10400

SECTION 10520- FIRE EXTINGUISHERS AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required and install fire extinguishers in cabinets where required and with brackets at other locations as shown on the Drawings and as specified herein.

1.02 NOT USED

1.03 REFERENCES

A. Underwriters Laboratories (UL)

B. Uniform Building Code (UBC)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 NOT USED

1.05 NOT USED

1.06 SUBMITTALS

A. Furnish the following in accordance with Specification Section 01300, “Submittals” and Section 01730, “Operation and Maintenance Data”: shop drawings showing details of construction and installation of fire extinguishers, cabinets and brackets.

1.07 NOT USED

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Store materials in unopened packages in a manner to prevent damage from environment and construction operations. Handle in accordance with manufacturer's instructions.

1.09 NOT USED

1.10 WARRANTY

A. Section 01700 – Execution Requirements: Product warranties and product bonds.

B. For warranty repair work, remove and replace materials as needed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fire extinguishers shall be as specified below by J.L. Industries; Larsen Manufacturing Company; Potter Roemer. or equal. J.L. Industries model numbers have been used to establish quality and type.

B. Type "A" units shall be 20 lb capacity, multi-purpose dry chemical type, for cabinets and elsewhere except electrical rooms, UL rated for 20A-120 B:C. Extinguishers shall be red enameled steel cylinder with indicating gauge, by J.L. Industries. Plan indicator “A”

C. Type "B" units to be used at all electrical rooms shall be 20 lb capacity carbon dioxide type, UL rated for 10 B:C. Units shall be red enameled aluminum cylinders, Sentinel 20 by J.L. Industries. Plan indicator “B”

D. Cabinets where shown shall be surface mounted, 18 gauge steel, factory epoxy-painted white body, Model 2037 V12 Cosmopolitan by J.L. Industries, similar by Larsen or equal with door, frame and 2-1/2-in welded and ground smooth return trim of No. 4 finish stainless steel and with continuous door hinge, satin finished pull handle and acrylic glazing.

E. For 1,000 s.f. of area, units shall be 5-lb capacity carbon dioxide type, UL rated for 5 B:C. Extinguishers shall be red enameled aluminum cylinders, Sentinel 5 by J.L. Industries. Provide units as indicated on contract documents.

F. Mark Series Fire Extinguisher Brackets, supporting bottom and sides of extinguishers, by J.L. Industries or equal, shall be provided for all fire extinguishers not in cabinets.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fire extinguishers and brackets shall be installed at the locations shown and as directed.

B. Install cabinets in masonry where shown conforming to approved shop drawings. Place extinguishers in cabinets where provided.

C. All fire extinguishers shall be inspected and certified within 30 days of start-up.

3.02 –3.10 (NOT USED)

3.11 MEASUREMENT AND PAYMENT

Unless otherwise indicated, no separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION 10520

SECTION 11149
SUBMERSIBLE SUMP PUMPS

PART 1 GENERAL

1.00 SCOPE OF WORK

A. Furnish labor, materials, equipment and incidentals necessary to install submersible sump pumps. Provide a sump pump capable of fitting in the size sump shown. Any structural modifications required at the structure shall be made at no additional cost to the Owner. The pump and motor shall have a standard Manufacturer's nameplate securely affixed in a conspicuous place showing the serial number, model number, Manufacturer, ratings, and other pertinent nameplate data.

1.01 RELATED WORK

A. Division 1, General Provisions.

B. Section 01300, Submittals.

C. Section 01730, Operation and Maintenance Data.

D. Division 16, Electrical.

1.02 QUALITY ASSURANCE

A. Acceptable Manufacturers:

1. Barnes.
2. Hydromatic.
3. Liberty Pumps.

B. The equipment covered by these specifications shall be the product of a reputable and qualified Manufacturer who is of proven ability and has at least 10 years experience in the production of such equipment in sizes as required for this project with a minimum of 100 operative units of equal or larger size.

C. The pump Manufacturer shall be fully responsible for the designing and manufacturing, arrangement, and operation of all connected rotating components of the assembled pumping unit.

D. The pump units shall be supplied by one Manufacturer, and shall be complete, including pump and motor. The pump Manufacturer, and shall be responsible for the furnishing and performance of the complete pumping units.

1.03 DELIVERY, HANDLING, AND STORAGE

A. All equipment shall be handled and stored in accordance with the

Manufacturer's guidelines.

1.04 SUBMITTALS

A. Submittals shall be in accordance with Section 01300, Submittals and shall include:

1. Shop drawings for all components of the submersible non-clog pumps.
2. Manufacturer's installation instructions.
3. Manufacturer's field testing instructions.
4. Manufacturer's certifications.
5. Operation and Maintenance Manuals.
6. If requested, the Equipment Manufacturer shall submit a list of 10 similar installations which have been in satisfactory operation for at least three years.

1.05 GUARANTEE AND WARRANTY

A. Manufacturer shall warrant that the complete system shall be free from defective material and workmanship for a period of two years from the date of written Owner acceptance. The warranty shall be provided in writing starting from the date of acceptance by Owner.

B. Before the warranty period will begin, equipment must operate as intended for thirty days without failure, maintenance, or operator intervention unless it is required as part of the normal function of the equipment. The warranty period will not officially begin until the Owner provides a written acceptance and establishes the warranty start date.

PART 2 PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

A. Provide submersible sump pumps in concrete vaults as shown on the Contract Drawings.

B. The sump pumps shall have cast iron motor housing and volute, cast iron/bronze/engineered polymer impellers, and a stainless steel shaft. Sump pump shall be suitable for use in outdoor applications.

C. Each pump shall be provided with a non-mercury-type ball float switch. The ball float shall have a minimum 20-foot water resistant cable.

D. The sump pump Manufacturer shall verify that the pump being provided shall fit into the size sump shown and that the sump pump shall not cycle excessively. See Section 3.02, Schedules for pump specifications.

E. Sump pump assembly shall be rated: Unclassified.

2.02 MOTOR

A. The motor shall be totally encased, sealed, and non-ventilating and shall have automatic thermal overload protection. The motor shall be a maximum of 1/2 hp, 115V ac, 3450 RPM and shall be suitable for continuous duty.

B. The pump shall be provided with a minimum 35-foot power cable. The Contractor shall verify the depth of vault and provide a longer power cord if required. The motor shall be hardwired to the control panel.

2.03 CONTROLS

A. The manufacturer shall provide a complete control system housed in a NEMA 4X, Type 316 stainless steel enclosure with hinged, gasketed door and mounting brackets or pedestal, and all necessary components shall comply with City Standard Technical Specifications Series 16000 to provide the following functions for each pump. Note: Series 16000 compliance for control panel wiring at Type SIS, 600V insulation.

1. Magnetic starter.
2. Circuit Breakers.
3. HAND-AUTO-OFF selector switch.
4. Pilot lights
5. Pump run status.
6. Non-fusable disconnect with handle
7. Floating level switch
8. Alarm light to be supplied on top of NEMA 4X control panel/alarm enclosure in such a manner as to maintain NEMA 4X rating. The visual alarm lamp shall be inside a red fluted lens at least 2-5/8 inches in diameter and 1-11/16 inches in height.

B. The control system enclosure shall be mounted where shown on the Yard Piping drawings. All cables and conduits between the control system and the pump shall be provided by the sump pump manufacturer.

C. Provide the following signals in a form of a dry contact for the SCADA system to monitor:

1. Sump pump 1 running.
2. Sump controls level high.
3. Sump pump 1 fail.
4. Sump pump 2 running.
5. Sump pump 2 fail.
6. Sump pump system power status.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install submersible sump pumps in accordance with the Manufacturer's

instructions.

3.02 SCHEDULE

A. The required pumps and certain pertinent data is given below.

Item No.	**Service**	**Number Required**	**Rated Capacity (gpm)**	**Rated Head (feet)**
1	Sump – South Austin Regional Valve Vaults	5	40	20
1	Sump – Electric Operated Ball Valve Vault – Montopolis Site	1	40	20

3.03 TESTING

A. Functional Test: Perform Manufacturer's standard test on equipment to ensure proper operation.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, an acceptance test to verify the satisfactory operation of each unit shall be conducted. The test shall be conducted in a manner approved by and in the presence of the Owner. The units shall be checked for excessive noise, vibration, general operation, etc. The units must perform in a manner acceptable to the Owner before final acceptance will be given by the Owner.

END OF SECTION

SECTION 11150
GRINDER PUMP STATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install factory-built and tested grinder pump station. Grinder pump system shall consist of a grinder pump, wet-well basin, valves, electrical control/alarm and disconnect panels, wiring and conduit, and service lines, as specified herein and as shown on the Yard Piping Plan and Plumbing Plan for a complete and operational system.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 16: Electrical.

1.03 SUBMITTALS

A. Submittals shall include all information necessary to substantiate compliance with all requirements of this and related sections and shall include but not be limited to the following:

1. Pump: Performance curve from shut-off to minimum TDH, capacity versus total head with horsepower required and efficiency, motor efficiency, dimensioned equipment and installation drawings, all construction material designations by ASTM standards.
2. Controls: Control schematic, field wiring diagram, manufacturer's catalog data on all components, panel arrangement, material and details.
3. Grinder Pump Station: Outline dimensions and materials of construction for pump basin, piping and valves, and piping and valve schematics with dimensions.
4. Manufacturer's Installation Instructions: Field connection procedures for inlet and discharge piping, provisions for vertical height adjustment and testing and start-up procedures.
5. Colors: Submit samples or color charts for control panels and other items of the system that will be mounted above ground or otherwise visible upon completion of installation.

1.04 MANUFACTURERS

A. The grinder pumps shall be Goulds Series RGS2012 three phase pump or approved equal.

PART 2 PRODUCTS

2.01 PERFORMANCE CHARACTERISTICS

A. Provide two (2) pumps. One to be installed into the wet well and the other will be a spare.

B. The pumps shall be designed for the following operating conditions

	Duty Point 1
Min. Rated Head (ft)	61
Min. Capacity at Rated Head (gpm)	30
Min. Motor Horsepower (HP)	2
Min. Motor Speed (RPM)	3450

C. Pump motors shall operate on 3 phase, 60 hertz, 460-volts.

2.02 PUMP REMOVAL

A. Pump removal shall be facilitated by the installation of the following:

1. A NEMA 6 electrical quick disconnect for the pump power cable.
2. 1\4” 7 x 19 stainless steel lifting cable assembly attached to lifting eyes on the pump.
3. Pump slide rail system complete with dual pipe stainless steel guide rail system assembly.

B. Piping shall be designed to disconnect with the use of unions to facilitate removal and disassembly of piping to remove the pump.

2.03 GRINDER PUMP BASIN/WET WELL

A. Grinder pump basin dimensions shall be a minimum 36 inches inside diameter and 84 inches tall. See extension noted in Item E.

B. Basins shall be laminated fiberglass, or molded high density polyethylene (HDPE) with a melt index of 2.0 grams/10 minutes, or less. Minimum wall thickness of basins shall be per manufacturer’s recommendation for the depth and backfill requirements for this project.

C. Tank wall and bottom must withstand the pressure exerted by saturated soil. Tank bottom shall include a fiberglass anti-float round flange to resist buoyancy when cast in concrete ballast.

D. The accessway, or basin lid, shall be an integral extension of the basin assembly and include a solid fiberglass cover assembly providing low profile mounting and watertight capability.

E. Manufacturer shall provide basin extension kits to allow the Contractor to provide vertical extensions as necessary to maintain the minimum dimensions for inlet piping as shown on the plans. Vertical adjustment shall be made in one-foot minimum increments. Extension kits shall be designed such that their use will not compromise the water-resistant integrity of the basin.

2.04 SUMP LEVEL CONTROLS

A. Sealed float type non-mercury switches connected to a pressure switch shall be furnished to control sump level and alarm signal.

B. The grinder pump shall be furnished with a motor power cord 14-gauge, type SJOW cable, pre-wired and watertight to meet UL requirements.

C. Alarm light to be supplied on top of stainless steel NEMA 4X control panel/alarm enclosure.

2.05 ELECTRICAL CONTROL PANEL

A. The control panel shall follow the requirements in City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment".

B. The grinder pump station shall include a lockable NEMA 4X, UL listed ALARM/DISCONNECT panel. The audio alarm shall be a printed circuit board in conjunction with an 86 dB buzzer with quick mounting terminal strip mounted panel suitable for wall or pole mounting. The NEMA 4X enclosure shall be manufactured of stainless steel to assure corrosion resistance. The enclosure shall include a hinged 12.0" H x 10.0" W x 6.00"D. Panel shall be mounted as on Electrical Site Plan.

C. For each core, the panel shall contain one (1) 15 amp, double pole circuit breaker for the power circuit and one (1) 15 amp single pole circuit breaker for the alarm circuit. The panel shall contain terminal blocks, integral power bus, push to run, or HOA switch, and a complete alarm circuit.

D. The Electrical Control Panel shall include the following features: Audio and visual alarm, push to run switch, and high level (redundant) pump starting control. The alarm sequence is to be as follows:

1. When liquid level in the sewage wet-well rises above the alarm level, the contacts on the alarm switch will close visual and audio alarms will be activated.
2. The audio alarm may be silenced by means of the externally mounted, push-to-silence button.
3. Visual alarm remains illuminated until the sewage level in the wet-well drops below the "off" setting of the alarm pressure switch or non-mercury float switch.

E. The visual alarm lamp shall be inside a red fluted lens at least 2-5/8 inches in diameter and 1-11/16 inches in height. Visual alarm shall be mounted to the top of the enclosure in such a manner as to maintain NEMA 4X rating.

F. The audio alarm shall be capable of being de-activated by depressing a push-type switch, per item H below and mounted on the bottom of the enclosure. The entire panel as manufactured shall be UL listed.

G. All electrical control panels shall include dry contacts to facilitate the future installation of an additional, remote mounted, rotating beacon.

H. Push-type switches shall be per division 16 specifications – 30mm oil tight.

2.06 VALVES AND PIPING

A. The grinder pump station shall be furnished with 2 inch internal piping, swing check, anti-siphon, and isolation valves.

B. Internal isolation valves shall be Class 200 bronze gate valve or approved equal.

C. Check valves shall be cast iron ball type.

D. All maintenance tasks for the grinder pump station must be possible without entry into the grinder pump basin/wet well. Unless precluded by the manufacturer's standard installation practices, all valves and piping shall be located no more than 18-inches from the top of the basin to allow operation of the isolation valve.

PART 3 EXECUTION

3.01 INSTALLATION

A. Grinder pump system shall be installed in full conformance with the Plans, these Specifications, and the manufacturer's requirements. The installed equipment shall result in a completely operational sewage pumping system.

B. Furnish conduit seals, sealing compound or sealing barriers on all conduit or wire way entrances into the control panel to preclude corrosive gases from entering the control/alarm panel.

C. The Plans depict the approximate location of the grinder pump system and other appurtenances. The Contractor will be responsible for coordinating with the Owner's Representative for actual location of facilities.

D. Install 7 cubic feet of ballast per standard 36-inch by 53-inch grinder station basin. Install one additional cubic foot of ballast per additional vertical foot added. Concrete ballast shall be provided with lifting lugs cast into the ballast to facilitate future removal/demolition of the station. The annular space in which concrete ballast is poured shall be tapered and the overexcavation above the ballast of sufficient width to preclude “locking” the ballast in the basin excavation.

3.02 INSPECTION AND TESTING

A. The Contractor shall field test all installed equipment, including pump and control operation, level setpoints, and alarms in the presence of the Owner’s Representative prior to placing each system into operation.

B. A factory trained manufacturer’s representative must be present to supervise the installation, testing and start-up. The manufacturer’s representative shall also instruct the Owner’s personnel in the operation and maintenance of the equipment.

3.03 WARRANTY

A. Contractor shall warrant the installation of the grinder pump system against defects in material and workmanship for one year from the date of Owner acceptance of the project and defective components shall be replaced at no cost to the Owner.

B. The Contractor shall provide a Manufacturer’s warranty for the grinder pump station and control panel. Manufacturer shall warrant the grinder pump stations against defects in workmanship and materials for a period of 5 years under normal use, operation and service. The warranty shall be a full, unlimited warranty for a 5-year period starting from the date the unit becomes operational. Limited or prorated warranties will not be acceptable. The manufacturer shall provide prior to award of Bid any required preventative maintenance, such as rinsing or cleaning grease/oil from level controls, including frequency, costs and labor-hours. Preventative maintenance not so listed shall be considered as inclusive of the Manufacturer’s warranty and shall not be considered as justification of refusal of warranty claims. A letter signed by an officer of the grinder pump manufacturer certifying full compliance with the terms of this warranty must be provided. The warranty shall be in published form and apply to all similar units.

END OF SECTION

SECTION 11211
HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Petroleum Institute (API):
   a. Standard 610, Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries.
   b. Standard 670, Machinery Protection Systems.
2. Hydraulic Institute Standards (HIS):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
   b. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

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

1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Performance data curves showing head, capacity, horsepower demand, NPSH required, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the design flow conditions.

4. Detailed structural, mechanical, and electrical drawings showing equipment dimensions, size, and locations of connections and weights of components. Assembly and installation drawings including shaft size, seal, coupling, bearings, anchor bolt plan, parts nomenclature, and materials of construction lists. Baseplate drawings with leveling jackscrew details, anchor bolt and sleeve details, and minimum foundation installation and leveling requirements.
5. Power and control wiring diagrams, including terminals and numbers.
6. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
7. Factory finish system.
8. Vibration monitoring system information including technical product bulletins and descriptions, specification data sheets, wiring diagrams, communications hardware and software, documentation sufficient for configuration of functions specified herein and shown on Drawings.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01740, Common Product Requirements, that factory finish system is identical to requirements specified herein.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer's printed installation instructions.
4. Factory Functional and Performance Test Reports and Log. Factory test data for each pump shall be submitted, reviewed, and approved by Engineer prior to shipment of equipment.
5. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01650, Facility Startup/Commissioning.

1.04 EXTRA MATERIALS

A. Furnish for each pump:

1. Complete seal kit.
2. Complete set bearings.
3. Complete set gaskets and O-ring seals.
4. Complete set of shaft sleeves.
5. Complete set keys, dowels, pins, etc.
6. Complete mechanical seal.

7. Impeller.
8. Impeller wear ring.
9. One complete set of special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.02 SHAFT SEALS

A. Sealing system for vertical turbine pump shafts shall be mechanical seal as indicated in pump data sheet.

B. Mechanical Seal Requirements:

1. Nonfretting type requiring no wearing sleeves for the shafts.
2. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area.
3. Split Type:
   a. Requiring no field assembly other than assembly around shaft and insertion into pump or balanced cartridge design in conjunction with a spool type spacer coupling as specified in pump data sheet.
   b. Nonshaft O-rings shall be of ball and socket type requiring no gluing.
   c. Initial seal installation at factory shall be with nonsplit seal faces, with spare seals and spare kits to have split faces.
   d. Unless otherwise specified, shall be capable of 400 psig service, be self-aligning, self-centering, single.
   e. Manufacturer and Product: A.W. Chesterton Company Chesterton; 442, or John Crane Type 3710 mechanical seal.
4. Arrangement shall allow removal of seal without disturbing pump or driver.
5. For clear water services and solids up to 5 percent by weight, face combination shall be hard/soft. Otherwise, hard/hard faces shall be used.
6. Designed so dynamic O-ring moves towards a clean surface as face wears and springs are not in pumped fluid.
7. Face shall be spring loaded to provide self-aligning despite stuffing box misalignment.
8. Where cartridge type mechanical seals are specified:
   a. Single, balanced, flexible stator design.
   b. Capable of 600 psig service.
   c. O-ring secondary seals and setscrew drive with three-point centering to ensure 0.003-inch of maximum perpendicularity of rotary face to shaft.
   d. Gland shall have flush port and be affixed to equipment with adjustable tabs to fit irregular bolt patterns.

e. Manufacturers and Products:
   1) A.W. Chesterton Company; 155.
   2) Crane; 1B.

9. Seal Materials:
   a. Metals:
      1) Loaded Parts Over 0.060-inch Cross Section: Type 316 stainless steel minimum.
      2) Thinner Parts (springs): Hastelloy-C, Alloy 20, AMS5876 Elgiloy, or other alloy that is not vulnerable to chloride stress corrosion.
   b. Elastomers: Fluorocarbon Viton, preferred unless seal manufacturer recommends ethylene propylene for service conditions.
   c. Faces: Homogeneous construction. Surface treatments and plated faces are unacceptable.
      1) Acceptable hard faces include nickel bound tungsten carbide, self sintered silicon carbide, reaction bonded silicon carbide, or graphitized silicon carbide. Silicon carbide is preferred because of its higher pressure-velocity capability.
      2) Acceptable soft face is carbon-graphite, either Union Carbide 658RC or Purecarbon P8412.

10. Seal Environmental Controls:
   a. Pipe seal flush port to drain to wet well or hub drain as shown on Drawings with a 1/8-inch orifice plate in the line. Provide venting of seal chamber.
   b. Mechanical seals for anything other than clear water services shall be fitted with Enviroseal SpiralTrac Version F, N, or D, installation Type I as recommended by A.W. Chesterton Company.
      1) Provide fluid circulation in seal chamber that removes frictional heat from mechanical seal.
      2) Convey particulate matter and contaminants for removal by conveying them from bore to shaft by means of integral machined spiral.
      3) Removes particulate matter from seal chamber, without seal flush water, through integral machined exit groove.
   c. Material of construction shall be Type 316 stainless steel.
   d. Connect mechanical seal to water purge supply where indicated on Drawings.

C. Packing Requirements:

1. Stuffing Box:
   a. Tap to permit introduction of seal liquid.
   b. Hold a minimum of five rows of packing and a lantern ring.
   c. Face attached.

d. Box and shaft shall be suitable for field installation without machining or other modifications of mechanical seal outlined above for applicable pump and operating conditions.

2. Packing Rings:
   a. Three asbestos free die-molded packing rings of braided graphite material free of PTFE.
      1) A.W. Chesterton Company; 1400R for nonpotable water services.
   b. Three die-molded rings of braided PTFE material.
      1) A.W. Chesterton Company; 1725 that is NSF/ANSI 61 acceptable for potable water services.
   c. Glands:
      1) Two-piece split construction.
      2) Fit impeller end of packing with A.W. Chesterton Company; Enviroseal SpiralTrac, Version P, packing protection.
3. Where pumped fluid is clear water:
   a. Pump discharge run through 1/8-inch orifice for packing lubrication.
   b. Otherwise, provide seal water flow control and monitoring as detailed on Drawings.
      1) External Seal Water Flow: 5 gallons to 30 gallons per hour flow rate, plus or minus 10 percent accuracy.
      2) Manufacturer and Product: A.W. Chesterton Company; SingleFlow.
4. Shaft Sleeve:
   a. Fit section of shaft or impeller hub that extends through or into stuffing box with replaceable stainless steel sleeve with a Brinell hardness of not less than 400.
   b. Sleeve shall be held to the shaft to prevent rotation.
   c. Gasketed to prevent leakage between shaft and sleeve.
   d. Thickness: 3/8 inch minimum.

2.03 VIBRATION AND TEMPERATURE TRANSDUCERS AND MONITORING SYSTEM

A. General:

1. Meet requirements specified herein and with motor temperature and vibration sensors specified in Section 16220, Low-Voltage AC Induction Motors.

B. Bearing Housing Vibration Velocity Transducers:

1. Permanently installed accelerometers by pump manufacturer.
2. Transducers:
   a. Located at inboard and outboard bearing housings.

b. Two radial velocity transducers shall be provided with one measuring discharge nozzle direction and one at 90 degrees to discharge nozzle direction.
c. One axial velocity transducer shall be installed at either bearing housing.

C. Bearing Temperature Elements:

1. Provide each pump bearing, radial and thrust, with two 100-ohm platinum resistance type temperature detectors (RTD).
2. Metal of bearings and mountings shall be drilled, milled, and tapped to place element at hottest points of bearings and within 1.6 mm of bearing metal.
3. Pump motor bearing temperature elements shall be permanently installed by motor manufacturer.
4. Motor bearing temperature elements shall be as specified in Section 16220, Low-Voltage AC Induction Motors.

D. Motor Casing Velocity Transducer: As specified in Section 16220, Low-Voltage AC Induction Motors.

E. Vibration and temperature transducers shall be installed in accordance with guidelines provided by API Standard 670.

1. Provide integrated vibration sensor and transmitter with 4 to 20 mA output signal.
a. Features:
1) Mounting: Single 1/4-28 threaded stud for side mount in location to be measured.
2) Enclosure: Hermetically sealed sensor housing with integral 6-foot armored cable for connection in Contractor supplied junction box.
3) Signal Interface: 2-wire, loop powered.
4) Programming: Sensor shall be fully programmable via USB adaptor. Provide a single programming kit that includes software and associated accessories for complete access to all transmitter features.
5) Output Acceleration: User Configurable either Velocity or displacement in rms or peak vibration.
6) Unit: User Configurable either English or SI units.
7) Filters: User selectable three low-pass filters and two high-pass filters.
8) Quantity: As need to comply with API Standard 670.
9) Range and Setpoint: As need to comply with API Standard 670**.**
10) Mounting Location: As needed to comply with API Standard 670**.**

11) Manufacturer/Model: IMI Sensors, 64xxxx Series.

F. Provide two terminal junction boxes mounted on pump lower volute. Provide conduit and cable from pump bearing temperature transducers to one of the terminal junction boxes and provide conduit and cable from pump vibration transducers to other terminal junction box.

2.04 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, Metal Fabrications. Coat in accordance with Section 09900, Painting and Coating.

2.05 FACTORY FINISHING

A. Prepare and prime, and finish Section 09900, Painting and Coating.

2.06 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all actually furnished.

C. Factory Test Report: Include test data sheets, curve test results, and performance test logs.

D. Functional Test: Perform manufacturer’s standard test, as follows:

1. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
2. Limits:
   a. Driving Unit Alone: NEMA MG 1 limits.
   b. Complete Rotating Assembly Including Coupling, and Motor: limits established in the Hydraulic Institute Standards.

E. Performance Test:

1. Conduct on each pump.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Test Log: Record the following:
   a. Total head.
   b. Capacity.

c. Horsepower requirements.
d. Flow measured by factory instrumentation and storage volumes.
e. Average distance from suction well water surface to pump discharge centerline for duration of test.
f. Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
g. Driving motor voltage and amperage measured for each phase.

5. Adjust, realign, or modify units and retest Hydraulic Institute Standards if necessary.

F. Motor Test: See Section 16220, Low-Voltage AC Induction Motors.

G. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

H. Witness of Pump Test: Provide the following for the Owner:

1. Travel costs for two (2) Owner representatives. Cost to include air travel to and from the testing facility and the local airport. The flight shall be non-stop from and to the nearest airport. Provide business class airline tickets for flights outside the Continental USA. Provide lodging, parking fees, ground transportation cost, and a $50 meal allowance per person.
2. Notification at least three (3) weeks prior to testing.
3. Cover above costs if retesting must be performed to obtain satisfactory results.

PART 3 EXECUTION

3.01 INSTALLATION

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

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

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

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of baseplate and concrete foundation with a poured, nonshrinking grout of the proper category, as specified in Section 03600, Nonshrink Grouting. Remove wedges after grout is set and pack void with grout.

E. Vibration and Temperature Transducers:

1. Install in accordance with API 670.
2. Install terminal junction boxes mounted on motor housing for temperature transducers.
3. Install conduit and cable from motor bearing temperature transducers to one of the terminal junction boxes.
4. Install conduit and cable from motor vibration transducers to contractor provided junction box mounted independent of pump and motor.

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

G. Pipe pump drain(s) to hub drain or scupper.

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

3.02 FIELD FINISHING

A. As specified in Section 09900, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
2. Vibration Test:
   a. Test with unit installed and in normal operation, and discharging to connected piping systems at rates between low discharge head and high discharge head conditions specified, shall not develop vibration exceeding of limits specified in HIS 9.6.4.
   b. If unit exhibits vibration in excess of limits specified, adjust or modify as necessary. Unit that cannot be adjusted or modified to conform as specified shall be replaced.
3. Flow Output: Measured by plant instrumentation and storage volumes.
4. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
5. Test for continuous 3-hour period.
6. Test Report Requirements: Provide a complete field test report to include: impact test, flow rates at three discharge pressures, discharge and suction pressers at each flowrate, vibration, rpm, voltage, and current. Provide field test curve comparison to factory test curve.

3.04 MANUFACTURER’S SERVICES

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

1. 5 person-days for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 2 person-days for facility startup.
5. 1/2 person-day for post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. See Section 01650, Facility Startup/Commissioning.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Pump Data Sheet.

END OF SECTION

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMP DATA SHEET, 11211-__

Tag Numbers: P003

Pump Name: Montopolis WRI Pump Station

Manufacturer and Model Number: (1) Flowserve Worthington

(2) Crane Deming

(3) Peerless Pumps

(4) Patterson

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Reclaimed Water

Pumping Temperature (Fahrenheit): Normal: _____ Max _____ Min _____

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 0.98

Vapor Pressure at 60 Degrees F: 0.4 pH: 6.7

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Min. NPSH Available (Ft. Absolute): 35

Altitude (Feet above Mean Sea Level): 595

Area Classification: F-2 Factory Industrial, Low-Hazard

Ambient Temperature (degrees F.): Max 90 – Min 45

Location: Indoor (Y/N): Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Rated: 1,400 Secondary: 1,800

Total Dynamic Head (Ft): Rated: 150 Secondary: 128

BHP at Rated Point: 68 Secondary: 72

Min. Pump Hydraulic Efficiency at Rated Capacity (%): 80

Max. NPSH Required at Rated Capacity (Ft. Absolute): 15

Max. Pump Speed at Rated Capacity (rpm): 1,800

Constant (Y/N): Y

Adjustable (Y/N): N

DESIGN AND MATERIALS

Pump Type: Horizontal (Y/N) Y Frame-Mounted (Y/N) _____

Vertical (Y/N) N Other _____

Casing Material: Cast Iron ASTM A48

Casing Wear Rings (Y/N) Y Casing Wear Ring Material: Cast Iron ASTM A48

Impeller: Type: Double Suction Material: Bronze ASTM B148

Impeller Wear Rings (Y/N) _____ Impeller Wear Ring Material: Bronze

Shaft Material: 316 SS Shaft Sleeve Material: 410SS

Shaft Seal: Packing (Y/N) N Mechanical (Y/N) Y Type: Split

Seal Lubrication: _____

ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: Oil

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMP DATA SHEET, 11211-__

Tag Numbers: _____P003_____

Bearings: Outboard End Type: _____ Inboard End Type: _____

Coupling: Falk (Y/N) ___Y___ Fast: (Y/N) ___N___ Spring-Grid (Y/N) ___N___

Gear Type (Y/N)_____Y___ Spacer (Y/N) _____Y_____

Manufacturer Standard (Y/N) _____

Baseplate Material: _____fabricated steel_____

Drive Type: Direct-Coupled __X__ Belt _____ Adjustable Speed _____ Other _____

DRIVE MOTOR (See Section 16220, Low-Voltage AC Induction Motors.)

Horsepower: ___100__ Voltage: ___460_ Phase: Synchronous Speed (rpm) __1,750_

Service Factor: _____1.15_____

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC X_____CISD-TEFC _____ TENV _____ WPI _____ WPII _____ SUBM _____

Mounting Type: Horizontal Y_____ Vertical Solid Shaft _____ Nonreverse Ratchet (Y/N) _____

REMARKS _____

_____

_____

_____

SECTION 11261
CHLORINE ANALYZER CONTROLLED
TABLET CHLORINATOR SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. The system shall be designed to feed low concentrations of calcium hypochlorite in solution intermittently or continuously as required for reclaimed water treatment applications. The system shall be a single pre-assembled, package unit in a welded aluminum frame consisting of chlorinator, electrical box, centrifugal pump(s), and solution tank for ease of installation and operation. Batch systems with pressure mixing components producing chlorine concentrations exceeding the limits of the specifications will not be considered.

B. Any system offered shall use an NSF Standard 61 listed erosion feeder, an NSF Standard 60 listed calcium hypochlorite tablet, and shall be capable of meeting all requirements of the state agency having jurisdiction over the installation.

1.02 CONTRACTOR SUBMITTALS

A. Manufacturer's Qualifications: The system manufacturer shall have at least 5 years experience in furnishing equipment of similar capacity and service capability to the equipment described herein. As a part of their submittal package, the system manufacturer shall submit the following:

1. Evidence that equipment of similar capacity and service capability has been in successful operation for at least 5 years and in at least five separate installations.
2. Current NSF/ANSI Standard 61 Certification (Drinking Water Additives—Health Effects) or satisfactory evidence of a current application for said certification and/or credible evidence from an independent testing laboratory for equipment of the same design and components that indicate that byproducts are within acceptable limits.

B. Shop Drawings: Furnish complete shop drawings in accordance with Section 1300, Submittals. In addition, the Contractor shall conform with the following conditions:

1. Manufacturer/suppliers literature, illustrations, and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications.
2. Dimensions (including anchor bolt layout), materials, size, operating weight and performance data for all major components.
3. Complete drawings showing fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall consist, at a minimum, of control schematics, including coordination with other electrical control devices operating in conjunction with the system. All electrical and instrumentation terminal points for the equipment shall be furnished.
4. Motor Data: For each motor furnish a certified motor data sheet for the actual motor or for a previously-manufactured electrically duplicate motor which was tested. The submittal shall indicate and guarantee all electrical loads for equipment in this Section including all NEMA motor starter ratings.
5. Pump Data: For each pump furnish a performance certification indicating head, capacity, efficiency, and horsepower.
6. Submit an explicit listing of any and all parameters, ratings, or characteristics where the proposed system deviates from the requirements set forth in these specifications.
7. The Contractor shall obtain written certification from the system manufacturer, addressed to the Owner, stating that:
    a. The equipment will efficiently and thoroughly perform the required functions in accordance with these specifications and as indicated on the Drawings.
    b. All materials of construction proposed are best suited for the chemicals being handled.
    c. The system manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, controls, and services required for proper installation and operation of the completely-assembled and installed equipment. The Contractor shall submit all such certificates to the Construction Manager.

C. Operations and Maintenance Manuals: Prior to startup, the Contractor shall furnish six copies of complete operation and maintenance manuals in accordance with the requirements of the Contract Documents and as described herein:

1. Required Operation Data:
    a. Complete, detailed operating instructions for each piece of equipment.

b. Explanations for all safety considerations relating to operations.
c. Recommended spare parts lists.

2. Required Maintenance Data:
   a. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
   b. Explanations with illustrations as necessary for each maintenance task.
   c. Recommended schedule of maintenance tasks.
   d. A table summarizing lubrication requirements, including recommended lubricants and frequency of lubrication.
   e. Instructions for troubleshooting system and component operation.
   f. A list of required and recommended maintenance tools and equipment.
   g. The name, address and phone number of the manufacture and the system manufacturer's local service representative.

D. Tools: Provide a complete set of any special tools and accessories required to maintain and repair the equipment and/or appurtenances specified herein. Such tools and accessories shall be suitably stored in metal tool boxes, identified by the tag number(s) of the equipment for which they are intended by means of stainless steel or plastic name tags attached to the box.

E. Spare Parts: The Contractor shall obtain from the system manufacturer a list of suggested spare parts of all items of each piece of equipment subject to wear, such as seals, packings, gaskets, nuts, bolts, washers, wear rings, etc., as well as a set of spare bearings.

F. Maintenance: Provide printed instructions relating to proper maintenance, including lubrication and parts lists indicating the various parts by name, number, and diagram where necessary. Such instructions shall be furnished in duplicate with each set or set of identical units.

G. Field Procedures: Provide instructions for field procedures for erection, adjustments, inspection, and testing of the equipment. Such instructions shall be provided prior to the installation of the equipment.

1.03 QUALITY ASSURANCE

A. Acceptance Criteria:

1. For coordination purposes, all equipment and appurtenances specified as part of the system, whether or not shown or specified herein, shall be supplied to the Contractor by the system supplier.
2. Although the system is furnished by a single supplier, the Contractor shall be wholly responsible for a complete facility in accordance with the Contract Documents, including performance requirements, exact

limits of work between Contractor and supplier, all necessary utilities and floor drains to avoid wet floors and coordination with all trades to obtain a complete and operable system.

1.04 GUARANTEE AND WARRANTY

A. Prior to acceptance of the system, provide written warranty from the system manufacturer that includes the following statements:

1. System manufacturer has inspected the installation during and after completion and the system is free from faults and defects and is in conformance with the Contract Documents.
2. The system will remain free of defects for a period of 1 year from the date of final acceptance.
3. If the equipment requires repair or replacement as a result of ordinary wear and tear under normal conditions, such equipment will be repaired or replaced as required without cost to the Owner.

B. After completion, the Contractor shall furnish to the Owner the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, flow ranges, and chemical concentrations and meet these specifications. The Contractor shall also furnish the manufacturer's warranties as published in its literature and as specified.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. A maximum chlorine solution level of 0.05 percent (500 ppm) shall be maintained to prevent calcification in system components. Systems producing chlorine concentrations higher than 0.05 percent shall not be acceptable.

B. Delivery shall be by erosion feed technology to control accurate and consistent concentration limits in the chlorine treatment solution.

C. All piping in the chlorinator unit shall be Schedule 80 PVC for durability. Systems with flexible tubing shall not be acceptable.

D. System shall have the capacity to supply chlorine as follows:

1. Minimum chlorine delivery of up to a maximum of 6 lbs/hr of equivalent free chlorine with a 10 to 1 turndown ratio.
2. A 2 mg/l chlorine demand with a maximum residual of 3 mg/l.
3. Inlet pressures from 70 to 80 psi.
4. Outlet pressure for injection 95 psi.

E. Each system shall be designed per available power. Two electrical circuits are required for operation: (1) dry contact or 110v 5 amp control, and (1) pump

circuit sized for the pump provided, and shall operate on 480 VAC – 3 phase power.

2.02 MANUFACTURERS

A. PPG Industries, Inc., Monroeville, PA.

B. Or approved equal.

2.03 SYSTEM COMPONENTS

A. Tablet Chlorinator.

B. Inlet Water Supply Connection with Filter and pressure regulator with gauge.

C. Inlet Solenoid Valve: Opens and closes on solution tank level control.

D. Digital Flow Meter: A flow sensor transmits a pulse signal to a digital monitor, measuring the flow of the fresh water-dissolving stream.

E. Flow Control Valve: PVC gate valve mounted in-line with the flow meter allows operator to adjust flow of water-dissolving stream.

F. Bypass Flow Meter and Control Valve: Clamp-on style flow meter and PVC gate valve installed on the bypass line to allow regulating of concentrations in the solution tank.

G. Solution Tank: Made of high-density polyethylene, minimum 92 gallon capacity.

H. High/Low Level Solution Tank Control: Produces a small batch of solution for multiple uses.

1. Low Level: Activation causes the solenoid valve to open filling the tank.
2. High Level: Activation causes the solenoid valve to close.

I. Low-Low Level Switch: Shuts pump down preventing cavitation. A restart timer will prevent the pump from “chattering”.

J. Solution Delivery Pump (plus one spare pump): Delivers chlorinated solution into a pressurized stream. A variable frequency drive (VFD) motor on the solution delivery pump is controlled by the process controller.

K. Solution Injection Pump Air Bleed: Used to prime the pump at start-up, or at any time, if necessary.

L. Primary Backflow Prevention: A PVC Y-check valve prevents reverse flow of water into the system.

M. Outlet Connection.

N. NEMA 4X Electrical Enclosure.

O. Aluminum Frame: Type 6061-T.

P. Weight Scale: Load cell factory-installed under the chlorinator to measure tablet weight.

Q. Process Controller: Control panel shall meet the requirements of City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment. Factory-installed PLC for automatic chemical delivery. Capability to control in Flow-Pacing, Residual, or Compound Loop modes. Capability to operate in a manual mode. Connections and programming to send alarms to the SCADA system for pump failure, valve failure, and low tablet level. PLC must be a Modicon M340.

PART 3 EXECUTION

3.01 INSTALLATION AND FIELD TESTING

A. The equipment shall be coordinated with other instrumentation and equipment and shall be installed, calibrated and tested according to the requirements of the manufacturer. In addition, the equipment shall be operationally tested in conjunction with the water treatment plant system. Contractor will be responsible for connecting water and electrical to equipment.

3.02 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment shall be present at the Site and/or classroom designated by the Owner for the minimum person-days listed for the equipment and services hereinunder, travel time excluded:

1. Hypochlorite System:
   a. 1 person-day for installation, inspection, and certification of the installation.
   b. 1 person-day for functional equipment testing and startup assistance.
   c. 1/2 person-day for training of Owner's personnel.

END OF SECTION

SECTION 11730
STORAGE RESERVOIR SUBMERSIBLE MIXER

PART 1 GENERAL

1.01 SCOPE

A. This section covers submersible tank mixing systems up to 0.5 hp in size intended for continuous use while submersed in reclaimed water storage tanks. Each mixer shall have the ability to function continuously on a year-round basis, regardless of drain and fill cycles. Each mixer shall consist of a water-filled submersible motor, an impeller and a non-submersible control center that houses all control electronics.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Comply with the applicable reference specifications as specified in the General Requirements.

1.03 CONTRACTOR SUBMITTALS

A. Design Calculations:

1. Based on models validated and/or calibrated with experimental data from laboratory-scale and real scale representative systems for similarly-sized reservoirs, manufacturer shall show completely mixed conditions for equipment configuration.
2. The manufacturer shall provide documentation of the Computational Fluid Dynamics (CFD) model parameters and assumptions, tank geometry and dimensions considered, mesh information, and CPU time required.
3. Analysis should include the following sections:
   a. Method of calibration reflecting field studies.
   b. Velocity vectors and contour plot at different cross-sections.
   c. The average flow induced throughout the tank.
   d. The corresponding average turnover for the tank (in hours).
   e. The corresponding average power consumption of the mixer.

1.04 QUALITY ASSURANCE

A. Each mixing system shall be tested prior to deployment according to standard engineering practices at the factory testing facilities. Certification of this completed testing shall accompany mixer installation documentation.

PART 2 PRODUCTS

2.01 PERFORMANCE

A. Mixing system shall completely mix reservoir according to the following minimum performance requirements. These requirements can be measured and validated after installation by manufacturer with readily-available tools such as temperature probes and total chlorine grab samplers.

1. Temperature Uniformity:
   a. For tanks larger than 500,000 gallons in volume: A beginning stratification of at least 5°C (2.2°C) shall converge to within 0.50°C within 24 hours after mixer is installed and activated. Mixer will blend according to the following formula:

      [Tank Vol. in MG] * 5 = # Hours until fully blended

   b. Number of hours until fully blended shall be less than the cycle time of the reservoir. Empirical evidence from a similarly sized tank shall be required to validate that the mixing equipment meets this Specification, otherwise mixer will be rejected. CFD is not an acceptable substitute for empirical claims.

2.02 GENERAL

A. Mixing system consists of an impeller mounted on a submersible motor and supported approximately three feet in height from the tank floor in order for it to launch a jet of water from the bottom of the tank up toward the surface of the water. Floating devices shall not be acceptable. Mixer duty cycle shall be variable with the size and volume of the tank. Mixer control and operation shall be independent of tank drain and fill cycles to ensure constant mixing. Wet-side of Mixer shall weigh less than 75 pounds (~34 kg) and dry-side shall weigh less than 50 pounds (~22 kg). Both wet-side and dry-side shall be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.

B. Mixing system active components shall be elevated at a minimum of 18 inches above tank floor to avoid disturbing accumulated tank sediment or entraining particles and causing accelerated wear of moving parts.

C. Mixers using submersible pump with slit or “water sheet” designs are not acceptable.

D. Power source for mixer shall be 110V ac grid power to allow unit to continue 24/7 operation where necessary.

2.03 CONSTRUCTION

A. Components – wet-side: Shall be NSF/ANSI Standard 61 certified.

1. Equipment entering tank shall not adhere to, scratch, or otherwise cause damage to internal tank coating or put undue stress on the materials of the tank construction. Equipment shall fit through a standard hatch of size 18 by 18 or larger.
2. Each submersible mixer shall consist of the following components, regardless of the power source selected:
3. Impeller:
   a. AISI Type 316 stainless steel.
   b. Balanced to within 0.5 gram-inches.
   c. Passivated per ASTM A380 to minimize corrosion.
   d. Not more than 8 inches in overall height.
   e. Not more than 4.5 inches in diameter.
   f. Not more than 2.4 pounds in weight.
   g. Shall not create cavitation at any rotational speed up to 2500 RPM.
4. Motor:
   a. AISI Type 304 stainless steel body.
   b. Chlorine/Chloramine resistant rubber seals.
   c. Fully submersible.
   d. Low power (0.5 hp maximum).
   e. Water-filled motor.
   f. Water-lubricated motor.
5. Mounting Tripod:
   a. AISI Type 316 stainless steel.
   b. Three-foot long detachable legs or pedestal mount.
   c. NSF/ANSI Standard 61 certified EPDM rubber, non-skid, non-scratch feet or insulating pad.
   d. Attachments secure motor cable away from impeller.
   e. Overall weight of wet-side unit not to exceed 75 lbs. to avoid damaging tank floor.
   f. Overall height of unit not to exceed 5 feet.

B. Components – dry-side: Each 110V ac control center shall meet the requirements of City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment and consist of the following components:

1. Enclosure:
   a. Lockable.
   b. Weather Resistant.
   c. Overall weight of control center not to exceed 50 pounds.
   d. Green and Red LED Indicator lights show motor status.
2. Motor Controller/VFD:

a. Rated to 1.0 hp.
b. Operating temperature range -30°C up to 50°C (-34°F to 122°F).
c. Manual speed control (potentiometer).
d. Thermal shut-off protection built-in.
e. Current overload protection built-in SCADA outputs included:
1) Digital Output signal indicating motor running.
2) Digital Output signal indicating fault.
3) Digital Input/output signal allowing remote motor on/off.
4) RS-232 (MODBUS) or RS-485 or Dry Contact connections.

3. GFCI-protection:
a. 120-volt, 60-Hz, single-phase GFCI included inside control center.
b. 40-Amp, 300mA trip level.

2.04 CONTROLS

A. Each unit shall be equipped with all necessary controls, interwired, to provide the following minimum functions:

1. On/Off switch to control power to mixer.
2. Automatically-activated motor shut-off if water level drops below motor height in tank.
3. Any other controls shown on electrical and instrumentation drawings.

2.05 ACCEPTABLE MANUFACTURERS:

A. PAX Water Technologies (Richmond, California), or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish services of a factory-trained installation contractor or crew having experience with installation procedures and operation and maintenance requirements for the type of equipment installed under these Specifications.

B. Tank penetration will be above tank water line.

1. Fitting shall be 1 inch diameter fitting to allow cable to pass through.
2. Strain relief for power cable shall be part of the contractor-supplied fitting for tanks more than 30 feet in depth.

3.02 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment shall be present at the Site and/or classroom designated by the Owner for the minimum person-days listed for the equipment and services hereinunder, travel time excluded:

1. 1 person-day for installation, inspection, and certification of the installation.
2. 1person-day for functional equipment testing and startup assistance.
3. 1/2 person-day for training of Owner's personnel.

END OF SECTION

SECTION 13122

PUMP STATION METAL BUILDING SYSTEMS

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. Structural-steel framing.

2. Metal roof panels.

3. Metal soffit panels.

4. Thermal insulation.

5. Windows.

6. Accessories.

B. Related Sections:

1. Section 08330 "Overhead Coiling Doors."

1.3 DEFINITIONS

A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Structural-steel-framing system.

2. Metal roof panels.

3. Metal liner panels.

4. Translucent panels.

5. Insulation and vapor retarder facings.

6. Flashing and trim.

7. Windows.

8. Accessories.

B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.

1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location.

2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.

   a. Show provisions for attaching roof curbs, service walkways, platforms, and pipe racks.

3. Metal Roof Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.

   a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.

   b. Show wall-mounted items including doors, windows, louvers, and lighting fixtures.

   c. Show translucent panels.

4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:

   a. Flashing and trim.

   b. Gutters.

   c. Downspouts.

   d. Roof ventilators.

e. Louvers.

f. Service walkways.

C. Samples for Initial Selection: For units with factory-applied color finish.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:

1. Metal Panels: Nominal 12 inches long by actual panel width. Include fasteners, closures, and other exposed panel accessories.

2. Translucent Panels: Nominal 12 inches long by actual panel width.

3. Flashing and Trim: Nominal 12 inches long. Include fasteners and other exposed accessories.

4. Vapor-Retarder Facings: Nominal 6-inch- square Samples.

5. Windows: Full-size, nominal 12-inch- long frame Samples showing typical profile.

6. Accessories: Nominal 12-inch- long Samples for each type of accessory.

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified manufacturer.

B. Welding certificates.

C. Metal Building System Certificates: For each type of metal building system, from manufacturer.

1. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

a. Name and location of Project.

b. Order number.

c. Name of manufacturer.

d. Name of Contractor.

e. Building dimensions including width, length, height, and roof slope.

f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.

g. Governing building code and year of edition.

h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).

i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.

j. Building-Use Category: Indicate category of building use and its effect on load importance factors.

k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility by an AISC-Certified Manufacturer.

D. Erector Certificates: For each product, from manufacturer.

E. Manufacturer Certificates: For each product, from manufacturer.

F. Material Test Reports: For each of the following products:

1. Structural steel including chemical and physical properties.

2. Bolts, nuts, and washers including mechanical properties and chemical analysis.

3. Tension-control, high-strength, bolt-nut-washer assemblies.

4. Shop primers.

5. Nonshrink grout.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor-retarder facings. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.

H. Source quality-control reports.

I. Field quality-control reports.

J. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.

K. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panel finishes to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.

2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

C. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

D. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

E. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. AWS D1.3, "Structural Welding Code - Sheet Steel."

G. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.

H. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

I. Fire-Resistance Ratings: Where indicated, provide metal panel assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2. Combustion Characteristics: ASTM E 136.

J. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

K. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.

2. Build mockups for typical wall metal panel including accessories.

a. Size: 48 inches long by 48 inches.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

L. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to metal building systems including, but not limited to, the following:

a. Condition of foundations and other preparatory work performed by other trades.

b. Structural load limitations.

c. Construction schedule. Verify availability of materials and erector's personnel, equipment, and facilities needed to make progress and avoid delays.

d. Required tests, inspections, and certifications.

e. Unfavorable weather and forecasted weather conditions.

2. Review methods and procedures related to metal roof panel assemblies including, but not limited to, the following:

a. Compliance with requirements for purlin and rafter conditions, including flatness and attachment to structural members.

b. Structural limitations of purlins and rafters during and after roofing.

c. Flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.

d. Temporary protection requirements for metal roof panel assembly during and after installation.

e. Roof observation and repair after metal roof panel installation.

3. Review methods and procedures related to metal wall panel assemblies including, but not limited to, the following:

a. Compliance with requirements for support conditions, including alignment between and attachment to structural members.

b. Structural limitations of girts and columns during and after wall panel installation.

c. Flashings, special siding details, wall penetrations, openings, and condition of other construction that will affect metal wall panels.

d. Temporary protection requirements for metal wall panel assembly during and after installation.

e. Wall observation and repair after metal wall panel installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect foam-plastic insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

2. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

3. Complete installation and concealment of foam-plastic materials as rapidly as possible in each area of construction.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements:

1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

2. Established Dimensions for Metal Panels: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.10 COORDINATION

A. Coordinate sizes and locations of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Section 410S "Concrete Structures."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

C. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty on Metal Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.

b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.

c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

B. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that leak or otherwise fail to remain weathertight within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with project requirements.

2.2 METAL BUILDING SYSTEMS

A. Description: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.

1. Provide metal building system of size and with bay spacings, roof slopes, and spans indicated.

B. Primary-Frame Type:

1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

C. Secondary-Frame Type: Manufacturer's standard purlins and joists.

D. Eave Height: Varies, as indicated on Drawings.

E. Bay Spacing: as indicated on Drawings.

F. Roof Slope: As indicated on Drawings.

G. Roof System: Manufacturer's standard standing-seam metal roof panels with field-installed insulation.

H. Exterior Wall System: To consist of Concrete Masonry Units by others as indicated on Drawings.

2.3 METAL BUILDING SYSTEM PERFORMANCE

A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: As indicated on Drawings.

2. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:

a. Purlins and Rafters: Vertical deflection of 1/240 of the span.

b. Metal Roof Panels: Vertical deflection of 1/240 of the span.

c. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.

3. Drift Limits: Engineer building structure to withstand design loads with drift limits no greater than the following:

a. Lateral Drift: Maximum of 1/400 of the building height.

4. Metal panel assemblies shall withstand the effects of gravity loads and loads and stresses within limits and under conditions indicated according to ASTM E 1592.

C. Seismic Performance: Metal building systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Air Infiltration for Metal Roof Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at negative test-pressure difference of 1.57 lbf/sq. ft.

F. Air Infiltration for Metal Wall Panels: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at static-air-pressure difference of 1.57 lbf/sq. ft.

G. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E 1646 at test-pressure difference of 2.86 lbf/sq. ft.

H. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E 331 at a wind-load design pressure of not less than [**2.86 lbf/sq. ft.**] <**Insert value**>.

I. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for Class 60.

2.4 STRUCTURAL-STEEL FRAMING

A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafter, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

3. Exterior Column Type: Uniform depth.

4. Rafter Type: Uniform depth or Tapered.

B. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.

a. Depth: As indicated or as needed to comply with system performance requirements.

2. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.

3. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch diameter, cold-formed structural tubing to stiffen primary-frame flanges.

4. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.

5. .

6. Purlin Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

7. .

8. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

C. Bracing: Attach metal system to surrounding CMU walls for lateral bracing.

D. Bolts: Provide plain-finish bolts for structural-framing components that are primed or finish painted. Provide zinc-plated or hot-dip galvanized bolts for structural-framing components that are galvanized.

E. Materials:

1. W-Shapes: ASTM A 992/A 992M.

2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M.

3. Plate and Bar: ASTM A 36/A 36M.

4. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

5. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.

6. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70.

7. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80; with G60 coating designation; mill phosphatized.

8. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80 or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80; with G90 coating designation.

    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Structural Steel (SS), Grade 50 or 80; with Class AZ50 coating.

9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 plain (flat) steel washers.

    a. Finish: Plain.

10. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563 heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.

    a. Finish: Plain.

11. Unheaded Anchor Rods: ASTM F 1554, Grade 36

    a. Configuration: Straight.

    b. Nuts: ASTM A 563 hex carbon steel.

    c. Plate Washers: ASTM A 36/A 36M carbon steel.

    d. Washers: ASTM F 436 hardened carbon steel.

    e. Finish: Plain

12. Headed Anchor Rods: ASTM F 1554, Grade 36

    a. Configuration: Straight.

    b. Nuts: ASTM A 563 hex carbon steel.

    c. Plate Washers: ASTM A 36/A 36M carbon steel.

    d. Washers: ASTM F 436 hardened carbon steel.

    e. Finish: Plain.

13. Threaded Rods: ASTM A 193/A 193M

a. Nuts: ASTM A 563 hex carbon steel.

b. Washers: ASTM A 36/A 36M carbon steel.

c. Finish: Plain

F. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.

1. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.

a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

2. Prime galvanized members with specified primer after phosphoric acid pretreatment.

3. Primer: SSPC-Paint 15, Type I, red oxide.

2.5 METAL ROOF PANELS

A. Vertical-Rib, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) steel sheet, 0.034-inch nominal thickness.

a. Exterior Finish: Fluoropolymer or Siliconized polyester.

b. Color: As selected by Architect from manufacturer's full range.

2. Clips: Manufacturer's standard, floating type to accommodate thermal movement; fabricated from zinc-coated (galvanized) steel sheet.

3. Joint Type: Panels snapped together.

4. Joint Type: Mechanically seamed or folded according to manufacturer's standard.

5. Panel Coverage: 16 inches.

6. Panel Height: 2 inches.

7. Uplift Rating: UL 60.

B. Trapezoidal-Rib, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using

concealed clips located under one side of panels and engaging opposite edge of adjacent panels.

1. Material: Zinc-coated (galvanized) steel sheet, 0.034-inch nominal thickness.

    a. Exterior Finish: Fluoropolymer or Siliconized polyester.

    b. Color: [As indicated by manufacturer's designations] [As selected by Architect from manufacturer's full range] <Insert color>.

2. Clips: Manufacturer's standard, floating type to accommodate thermal movement; fabricated from zinc-coated (galvanized) steel sheet.

3. Joint Type: Panels snapped together.

4. Joint Type: Mechanically seamed or according to manufacturer's standard.

5. Panel Coverage: 24 inches.

6. Panel Height: 3 inches>.

7. Uplift Rating: UL 60.

C. Materials:

1. Metallic-Coated Steel Sheet: Restricted-flatness steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

    a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.

    b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.

    c. Surface: Smooth, flat finish.

D. Finishes:

1. Exposed Coil-Coated Finish:

    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    b. Three-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear

topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

c. Siliconized Polyester: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil for primer and 0.8 mil for topcoat.

2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

2.6 METAL SOFFIT PANELS

A. General: Provide factory-formed metal soffit panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for weathertight installation.

B. Metal Soffit Panels: Match profile and material of metal roof panels.

1. Finish: As indicated on Drawings.

C. Tapered-Rib-Profile, Exposed-Fastener Metal Soffit Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.

1. Material: Zinc-coated (galvanized), 0.034-inch nominal thickness.

a. Exterior Finish: Fluoropolymer or Siliconized polyester.

b. Color: **As selected by Architect from manufacturer's full range**.

2. Major-Rib Spacing: 6 inches o.c.

3. Panel Coverage: 36 inches.

4. Panel Height: 0.75 inch.

D. Concealed-Fastener Metal Soffit Panels: Formed with vertical panel edges and a single wide recess, centered between panel edges; with flush joint between panels; with 1-inch- wide flange for attaching interior finish; designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps.

1. Material: Zinc-coated (galvanized) steel sheet, 0.034-inch nominal thickness.

a. Exterior Finish: Fluoropolymer or Siliconized polyester.

b. Color: As selected by Architect from manufacturer's full range.

2. Panel Coverage: 12 inches.

3. Panel Height: 1 inch.

2.7 THERMAL INSULATION

A. Faced Metal Building Insulation: ASTM C 991, Type II, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

B. Unfaced Metal Building Insulation: ASTM C 991, Type I, or NAIMA 202, glass-fiber-blanket insulation; 0.5-lb/cu. ft. density; 2-inch- wide, continuous, vapor-tight edge tabs; with a flame-spread index of 25 or less.

1. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.

a. Composition: White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.

b. Composition: Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.

c. Composition: White polypropylene film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.

d. Composition: White polypropylene film facing and fiberglass-polyester-blend fabric backing.

C. Mineral-Fiber-Blanket Insulation: ASTM C 665, type indicated below; consisting of fibers manufactured from glass, slag wool, or rock wool.

1. Nonreflective Faced: Type II (blankets with nonreflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).

2. Reflective Faced: Type III (blankets with reflective membrane covering), Category 1 (membrane is a vapor retarder), Class A (membrane-faced surface with a flame-spread index of 25 or less).

3. Unfaced: Type I (blankets without membrane covering), passing ASTM E 136 for combustion characteristics.

a. Vapor-Retarder Facing: ASTM C 1136, with permeance not greater than 0.02 perm when tested according to ASTM E 96/E 96M, Desiccant Method.

1) Composition: White metallized-polypropylene film facing, fiberglass scrim reinforcement, and kraft-paper backing.

2) Composition: Aluminum foil facing, elastomeric barrier coating, fiberglass scrim reinforcement, and kraft-paper backing.

3) Composition: White polypropylene film facing, fiberglass scrim reinforcement, and metallized-polyester film backing.

4) Composition: White polypropylene film facing and fiberglass-polyester blend fabric backing.

D. Faced, Polyisocyanurate Board Insulation: ASTM C 1289, Type I (foil facing), Class 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core. Provide units tested for interior exposure without an approved thermal barrier.

E. Retainer Strips: 0.025-inch nominal-thickness, formed, metallic-coated steel or PVC retainer clips colored to match insulation facing.

F. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.8 WINDOWS

A. As indicated in Architects drawings.

2.9 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.

2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.

3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.

4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same material as metal wall panels.

2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

D. Flashing and Trim: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match adjacent metal panels.

1. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

2. Opening Trim: Formed from 0.034-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.

E. Gutters: Formed from 0.022-inch nominal-thickness, metallic-coated steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.

2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Formed from 0.022-inch nominal-thickness, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Roof Ventilators: As indicated on Architect's drawings.

H. Louvers: As indicated on Architect's drawings.

I. Roof Curbs: As indicated on Architect's drawings.

J. Service Walkways: Fabricated from 0.052-inch nominal-thickness, metallic-coated Pipe flashing in first paragraph below is not designed for high-temperature applications.

K. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

L. Materials:

1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.

a. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM sealing washer.

b. Fasteners for Metal Roof Panels: Self-drilling, Type 410 stainless-steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM washer under heads of fasteners bearing on weather side of metal panels.

c. Fasteners for Metal Wall Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with EPDM sealing washers bearing on weather side of metal panels.

d. Fasteners for Metal Wall Panels: Self-drilling, Type 410 stainless-steel or self-tapping, Type 304 stainless-steel or zinc-alloy-steel hex washer head, with EPDM sealing washers bearing on weather side of metal panels.

e. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.

f. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

4. Metal Panel Sealants:

a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.

b. Joint Sealant: ASTM C 920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

2.10 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate product.

B. Special Inspector: Owner will engage a qualified special inspector to perform the following tests and inspections and to submit reports. Special inspector will verify that manufacturer maintains detailed fabrication and quality-control procedures and will review the completeness and adequacy of those procedures to perform the Work.

1. Special inspections will not be required if fabrication is performed by manufacturer registered and approved by authorities having jurisdiction to perform such Work without special inspection.

a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

C. Testing: Test and inspect shop connections for metal buildings according to the following:

1. Bolted Connections: Shop-bolted connections shall be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

2. Welded Connections: In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

D. Product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.11 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.

2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

1. Make shop connections by welding or by using high-strength bolts.

2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.

3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.

4. Weld clips to frames for attaching secondary framing.

5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

1. Make shop connections by welding or by using non-high-strength bolts.

2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.

1. Engage land surveyor to perform surveying.

C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when

permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.

2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.

3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.

a. Joint Type: Snug tightened or pretensioned.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.

2. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.

H. Bracing: Provide adequate attachment to the exterior CMU walls to transfer all required lateral loads.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 METAL PANEL INSTALLATION, GENERAL

A. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.

1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.

B. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.

3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.

4. Locate and space fastenings in uniform vertical and horizontal alignment.

5. Locate metal panel splices over, but not attached to, structural supports with end laps in alignment.

6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

C. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.

2. Prepare joints and apply sealants to comply with requirements in Section 07920 "Joint Sealants."

3.5 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.

2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint, at location and spacing and with fasteners recommended by manufacturer.

1. Install clips to supports with self-drilling or self-tapping fasteners.

2. Install pressure plates at locations indicated in manufacturer's written installation instructions.

3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.

4. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so that clip, metal roof panel, and factory-applied sealant are completely engaged.

5. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels for fasteners.

6. Provide metal closures at peaks, rake edges, rake walls, and each side of ridge and hip caps.

C. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.

2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.

3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.

4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

D. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

E. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 METAL SOFFIT PANEL INSTALLATION

A. Provide metal soffit panels the full width of soffits. Install panels perpendicular to support framing.

B. Flash and seal metal soffit panels with weather closures where panels meet walls and at perimeter of all openings.

3.7 THERMAL INSULATION INSTALLATION

A. General: Install insulation concurrently with metal panel installation, in thickness indicated to cover entire surface, according to manufacturer's written instructions.

1. Set vapor-retarder-faced units with vapor retarder toward warm side of construction unless otherwise indicated. Do not obstruct ventilation spaces except for firestopping.

2. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to the surrounding construction to ensure airtight installation.

3. Install factory-laminated, vapor-retarder-faced blankets straight and true in one-piece lengths, with both sets of facing tabs sealed, to provide a complete vapor retarder.

4. Install blankets straight and true in one-piece lengths. Install vapor retarder over insulation, with both sets of facing tabs sealed, to provide a complete vapor retarder.

B. Blanket Roof Insulation: Comply with the following installation method:

1. Over-Framing Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal roof panels fastened to secondary framing.

2. Between-Purlin Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Hold in place with bands and crossbands below insulation.

3. Over-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Install layer of filler insulation over first layer to fill space formed by metal roof panel standoffs. Hold in place by panels fastened to standoffs.

   a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

4. Two-Layers-between-Purlin-with-Spacer-Block Installation: Extend insulation and vapor retarder between purlins. Carry vapor-retarder-facing tabs up and over purlin, overlapping adjoining facing of next insulation course and maintaining continuity of retarder. Install layer of filler insulation over first layer to fill space between purlins formed by thermal spacer blocks. Hold in place with bands and crossbands below insulation.

   a. Thermal Spacer Blocks: Where metal roof panels attach directly to purlins, install thermal spacer blocks.

5. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

C. Blanket Wall Insulation: Extend insulation and vapor retarder over and perpendicular to top flange of secondary framing. Hold in place by metal wall panels fastened to secondary framing.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

2. Sound-Absorption Insulation: Where sound-absorption requirement is indicated for metal liner panels, cover insulation with polyethylene film and provide inserts of wire mesh to form acoustical spacer grid.

D. Board Wall Insulation: Extend board insulation in thickness indicated to cover entire wall. Hold in place by metal wall panels fastened to secondary framing. Comply with manufacturers' written instructions.

1. Retainer Strips: Install retainer strips at each longitudinal insulation joint, straight and taut, nesting with secondary framing to hold insulation in place.

3.8 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges

folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

2. Tie downspouts to underground drainage system indicated.

E. Circular Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Mount ventilators on flat level base. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

G. Louvers: Locate and place louver units level, plumb, and at indicated alignment with adjacent work.

1. 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.

2. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

3. Protect galvanized- and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of corrosion-resistant paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

4. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply

with Section 079200 "Joint Sealants" for sealants applied during louver installation.

H. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

I. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.9 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspection of fabricators.

2. Steel construction.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Tests and Inspections:

1. High-Strength, Field-Bolted Connections: Connections shall be inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:

a. Liquid Penetrant Inspection: ASTM E 165.

b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.

c. Ultrasonic Inspection: ASTM E 164.

d. Radiographic Inspection: ASTM E 94.

D. Product will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 ADJUSTING

A. Roof Ventilators and Adjustable Louvers: After completing installation, including work by other trades, lubricate, test, and adjust units to operate easily and be free of warp, twist, or distortion as needed to provide fully functioning units.

1. Adjust louver blades to be weathertight when in closed position.

3.11 CLEANING AND PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories.

1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."

2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

D. Touchup Painting: Cleaning and touchup painting are specified in Section 09900 "Painting and Coating" and Section 09910 "Architectural Painting."

E. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

F. Louvers: Clean exposed surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

1. Restore louvers damaged during installation and construction period so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

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

END OF SECTION

SECTION 13315
PLC NETWORK REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. This section defines the requirements for Local Area Networks (LAN) to support the system interconnectivity required by the PLC portion of the distributed computing and control systems specified in other sections. The LAN network shall be seamlessly integrated with the systems as required to meet the system performance requirements.

B. The Contractor shall include in the bid all security related LAN equipment as shown on contract drawings. LAN equipment includes network switches, router, fiber optic patch panel, fiber optic patch cable, and Cat-6 patch cable needed. LAN equipment shall not include access control controller, digital video recorder, UPS associated with the security control panel or any security related devices. Security contractor shall provide panel design, all LAN equipment, and security equipment mounting inside the security control panel. Instrumentation contractor shall provide security contractor LAN equipment physical dimension, spacing requirement, and power requirement.

C. The Contractor shall be responsible for the following equipment and software:

1. Industrial Ethernet switch with minimum ports requirement listed in section below.
2. All fiber-optic patch cables needed.
3. All Cat-6 patch cables needed.
4. Fiber optic cables.
5. Fiber optic patch panel.
6. Router.

1.02 SUBMITTALS

A. The following items shall be furnished in the submittal package for this section:

1. Data sheets and catalog literature for the fiber optic cable, the industrial Ethernet switches, the fiber optic transceivers, and the proposed fiber optic patch panels, terminations and connectors.
2. Manufacturer specifications and data which clearly and unambiguously show that the cable meets all of the requirements specified herein.
3. Samples of the specified cable and of the proposed terminators and connectors.
4. Drawings showing the physical dimensions of all products to be furnished.

5. Identification and labeling of cable, cable fibers, and cable terminations.
6. Detailed network riser and connection diagram.
7. Rack-up drawings of all equipment.
8. A list of all network equipment used to make up the LAN and software provided with each.
9. Testing sequence, expected duration and schedule for the network test.
10. Network equipment, cable and system test documentation forms.
11. A list of the personnel who will be conducting the network equipment, cable and system testing, and their qualifications.

1.03 WARRANTY

A. Reference specification 13400.

1.04 SPARE PARTS AND TOOLS

A. Maintenance Materials (Extra Stock): Spare parts shall include the following minimum renewal parts in original packaging complete with wiring diagram and installation guide:

1. Five 10 feet Ethernet Cat-6 molded patch cables.
2. Two of each type of fiber-optic molded patch cables used.
3. One Ethernet cable Cat-6 crimper.
4. Five hundred feet of Cat-6 cable.
5. 100 Cat-6 crimp connectors.
6. One of each type of Ethernet switch used.
7. One of each type of router used.
8. One of each router module used.

PART 2 PRODUCTS

2.01 NETWORK CONFIGURATION

A. The System Network consists of a Local Area Network (LANs) for the Montopolis Pump station. Refer to the drawings for the overall network:

1. The MOPR-PSCP01 – The PLC, the three radios and the power monitors from the Motor Control Centers shall be connected together and exchange data via a 10/100BaseT Local Area Network (LAN).
2. All necessary LAN interconnecting hardware and cables shall be included with the system. The Contractor shall coordinate LAN cable lengths and equipment locations with the Owner and shall be responsible for the total connectivity of the equipment utilizing the LAN. The fiber optic cables shall be terminated in patch panels located in each security enclosure.

2.02 LAN NETWORK FUNCTIONS

A. General Requirements:

1. All necessary information shall be transmitted by the system network to and/or between the following, all PLC's, various other processors connected to the system, all control subsystems, and peripherals.
2. The LANs shall utilize Ethernet.
3. The LANs shall support installation in facilities where RFI/EMI noise is commonly experienced. The LAN's shall be designed to provide efficient and secure data transfer under these conditions.
4. All Cat-6 network connections shall be provided with surge protection at both ends of any runs where the cable leaves a building.
5. In no case shall the LAN fail to meet the data transmission rates and throughput required to meet the system performance requirements for any function defined in this Specification.
6. Each LAN shall have data transmission speeds of a minimum of 100MB. The Contractor shall be responsible for meeting all system performance requirements using these communications links.

B. Local Area Network Requirements: The LANs shall comply with the Ethernet specification and shall support connectivity between all LAN resident devices. The Contractor shall provide all network equipment including cable, cable connectors, amplifiers, splitters, and communication cards required to make a complete and operational network.

C. Network Configuration: It is the Contractor's responsibility to provide a local area network configuration, which provides secure and error free communications between all stations or connections on the Local Area Network. The configuration provided by the Contractor shall take into account distances between any two stations or segments of the Local Area Network and shall provide ample signal-to-noise ratio (S/N) at the receiver, which equates to an average residual bit-error-rate (BER) of 1x10-11.

2.03 INDUSTRIAL ETHERNET SWITCH FOR SCADA

A. The Ethernet Switches shall be IEEE-802.3 compliant.

B. The Ethernet switch shall be industrial rated and can be operated in industrial environments.

C. The Ethernet Switch shall have no moving parts.

D. The Ethernet Switch shall have redundant power inputs for 24 VDC

E. Ethernet Switch shall be configurable via web interface.

F. Ethernet Switch shall be capable of -40ºC to 85 Degree Celsius operating temperature.

G. Manufacturer: The Industrial Network Company

H. Product: N-Tron Ethernet Switch Model 516TX-A (or approved similar industrial Ethernet switch).

2.04 INDUSTRIAL ETHERNET ROUTER FOR SCADA

A. The Router shall be IEEE-802.3 compliant.

B. The Route shall be industrial rated and can be operated in industrial environments.

C. The Router shall have no moving parts.

D. The Router shall enable remote management and monitoring with Simple Network Management Protocol (SNMP), Telnet or HTTP.

E. Ethernet Switch shall support four synchronous/asynchronous serial ports, four fast Ethernet ports, 802.11 a/b/g and 4.9 GHz support and a AC/DC power converter card.

F. Ethernet Switch shall be capable of -40ºC to 85 Degree Celsius operating temperature.

G. Manufacturer: Cisco

H. Product: Model 3250.

2.05 INDUSTRIAL AUTODIALER FOR SCADA

A. The Autodialer shall comply with UL 1459 and 1950 standards.

B. The Autodialer shall be industrial rated and can be operated in industrial environments.

C. The Autodialer Telephone shall:

1. Be compatible with most cellular telephone systems.
2. Be compatible with rotary pulse or tone dialing, keyboard selectable.
3. Allow programming of PBX delays in 1 second increments.
4. Be FCC registered Part 68, “Ringer Equivalence”: 0.3A.
5. Allow for alarm acknowledgment by Touchtone key or by calling back.
6. Provide up to 16 different numbers to be dialed, each up to 60 digits long.

D. The Autodialer shall function with 105-135 VAC, 50/60 HZ, 15 watts maximum or 8-14 VDC at 500 mA maximum.

E. Autodialer shall be provided with a rechargeable gel-cell battery with up to 20 hours of continuous operation in the event of the loss of power.

F. Autodialer shall modular and expandable to provide support for up to 32 digital inputs, 16 analog inputs and 8 digital control outputs.

G. Contractor shall coordinate with the local telephone company and Owner to establish the phone service to initiate the Autodialer.

H. Manufacturer: Raco:

I. Model: Verbatim.

2.06 900 MHZ RADIO

A. The radio shall comply with FCC Part 90 and Part 101 approvals.

B. The radio shall be industrial rated and can be operated in industrial environments.

C. The radio shall:

1. Be operational in simplex and half-duplex modes.
2. Possess operational power from 0.1 to 5 watts, programmable.
3. Include a receiver capable of double conversion.
4. Include a receiver with a sensitivity of -112 dBm at 1X10^-6 BER.
5. Be capable of interfacing with MDS Pulsenet NMS, MDS InSite and MDS Radio Configuration software.

D. The radio shall include the following interfaces:

1. Serial COM1: RS-232, DB-9.
2. Serial COM2: RS-232, RS-485, DB-9.
3. Ethernet: 10/100 BaseT, RJ45.
4. Antenna: TNC Female.

E. The radio shall be enclosed in a rugged die-cast aluminum panel.

F. Manufacturer: GE Digital Energy:

G. Model: SD9.

2.07 NETWORK CABLES

A. Fiber Optic Cable:

1. Physical Characteristics (Overall):
    a. Fiber Type: Single Mode/125/900 Micron.
    b. Number of Fibers: 24.
    c. Buffer Tube Material: Thermoplastic.
    d. Outer Jacket Material: PVC - Polyvinyl Chloride.
    e. Strength Member Material: Aramid Yarn.
    f. Overall Nominal Diameter: 0.260 inches.
2. Mechanical Characteristics (Overall):
    a. Storage Temperature Range: -40°C To 75°C.
    b. Installation Temperature Range: 0°C To +75°C.
    c. Operating Temperature Range: -20°C To +70°C.
    d. Bulk Cable Weight: 34 lbs/1000 Min.
    e. Bend Radius (Install)/Minor Axis: 5.500 inches.
    f. Min. Bend Radius for Long Term Application: 2.800 inches.
    g. Max. Load for Installation: 388 lbs.
    h. Max. Load for Long Term Application: 194 pounds.
3. Applicable Specifications and Agency Compliance Applicable Standards & Environmental Programs:
    a. NEC/(UL) Specification: OFNP.
    b. CEC/C(UL) Specification: OFNP.
    c. EU Directive 2000/53/EC (ELV): Yes.
    d. EU Directive 2002/95/EC (RoHS): Yes.
    e. EU Directive 2002/96/EC (WEEE): Yes.
    f. EU Directive 2003/11/EC (BFR): Yes.
    g. CA Prop 65 (CJ for Wire & Cable): Yes.
    h. MII Order #39 (China RoHS): Yes.
4. Flame Test:
    a. UL Flame Test: UL910 Plenum.
    b. CSA Flame Test: FT.
5. Suitability:
    a. Suitability - Indoor: Yes.
    b. Suitability - Outdoor: Yes.
    c. Suitability - Aerial: No.
    d. Suitability - Burial: Yes.
    e. Sunlight Resistance: Yes.
6. Plenum/Non-Plenum:
    a. Plenum (Y/N): Yes.
7. Optical Characteristics (Overall):
    a. Maximum Attenuation @ 1300nm: .5 dB/km.
    b. Maximum Attenuation @ 1550nm: .5 dB/km.
    c. Maximum Gigabit Ethernet Length @ 1300nm: 5,000.
8. Fibers within the cable shall be color-coded so that each fiber may be individually identified. The color sequence suggested is as follows: blue, orange, green, brown, gray, white, red, black, yellow, purple, rose, and aqua. Dashed versions of the same colors may be used to continue the sequence, depending on the cable structure and fiber count.

9. The outer jackets of the cable shall be continuous, free from holes, splits, blisters or inclusions. The same requirement holds for any inner jackets within a given cable structure as well as for fiber coatings.
10. Materials used for fiber optic cable shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards or applicable federal or state laws or regulations.
11. The outer jacket material shall be high density polyethylene. The color of the polyethylene jacket material shall be black.
12. The cable jacket shrinkage test measures the shrinkage or expansion of a cable jacket exposed to temperature aging for a specified period of time. Maximum shrinkage shall be less than 5% for each specimen tested. The test procedure is described in EIA-RS-455, FOTP-86.
13. All fiber optic patch cables shall be single mode with stick and click (SC) connectors on each end.
14. The fiber optic cable furnished under this Contract shall be General Cable – AP0241ANU or approved equal.

B. RJ-45 Network Cable and Connectors: The RJ-45 cables shall be plenum rated, Teflon coated, Category 6 (ANSI/TIA-568-B.2-1) cables. Standard RJ-45 quick connectors shall be provided to connect 10/100-BaseT network to LAN resident devices. The network patch bay will be Category 6 rated (ANSI/TIA-568-B.2-1) with punch down type connections on back side and RJ-45 connectors on the front. All patch connections to the hub shall be made to fit at the proper length (no oversized cables). All patch cables will be Category 6 rated (ANSI/TIA-568-B.2-1) and clearly labeled. The cable is designated Cat 6 Ethernet Wiring on Contract Drawings. The wires shall be Belden 2413, or General Cable GenSPEED 6.

C. Fiber Optic Patch Panels: All fiber optic cable (including spares shall be terminated or spliced in fiber optic patch panels. All patch panels indoors not mounted in an instrument panel shall be provided with NEMA 12 enclosures. All panels outdoors shall be located in NEMA 4X 316 Stainless Steel enclosures. Provide patch panels at every structure boundary and in every panel enclosure. Fiber optic patch panel shall be Corning SPH-01P with appropriate CCN connector panels or approval equal.

PART 3 EXECUTION

3.01 TEST REQUIREMENTS

A. Fiber Optic Cable Testing:

1. Prior to final acceptance of the Work, inspection and cable testing may be performed. The Owner's Representative may perform inspections of all equipment and work for general conformance with the requirements of the specification. Testing of the fiber optic cable shall be performed

by the Contractor and may be witnessed by the Owner's Representative. All equipment for cable testing shall be furnished by the Contractor; however, this test equipment will not become the property of the Owner.

2. Prior to the physical placement of the fiber optic cable, each fiber shall be tested, while on the spool, with an Optical Time Domain Reflectometer (OTDR) at wavelength of 1300 nm. The OTDR test shall ensure that the fibers conform to the Manufacturers' attenuation specifications and that no damage occurred to the cable during shipping. Hard copy plots of the tests shall be provided to the Owner prior to approval for the placement to proceed.
3. Final inspection and testing shall be conducted after the Contractor has completed the Work. Specific prerequisites are as follows:
    a. All submittals have been received and successfully reviewed.
    b. The fiber optic cable has been installed and terminated at both ends of each cable.
    c. Agreeable dates for inspection and testing have been established.
4. Equipment used for testing of the fiber optic cable shall be furnished by the Contractor and shall be on site.
5. All test equipment used shall have been calibrated within the preceding 30 days using a stabilized laboratory calibration source. Calibration documentation and/or certificates shall be supplied at the time of testing.
6. The following equipment shall be used for testing of the fiber optic cable:
    a. Laser light source (1300 nm), Fluke OptiFiber, or equal.
    b. Laser light source (1550 nm), Fluke OptiFiber, or equal.
    c. Optical Power Meter (1300 & 1500 nm), Fluke OptiFiber, or equal.
    d. Optical Time Domain Reflectometer, Fluke OptiFiber, or equal.
7. Jumpers, connectors, adapters and other miscellaneous items, as required.
8. All testing of the fiber optic cable and inspections shall be scheduled to take place during normal working hours. Any testing witnessed by the Owner's Representative that does not meet with the specified requirements shall be repeated. All tests shall be signed off as successful, by the Contractor and the Owner's Representative. Any test which does not show acceptable results shall be marked as failed by all parties and a complete description of the test, its results and other important factors shall be prepared on-site by the Owner's Representative with a copy presented to the Owner and the Contractor prior to leaving the test site.

B. Pigtail Splice Loss:

1. The splice loss for each pigtail assembly shall have been tested and documented with an OTDR trace during cable termination. The documentation for this testing shall be submitted as a part of the cable testing procedure. Measurements shall be made at 1300 nm.

2. Documentation shall include the following information for each splice made:
    a. Test date, Tester, OTDR Mfgr, model and serial number.
    b. Fiber ID.
    c. Location.
    d. Wavelength.
    e. Splice Loss.
    f. Witness Signature.
3. No splices having a loss greater than -1 dB shall be accepted.

C. Excess Fiber Coefficient: The Contractor shall determine and record the Excess Fiber Coefficient (EFC). This shall be determined on a single fiber, from either end.

1. Record fiber length from cable meter mark (prior to stripping for splices).
2. Record fiber Index of Refraction (IOR) from Mfg. data.
3. Measure fiber length with OTDR set to proper IOR.
4. Calculate EFC: EFC = OTDR length / Sheath Length:
    a. Document EFC with:
        1) Test date, Tester, OTDR Mfgr, model and serial number.
        2) Calculation values.
        3) EFC.
        4) Fiber ID and location.
        5) Witness signature.

D. Fiber Continuity and Length:

1. The continuity and length of each fiber after termination shall be measured with the OTDR. Each fiber shall be measured from either end, an OTDR trace is required for each measurement. Measurements shall be taken at 1300 nm.
2. The documentation for each fiber shall include the following:
    a. Test date, Tester, OTDR Mfgr, model and serial number.
    b. Fiber ID.
    c. Location.
    d. Fiber Length.
    e. Continuous -- yes/no.
    f. Wavelength.
    g. OTDR Trace.
    h. Witness signature.
3. To be accepted, each fiber shall show that it is continuous from one end to the other, with no severe transmission anomalies showing on the OTDR trace, when compared to OTDR traces taken by the Manufacturer, prior to installation.

E. Insertion Loss Attenuation:

1. Insertion loss attenuation shall be measured for each fiber, from either end. The test shall utilize the stabilized laser light sources and optical power meter. Testing shall be made at both 1,300 nm and 1,550 nm.
2. The test shall require the establishment of a reference power receive level measured with a piece of patch cord and connectors of the same types used on the full cable. Care shall be taken to provide an exact match of connectors and mating hardware used in the reference measurement so that the same setup losses are reproduced when measuring the full cable. The laser source shall not be turned off anytime during the testing. The Contractor shall make sure that all connectors have been properly cleaned.
3. The Contractor shall measure and record the reference receives power level at 1,300 nm.
4. The Contractor shall measure the received power level of each fiber and record the results.
5. Test documentation shall include the following:
   a. Test Date, Tester, Manufacturer, models and serial numbers.
   b. Fiber ID.
   c. Location.
   d. Wavelength.
   e. Reference power reading.
   f. Actual power reading.
   g. Insertion Loss.
6. The measured insertion loss shall be no greater than that calculated by the equation below, as adjusted for actual cable length:

$$IL = 2(L_S) + 2(L_C)(L_A) + 1.5 \text{ dB}$$

Where IL = Insertion loss

L_S = Splice loss at pigtail (1 dB max)

L_C = Connector face loss (1 dB max)

L_A = Manufacturer's cable attenuation

7. If the testing reveals that any of the requirements above are not met, the Contractor shall take immediate steps to identify the cause of the condition. If the cause can be identified and corrected, the Contractor shall notify the Owner's Representative in writing of its nature and shall provide a description of his proposed method or procedure to rectify the problem. This notification shall be made within seven working days after the conclusion of the testing. Upon Owner's Representative concurrence, the Contractor shall perform corrections, and shall retest the cable in accordance with this section. If the cause cannot be identified or cannot be corrected, the Contractor shall replace the fiber optic cable.

F. Ethernet Switch and Router Firmware and Software Update: Update all Ethernet switches provided to latest available firmware and software version at the time of installation. Assign I.P. addresses to all Ethernet switches provided according the Owner Information Technology (IT) I.P. addressing standard. Provide Owner computers with the latest manufacture recommended web browser and associated add-on for monitoring and configure the Ethernet switches if needed.

G. Cat.6 Cable Testing:

1. Each cable shall be tested for continuity on all pairs and/or conductors. Twisted-pair voice cables shall be tested for continuity, pair reversals, shorts, and opens using a “green light” type test set. Twisted-pair data cables shall be tested for the all of the above requirements, plus tests that indicate installed cable performance. These data cables shall be tested using a Level III cable scanner.
2. Continuity - Each pair of each installed cable shall be tested using a “green light” test set that shows opens, shorts, polarity and pair-reversals. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test set in accordance with the Manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
3. Length - Each installed cable shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the longest pair length shall be recorded as the length for the cable.
4. Performance Verification - Category 6 data cabling systems shall be performance verified using an automated test set. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:
   a. Pair-to-Pair Near End Crosstalk (NEXT).
   b. Power Sum Near End Crosstalk (PSNEXT).
   c. Insertion Loss.
   d. Return Loss.
   e. Equal Level Far End Crosstalk (ELFEXT)
   f. Power Sum Equal Level Far End Crosstalk (Power Sum ELFEXT).
   g. Attenuation to Crosstalk Ratio (ACR).
5. Category 6 data cable shall be performance verified using an automated test set. Test results shall be automatically evaluated by the equipment,

using the most up-to-date criteria from the ANSI/TIA/EIA-568-B.2.1 Standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment Manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved.

3.02 EQUIPMENT FABRICATION AND ASSEMBLY

A. Cable Terminations: All cable terminations shall be through an industry standard interface which allows proper termination.

B. Cable Runs:

1. All cables in the Control System LAN shall be run inside a metal conduit, and in a manner which protects the cable from damage or electrical noise.
2. Cables shall not be supported by their connections or terminations.
3. Cables shall not run across hinges of doors or panels at 90 degree angles to the hinge or panel.
4. All cables shall be protected from abrasion, multiple flexing at any one spot, and accidental snagging during maintenance.
5. All connectors shall be keyed and allow the connection to fit only one way.

C. Labeling:

1. All cables and connectors shall be labeled. The connector on the cable end and the receptacle into which the cable fits shall be labeled in a way which clearly identifies the proper cable and receptacle connection.
2. The length of each piece of cable shall be recorded on the cable tag and documented in tables or a data base on digital media. The location of each cable splice shall be documented on digital media. This information shall be included in the as-built drawings.

END OF SECTION

SECTION13321
WIRELESS BROADBAND SUBSYSTEM

1 PART 1 GENERAL

1.01 SCOPE

A. This section specifies the requirements for the Wireless Broadband (WB) subsystems, which is being installed to support the site to site transmission of Supervisory Control and Data Acquisition (SCADA) and Facility Electronic Security (FES) System data for the City of Austin, Texas between the following two locations:

1. SCADA Systems at the South Service Center Control Center and the Montopolis Pump Station.
2. SCADA system at the South Austin Regional (SAR) Wastewater Treatment Plant (WWTP) and the Montopolis Pump Station.

B. This Wireless Broadband subsystem shall be routed to maintain a loop configuration as follows:

1. SAR Wastewater Treatment Plant, South Service Center and the Montopolis Pump Station.

C. Diagram showing the relative location of each site and the paths is given in Drawing titled “Communication Systems Architecture”.

D. This Wireless Broadband equipment shall operate in the 5.8 GHz frequency band and provide the capacity of up to 36Mbps of data throughput. Channelized data paths will be created with router/switch network equipment specified in the SS 13315, PLC Network Requirement.

E. Its primary purpose shall be to provide SCADA communications as well as to support remote administration tasks at each of the other locations in the loop.

F. Its secondary purposes shall be:

1. Support of FES System transmissions between the Montopolis Pump Station and the South Service Center Central FES System.
2. Provide data and other inter-facility communications.

G. The channelization of this subsystem shall be designed to support the Water Utility’s SCADA and FES system communications requirements.

1.02 WORK INCLUDED

A. The Work consists of furnishing and installing all labor, services, materials, tools, equipment, software and appurtenances necessary to implement the wireless broadband and

ADSL broadband subsystems as described herein. This will include, but not be limited to, the Work to furnish and install the following major elements:

1. Wireless Broadband Radio Terminals including supporting Ethernet cabling and termination for connection to network routing/switching equipment as specified in SS 13315, PLC Network Requirement.
2. Grid antennas including cabling and connectors and alignment positioner units along with any necessary mounting hardware.
3. Network administration software that processes wireless Broadband subsystem configuration, performance monitoring and diagnostics and performs Quality of Service (QoS) configuration control, display and diagnostics.
4. All other elements that are defined in more detail in later sections of this wireless broadband subsystem specification and in section 13315, PLC Network Requirement.

B. All radio equipment furnished and placed in operation shall be in compliance with FCC rules and regulations.

C. The Work shall also include field end-to-end performance testing and demonstration of each hardware and software element of the subsystem.

D. The Work shall include the operation and maintenance training of SCADA personnel on all aspects of the use of these subsystems.

E. The Network administration software for the radio systems will be accessible from a SCADA network connected PC running the latest version of Microsoft Internet Explorer or functional equivalent World Wide Web browser software or from TELNET client software for Command Line Interface access.

F. All equipment and services provided shall meet the requirements of this section.

1.03 WIRELESS BROADBAND SYSTEM PERFORMANCE REQUIREMENTS

A. General Link Requirements:

1. Each wireless broadband link shall be a 5.8 GHz point-to-point digital communications link between the two sets of locations as defined in bullets 1 and 2 in Paragraph 1.01 B of this specification. In the event that the installation remote wireless broadband radios at the two sets of locations is not complete, The Owner will provide and install a set of test radios and antennas to verify communications link operations.
2. These wireless broadband links shall operate under the constraints of the FCC limitations for the 5.8 GHz ISM frequency band.

B. Link Availability and Reliability: Each wireless broadband link shall operate with a minimum availability of 99.99 percent, including the effects of all sources of outages. The Contractor shall demonstrate the availability of the system to satisfy the requirements of the Owner.

C. The entire wireless broadband subsystem shall be connected to a back-up or UPS power source to the site security panel.

1.04 QUALITY ASSURANCE

A. It is the intent of these Specifications and of the Contract Drawings to establish quality standards of all equipment and materials and to require first class workmanship.

B. All equipment and materials shall be new and of the highest quality.

C. All work shall be accomplished by qualified, experienced personnel working under continuous and competent supervision.

1.05 REFERENCED STANDARDS

A. This section references the latest revisions of the following standards. They are a part of Section 13400 as specified. These shall govern, as applicable, the electrical terminology, the design, the materials, the construction and the testing methods for the equipment specified in this Section. In case of conflict between the requirements of this Section and those of the listed standards, the requirements of this Section shall prevail.

Standard	**Title**
IEEE 802.11a-1999	IEEE Standard for Telecommunications and information exchange between systems using LAN/MAN Wireless LANS.
IEEE 802.3-2005	IEEE Standard for Telecommunications and information exchange between systems using LAN/MAN CSMA/CD Access Method
IEEE 802.16-2004(d)	IEEE Standard for Local and Metropolitan Area Networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems.
IEEE 802.3af-2003	IEEE Standard for Telecommunications and information exchange between systems – Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI)
ANSI/IEEE Std. 100	IEEE Standard, Dictionary of General and Electronic Terms.
EIA/TIA-222-E	Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

Standard	Title
EIA-RS-232-D	Compatible Interface Between Data Terminal Equipment and Communication Equipment Employing Serial Binary Interchange.
EIA/TIA 568	Performance Standards for Data Communication Wiring Systems.
EIA-RS-210-C	Racks, Panels and Associated Equipment.
ISO 2110	Data Communication 25-pin DTE/DCE Interface Connector and Pin Assignments.
ISO 2593	Interface Standard for High Speed Data Transmission Equipment.
FCC Rules	Part 2
	Part 15 Specifically Subpart J, Class B Radiation Limits
	Part 17 Construction, Marking, and Lighting of Antenna Structures
	Part 21 All applicable sections
	Part 94 All applicable sections.
Bellcore GR-499-CORE	Transport System Generic Requirements: Common Requirements.
Bellcore TR-332	Reliability Prediction Procedure for Electronic Equipment.
Bellcore GR-1089-CORE	Electromagnetic Compatibility and Safety.
ANSI T1.102	North American Digital Hierarchy – Electrical Interfaces.
ANSI C63.4-1992	Methods of Measurement of Radio Noise Emission.
ANSI C63.12-1987	Recommended Practice for Electromagnetic Compatibility Limits.
CCITT Specifications	Committee Consultant International Telegraph and Telephone - All applicable sections.

B. Codes and Regulations: This section references the following codes. They are a part of Section 13400 as specified. Apparent conflicts between the contract documents and the listed codes shall be submitted to the Engineer for resolution, prior to ordering materials or performing affected work.

CODE	**Title**
NEC	NATIONAL ELECTRIC CODE (NFPA 70)
NESC	NATIONAL ELECTRICAL SAFETY CODE
UBC	UNIFORM BUILDING CODE

C. Measuring Equipment and Tools: Validity of measurements and tests shall be insured through the use of suitable inspection, measuring and test equipment of the range and type necessary to determine conformance of items with the Contract requirements. Measuring devices shall be verified or calibrated against certified standards that have a known traceable relationship to the National Bureau of Standards. Every device so verified or calibrated shall bear an indication attesting to the current status and showing the date on which inspection or re-calibration is next required. Any tests run with instruments not in compliance with the requirements if this paragraph shall be considered invalid.

1.06 SUBMITTALS

A. The Contractor shall provide submittals in accordance with this Section as well as in accordance with Section 01300 and their component and referenced subsections.

B. Each submittal shall be complete, with all required information provided together at one time, and submitted in a sequence that allows the Owner to have all of the information necessary for checking and approving a particular document at the time of the submittal.

C. The Contractor shall be responsible for planning and making all submittals as necessary to avoid delays or conflicts in the work.

1.07 SITE LOCATIONS

A. Reference contract drawing titled “Network Architecture”.

1.08 ENVIRONMENTAL SPECIFICATIONS

A. All equipment shall function properly and meet all specifications under the following environmental conditions specified in section 13400 as well as additional items noted here:

B. Equipment Location: Equipment (antennas and associated connecting feed lines and support hardware excluded) will be installed in enclosed structures under the elevated water tower.

C. Thermal Shock: Equipment shall comply with the thermal shock test requirements established in Bellcore Technical Advisory TR-TSY-000752, Section 17.

D. Electromagnetic Interference and Susceptibility: Shielding and filtering shall be provided to prevent Radio Frequency Interference (RFI) from, or to, other radio frequency equipment installed near, or in the vicinity of the proposed equipment.

E. Interference to Other Equipment: Equipment supplied by the Contractor shall not interfere with the following types of equipment (operating within specifications) located in the same facility:

1. Analog and Digital Microwave Equipment.
2. Low Power FM & TV Transmitters.
3. VHF/UHF Mobile Base Stations.
4. VHF/UHF Hand Held/Cellular Radios (limited to 5-watts at antenna port).
5. Remote Alarm Units (RAU).
6. Remote Terminal Units (SCADA).
7. Remote Terminal Units (Security).
8. Security Cameras and Motion Detection Units.
9. MAS Radio Subsystem.

F. Such interference shall cause a maximum of 1.0 dB degradation to any of the above equipment co-located at the same communication site. Interference shall be evaluated and considered on a case-by-case basis with the Owner or the Owner's Representative.

G. The Contractor shall be responsible for the total cost of mitigation of interference caused by equipment supplied under this Contract.

H. Interference Susceptibility: Equipment supplied by the Contractor shall be operationally compatible with the following types of equipment (operating within specifications) located in the general vicinity of:

1. VHF/UHF Vehicular Mobile Radios (40 Watt output EIRP, operating at a distance of 3 meters or greater)
2. VHF/UHF Cellular Hand Held Radios (5 Watt output EIRP, operating at a distance of 1 meter or greater)

I. The Contractor supplied communications equipment shall be capable of operating without degradation to the normal operation of the equipment when exposed to RFI/EMI fields of 15 v/m (Reference ANSI/IEEE C37.90.2, Section 3).

J. RFI/EMI Susceptibility Mitigation:

1. The Contractor-supplied radio equipment that are part of this wireless broadband subsystem, located as specified, shall not cause measurable performance degradation, bit-errors, loss-of-lock or spurious alarms to the radio equipment, Ethernet switches, network routers, and all other Contractor-supplied equipment.

2. Corrective measures to eliminate interference from external equipment shall be made at Contractor's expense. The RFI/EMI susceptibility of Contractor-supplied equipment co-located with the equipment above shall be mitigated to less than 1.0 dB degradation of the BER threshold. Contractor will be given a list of all equipment that is now in place at each of the equipment rooms.

K. Use of Shielded and Grounded Cables: Shielded and grounded coaxial and twisted pair cable for inter-shelf wiring of equipment shall be used, unless otherwise noted.

L. Power Over Ethernet: The wireless broadband radio units shall be equipped with an Active Ethernet module to support Power-over-Ethernet (PoE), to the radio.

1. The Active Ethernet integrated module provides –48 VDC over a standard Cat5 Ethernet cable.
2. Maximum power supplied to each radio will not exceed 11 Watts.
3. An Active Ethernet switch (also known as a power injector) shall be connected to the network to use Active Ethernet capability of the radio.
4. When connected to both the Active Ethernet switch, and an AC power supply simultaneously, the radio shall draw primary power from Active Ethernet.
5. The cable length between the Active Ethernet switch and the radio shall not exceed 100 meters.
6. Low loss cables of the required length to extend to the radios shall have no more than 4.5 dB loss.

2 PART 2 PRODUCTS

2.01 WIRELESS BROADBAND RADIOS

A. The wireless broadband radio pair installed on site shall consist of one Base Station Unit (BSU) and one Subscriber Unit (SU). The BSU shall serve as the base station radio for the SU at SAR WWTP. The SU shall connect to the BSU at the Montopolis Pump Station. Coordinate with Owner prior to installation to determine which remote site is equipped with a BSU or SU unit.

B. Each wireless broadband radio shall have the ability to send Simple Network Management Protocol (SNMP) alarm and diagnostic messages for module-level trouble-shooting to a remote SNMP host located at Waller Creek Center.

C. Each radio shall also measure and record each link’s error rate performance and the number of error transmissions that may result from major link dropouts and/or outages resulting from uncontrollable causes such as extraordinarily heavy rainfall or ice formation on antennas. This data shall be accessible using a Web Browser, or a Telnet session.

D. The wireless broadband radio equipment shall be configured for a single selectable frequency, full duplex operation, with a minimum channel capacity of at least 18Mbps using Dynamic Data Rate Selection (DDRS). Broadband radios shall be configured as loop

repeaters with dropping capability at the site using Quality of Service (QoS) classes configured to support the data transmissions required.

E. Wireless Broadband radios shall be Proxim Model 820-SUA-100 and Model 820-BSU-100, or approved equal.

F. Data Transmission Rate and Interfaces:

1. RF Modulation: The radio equipment shall employ Orthogonal Frequency Division Multiplexing (OFDM) RF Modulation that support data transmission rates as shown in the table below:

OFDM Modulation Data Rates	
Modulation Scheme	Data Rates
Binary Phase Shift Keying (BFSK)	6 and 9 Mbps
Quadrature Phase Shift Keying (QPSK)	12 and 18 Mbps
Quadrature Amplitude Modulation 4 (16-QAM)	24 and 36 Mbps
Quadrature Amplitude Modulation 8 (64-QAM)	48 and 54 Mbps

2. Radio Interfaces
   1) The radio equipment shall include one Autosensing 10/100 Base-TX Ethernet interface port, usable for radio configuration or data transmission.
   2) The radio equipment shall include one Serial RS232 DB-9 interface port configurable to data rates from 2,400 bps to 57,600 bps using either XON/XOFF flow control or no flow control, usable for radio configuration only.
   3) The radio equipment shall include a wireless interface port for antenna connection utilizing a standard N-type male connector.

G. Base Station Unit (BSU) Radio: The Base Station Radio Unit shall support one or more connections from an SU radio. It shall be configurable to operate in either BSU mode or SU mode. The BSU, in BSU mode, shall have the ability to enable or disable Dynamic Data Rate Selection (DDRS) mode in a link between a BSU and an SU. The BSU shall provide for Quality of Service (QoS) provisioning.

H. Subscriber Unit (SU) Radio: The Subscriber or Satellite Unit (SU) shall support Network Address Translation (NAT RFC 3022) and Dynamic Host Configuration Protocol Relay (DHCP Relay RFC 2131).

I. Frequency Range and Channels: To select the unlicensed frequency at which the BSU and SU communication with the other, the BSU and SU shall provide for user configurable selection of the operating frequency based on the table below:

Frequency ID	**Center Frequency**	**Frequency Band**
56	5.280 GHz	5.25 – 5.35 GHz
60	5.300 GHz	5.25 – 5.35 GHz
64	5.320 GHz	5.25 – 5.35 GHz
149	5.745 GHz	5.725 – 5.85 GHz
153	5.765 GHz	5.725 – 5.85 GHz

Frequency ID	Center Frequency	Frequency Band
157	5.785 GHz	5.725 – 5.85 GHz
161	5.805 GHz	5.725 – 5.85 GHz
165	5.825 GHz	5.725 – 5.85 GHz

J. Wireless Broadband Subsystem Administration: The wireless broadband radios shall provide for its configuration and management using three management interfaces. These interfaces shall provide for the viewing and changing of the BSU and SU setting.

1. Web Browser Interface: The Web interface (HTTP) shall provide for access to configuration settings and network statistics from any computer on the SCADA network or with a crossover Ethernet cable connected directly to your computer's Ethernet port. The installation contractor shall provide O&Ms that give detailed information regarding use of the Web interface.
2. Command Line Interface: The BSU and SU shall support the use of a Command Line Interface (CLI,) a text-based configuration utility that supports a set of keyboard commands and parameters to configure and manage the wireless broadband units. The CLI shall all a user to enter command statements, composed of CLI commands and their associated parameters. The user will use CLI to issue commands from the keyboard for real-time control or from scripts that will allow for automated configuration. The installation contractor shall provide O&Ms that give detailed information regarding use of the CLI interface. An Ethernet or serial cable connected directly to your computer's Ethernet or serial port shall be used to gain access to the CLI interface.
3. Simple Network Management Protocol (SNMP): In addition to the Web interface and the CLI, the wireless broadband subsystem shall be managed and configurable using the Simple Network Management Protocol (SNMP), which requires an Ethernet connection of the BSU and SU to the SCADA Network. SNMP requires an SNMP manager program, which will be provided by the Owner. The wireless broadband subsystem shall support the following Management Information Base (MIB) files that describe the parameters that can be viewed and configured using SNMP:
   a. mib802.mib.
   b. orinoco.mib.
   c. rfc1213.mib.
   d. rfc1493.mib.
   e. rfc1643.mib.
4. The Contractor shall provide these Proxim MIB files on a CD. The Owner shall compile these MIB files for configuration and management of the wireless broadband subsystem using SNMP. The installation contractor shall provide O&Ms that give detailed information regarding use of SNMP and about how to compile MIBs.

K. Bridging and Routing Modes: The BSU and SU shall support Bridging and Routing network operating modes. These modes of operation shall be user configurable from all three of the management interfaces: Web, CLI, and SNMP.

1. Bridge Mode: In bridge mode, the BSU and SU shall work at the data-link (physical) layer of a network, copying a data packet from one network to the next network along the communications path. In bridge mode the BSU and SU shall support three modes of operation listed below:
a. Transparent Bridging Mode.
b. Multi-Ring SRTB Bridging Mode.
c. Single-Ring SRTB Bridging Mode.
2. Routing Mode:
a. In Routing mode, the BSU and SU shall provide the ability to segment outdoor wireless network using routers. The BSU and SU shall be configured to operate in router mode, which will segment the network by a layer 3 (IP) device (BSU and SU).
b. The Owner will provide network topology configuration information to allow for proper configuration and integration of the wireless broadband subsystem into the existing SCADA network.

L. Wireless Broadband Subsystem Security: The wireless broadband subsystem shall support security features that protect the wireless network against access by unauthorized personnel attempting to use non-SCADA network wireless devices to eavesdrop and/or gain access to the Owner's wireless network for any known or unknown unauthorized purpose.

1. Wireless Data Encryption: The wireless broadband subsystem shall have the ability to protect the Owner's wireless network with the use of the encryption. Encryption settings shall be user-configurable using the Web, CLI, or SNMP interfaces.
a. Wi-Fi Protected Access (WPA): Encryption Keys shall be up to 5 characters or 64-bit in length.
b. Wired Equivalent Privacy (WEP): Encryption Keys shall be up to 13 characters or 128-bit in length.
c. Advanced Encryption Standard (AES): Encryption Keys shall be up to 16 characters or 128- bit in length.
2. Media Access Control (MAC) Address Authentication: The wireless broadband subsystem shall have the ability to protect the Owner's wireless network from unauthorized connection by an unknown wireless device using MAC Authentication. The BSU shall provide a method for storing user-entered wireless MAC addresses into a list of authorized addresses, disallowing any addresses not in the list to make a connection to it.
3. RADIUS Authentication: The wireless broadband subsystem shall have the ability to protect the Owner's wireless network from unauthorized access to the BSU or SU Web or CLI interfaces for system configuration by using RADIUS Authentication. The BSU or SU shall allow the creation of RADIUS profiles on an Owner-provided RADUIS Server.

M. Transmitter:

1. Transmit Power Control (TPC):
a. With TPC, you shall have the ability to adjust the output power of the unit to a lower level in order to reduce interference to neighboring devices or to use a higher gain antenna without generating excess interference.

b. By default, the unit shall transmit at the maximum output power that the radio can sustain for the data rate and frequency selected. The maximum output power level for the operating frequency shall be determined automatically by the embedded software and shall be found in the event log of the unit's status database. The event log shall be accessible via a web browser session connected to the system network.
c. TPC shall be user configurable to reduce the transmitter's output power as indicated in the following table:

TPC Selection dB	Maximum TX Power dBm
0	16
-3	13
-6	10
-9	7
-12	4
-15	1
-18 (minimum TPC level)	0

d. The event log shall exhibit the selected power for all data rates as well at the transmitter's current output power for the selected frequency.
e. The maximum output power for any frequency shall be +16 dBm.
1) Spectrum Efficiency: The modulation used by the radio shall meet the spectral efficiency requirements of the relevant FCC specifications identified in this Section.
2) Frequency Stability: Frequency stability shall be at least ± 0.001 %, over the temperature range of 0° to +40° C.

N. Receiver:

1. Receiver Sensitivity Threshold: The receiver threshold shall be referenced to a non-protected assembly at the receiver input port. The guaranteed threshold at 10 6 BER shall be as follows using a channel bandwidth of 20 MHz.

Receive Sensitivity	Modulation	20 MHz Channels Standard Mode
	64 QAM 3/4	-69 dBm @ 54 Mbps
	64 QAM 1/2	-72 dBm @ 48 Mbps
	16 QAM 3/4	-77 dBm @ 36 Mbps
	16 QAM 1/2	-80 dBm @ 24 Mbps
	QPSK 3/4	-83 dBm @ 18 Mbps
	QPSK ½	-86 dBm @ 12 Mbps
	BPSK 3/4	-87 dBm @ 9 Mbps
	BPSK ½	-88 dBm @ 6 Mbps

2. Adjustable Receiver Sensitivity: The BSU and SU shall provide a user-configurable adjustment of the receiver sensitivity to achieve maximum bandwidth for the wireless broadband network. The adjustment shall be used to improve operations in environments with high noise levels. Termed Satellite Density, this adjustment shall modify sensitivity levels using the five setting as shown the following table:

Satellite Density	Large	Medium	Small	Mini	Micro

Receive Sensitivity Threshold	-95 dBm	-86 dBm	-78 dBm	-70 dBm	-62 dBm
Defer Threshold	-62 dBm	-62 dBm -	52 dBm	-42 dBm	-36 dBm

3. Frequency Stability: Frequency stability shall be at least plus or minus 0.001 percent, over the temperature range of 0 degrees to plus 40 degrees C.

O. Antenna Interface Unit:

1. Antenna Port: Standard N-type male.
2. RF Impedance: 50 ohms.

P. RF Frequencies: The operational frequencies are provided in the previous section.

Q. Jitter Requirements: Radio terminals and multiplex shall meet the requirements outlined in Bellcore Technical Reference TR TSY 000752, Issue 1, October 1989, for the following:

1. Jitter Accommodation.
2. Jitter Generation.
3. Jitter Transfer Functions.
4. Jitter Enhancement.

R. Equipment Reliability:

1. The mean time between failure (MTBF) of the BSU and SU transceivers shall meet or exceed 150,000 hours. The data and methods used to determine the values shall be supplied.
2. In lieu of adequate field data for equipment recently placed into service, the MTBF may be calculated from Bellcore Technical Reference TR-NWT-000332, “Reliability Prediction Procedure for Electronic Equipment”. The supplier of the wireless broadband radios shall show the calculation and assumptions used to derive the MTBF.

S. Power Supply Units:

1. Each transceiver shall have redundant power supply units. Power supply failure shall not cause the alarm and control circuits to fail. Provisions for operation with either one or two DC power supplies shall be provided. Each power supply unit shall have its own on/off switch.
2. A circuit shall monitor all outputs for an over-voltage or under-voltage condition and shall generate an alarm signal if an abnormal voltage level should occur. A visual indicator shall be included to indicate proper operation of each power supply unit.

2.02 QUALITY OF SERVICE PROVISIONING

A. Only the BSU radio shall provide the ability to provision Quality of Service (QoS) bandwidth allocations based on the IEEE 802.16 standard. The QoS defines classes, service flows, and packet identification rules for specific types of traffic used in this installation. QoS shall be used to guarantee a reliable and adequate transmission quality for the required types

of network traffic under conditions of high congestion and bandwidth reduction. The QoS protocol shall combine the required types of network traffic and the necessary miscellaneous other support protocols into a single serial bit stream at the rate of at least 24 Mbps which is passed to the broadband radio transmitter's output.

B. The QoS protocol software in the BSU shall provide the ability to create, edit, and delete classes of service that are specified by the following hierarchy of parameters:

1. Packet Identification Rule (PIR) – up to 64 rules, including 17 predefined rules.
2. Service Flow class (SFC) – up to 32 SFs, including 7 predefined SFCs; up to 8 PIRs may be associated per SFC.
3. Priority for each rule within each SF class – 0 to 255, with 0 being lowest priority.
4. QoS class – up to 8 QoS classes, including 4 predefined classes; up to 4 SFCs may be associated per QoS class.

C. Packet Identification Rule (PIR): A Packet Identification Rule is a combination of parameters that specifies what type of traffic is allowed or disallowed. The QoS protocol software shall allow the creation of up to 64 different PIRs, including 17 predefined PIRs. It shall provide the ability to create, edit, and delete PIRs that contain none, one, or more of the following classification fields:

1. Rule Name.
2. IP ToS (Layer 3 QoS identification).
3. IP Protocol List containing up to 4 IP protocols.
4. 802.1p tag (layer 2 QoS identification).
5. Up to 4 pairs of Source IP address + Mask.
6. Up to 4 pairs of Destination IP address + Mask.
7. Up to 4 source TCP/UDP port ranges.
8. Up to 4 destination TCP/UDP port ranges.
9. Up to 4 source MAC addresses.
10. Up to 4 destination MAC addresses.
11. VLAN ID.
12. Ether type (Ethernet protocol identification).

D. The QoS protocol in the BSU shall provide the following 17 predefined PIRs. These rules are provided to assist in identifying specific traffic types:

1. All – No classification fields, all traffic matches.
2. Cisco VoIP UL:
a. Protocol Source Port Range (16,000-32,000).
b. IP Protocol List (17 = UDP).
3. Vonage VoIP UL:
a. Protocol Source Port Range (8000-8001, 10000-20000).
b. IP Protocol List (17 = UDP).
4. Cisco VoIP DL:
a. Protocol Destination Port Range (16,000-32,000).

b. IP Protocol List (17 = UDP).
5. Vonage VoIP DL:
a. Protocol Destination Port Range (8000-8001, 10000-20000).
b. IP Protocol List (17 = UDP).
6. TCP: IP Protocol List (6).
7. UDP: IP Protocol List (17).
8. PPPoE Control: Ethertype (type 1, 0x8863).
9. PPPoE Data: Ethertype (type 1, 0x8864).
10. IP: Ethertype (type 1, 0x800).
11. ARP: Ethertype (type 1, 0x806).
12. Expedited Forwarding: IP TOS/DSCP (low=0x2D, high=0x2D, mask = 0x3F).
13. Streaming Video (IP/TV): IP TOS/DSCP (low=0x0D, high=0x0D, mask = 0x3F).
14. 802.1p BE: Ethernet Priority (low=0, high=0) (this is the equivalent of the User Priority value in the TCI (Tag Control Information) field of a VLAN tag).
15. 802.1p Voice: Ethernet Priority (low=6, high=6) (this is the equivalent of the User Priority value in the TCI (Tag Control Information) field of a VLAN tag).
16. 802.1p Video: Ethernet Priority (low=5, high=5) (this is the equivalent of the User Priority value in the TCI (Tag Control Information) field of a VLAN tag).
17. L2 Broadcast/Multicast: Ethernet Destination (dest = 0x80000000, mask = 0x80000000).

E. Two different VoIP rule names have been defined for each direction of traffic, Uplink (UL) and Downlink (DL), (index numbers 2 to 5). This has been done to distinguish the proprietary nature of the Cisco VoIP implementation as opposed to the more standard Session Initiation Protocol (SIP) signaling found, for example, in the Vonage type VoIP service.

F. Service Flow Class (SFC): The BSU QoS software shall support a Service Flow class that defines a set of parameters that determines how a stream of application data that matches a certain classification profile will be handled. The software shall provide for the creation of up to 32 different SFs, including seven predefined SFs. The software shall provide for the ability to create, edit, and delete SFs that contain the following parameters and values:

1. Service flow name.
2. Scheduling type – Best Effort (BE); Real-Time Polling Service (RtPS).
3. Service Flow Direction – Downlink (DL: traffic from BSU to SU); Uplink (UL: traffic from SU to BSU).
4. Maximum sustained data rate (or Maximum Information Rate, MIR) – specified in units of 1 Kbps from 8Kbps up to the maximum rate of 108000 Kbps per SU.
5. Minimum reserved traffic rate (or Committed Information Rate, CIR) – specified in units of 1 Kbps from 0 Kbps up to the maximum rate of 10000 Kbps per SU.
6. Maximum Latency – specified in increments of 5 ms steps from a minimum of 5 ms up to a maximum of 100 ms.
7. Tolerable Jitter – specified in increments of 5 ms steps from a minimum of 0 ms up to the Maximum Latency (in ms).
8. Traffic priority – zero (0) to seven (7), 0 being the lowest, 7 being the highest.

9. Maximum number of data messages in a burst – one (1) to four (4), which affects the percentage of the maximum throughput of the system.
10. Activation state – Active; Inactive.
11. Note that traffic priority refers to the prioritization of this specific Service Flow.

G. The QoS software shall attempt to deliver the packets within the specified latency and jitter requirements, relative to the moment of receiving the packets in the unit. For delay-sensitive traffic the jitter must be equal to or less than the latency. A packet shall be buffered until an interval of time equal to the difference between Latency and Jitter (Latency – Jitter) has elapsed. The software shall attempt to deliver the packet within a time window starting at (Latency – Jitter) until the maximum Latency time is reached. If the SFC's scheduling type is real-time polling (rtPS), and the packet is not delivered by that time, it shall be discarded. This can lead to loss of packets without reaching the maximum throughput of the wireless link. For example, when the packets arrive in bursts on the Ethernet interface and the wireless interface is momentarily maxed out, then the packets at the "end" of the burst may be timed out before they can be sent.

H. Users are able to set up their own traffic characteristics (MIR, CIR, latency, jitter, etc.) per service flow class to meet their unique requirements. A good example is provided by the seven predefined SFCs:

1. UL-Unlimited BE:
a. Scheduling Type = Best Effort.
b. Service Flow Direction = Uplink.
c. Initialization State = Active.
d. Maximum Sustained Data Rate = 20 Mbps.
e. Traffic Priority = 0.
2. DL-Unlimited BE (same as UL-Unlimited BE, except Service Flow Direction =Downlink).
3. UL-G711 20 ms VoIP rtPS:
a. Schedule type = Real time Polling.
b. Service Flow Direction = Uplink.
c. Initialization State = Active.
d. Maximum Sustained Data Rate = 88 Kbps.
e. Minimum Reserved Traffic Rate = 88 Kbps.
f. Maximum Latency = 20 milliseconds.
g. Traffic Priority = 1.
4. DL-G711 20 ms VoIP rtPS (same as UL-G711 20ms VoIP rtPS, except Service Flow Direction = Downlink).
5. UL-G729 20 ms VoIP rtPS (same as UL-G711 20ms VoIP rtPS, except Maximum Sustained Data Rate and Maximum Reserved Traffic Rate = 64 Kbps).
6. DL-G729 20 ms VoIP rtPS (same as UL-G729 20ms VoIP rtPS, except Service Flow Direction = Downlink).
7. DL-2Mbps Video:
a. Schedule type = Real time Polling.
b. Service Flow Direction = Downlink.

c. Initialization State = Active.
d. Maximum Sustained Data Rate = 2 Mbps.
e. Minimum Reserved Traffic Rate = 2 Mbps.
f. Maximum Latency = 20 milliseconds.
g. Traffic Priority = 1.
I. Two different VoIP Service Flow classes for each direction of traffic shall be defined (index numbers 3 to 6) which follow the ITU-T standard nomenclatures: G.711 refers to a type of audio companding and encoding that produces a 64 Kbps bitstream, suitable for all types of audio signals. G.729 is appropriate for voice and VoIP applications, but cannot transport music or fax tones reliably. This type of companding and encoding produces a bit-stream between 6.4 and 11.8 Kbps (typically 8 Kbps) according to the quality of voice transport that is desired.

J. QoS Class: A QoS class shall be defined by a set of parameters that includes the PIRs and SFCs that were previously configured. The software shall provide for the creation of up to eight different QoS classes, including four predefined QoS classes. Up to four SF classes shall be associated to each QoS class, and up to eight PIRs shall be associated to each SF class. For example, a QoS class called “G711 VoIP” may include the following SFCs: “UL-G711 20 ms VoIP rtPS” and “DLG711 20 ms VoIP rtPS”. In turn, the SFC named “UL-G711 20 ms VoIP rtPS” may include the following rules:

1. “Cisco VoIP UL” and “Vonage VoIP UL”.

K. The software shall provide for the ability to create, edit, and delete QoS classes that contain the following parameters:

1. QoS class name.
2. Service Flow (SF) class name list per QoS class (up to four SF classes can be associated to each QoS class).
3. Packet Identification Rule (PIR) list per SF class (up to eight PIRs can be associated to each SF class).
4. Priority per rule which defines the order of execution of PIRs during packet identification process. The PIR priority is a number in the range 0-63, with priority 63 being executed first, and priority 0 being executed last. The PIR priority is defined within a QoS class, and can be different for the same PIR in some other QoS class. If all PIRs within one QoS class have the same priority, the order of execution of PIR rules will be defined by the order of definition of SFCs, and by the order of definition of PIRs in each SFC, within that QoS class.

L. The four predefined QoS Classes shall be characterized as in the following hierarchy:

1. Unlimited Best Effort:
a. SF Class:
1) UL-Unlimited BE.
2) PIR: All; PIR Priority: 0.
b. SF Class:
1) DL-Unlimited BE.

2) PIR: All; PIR Priority: 0.
2. G711 VoIP:
a. SF Class:
1) UL-G711 20 ms VoIP rtPS.
2) PIR: Vonage VoIP UL; PIR Priority: 1.
3) PIR: Cisco VoIP UL; PIR Priority: 1.
b. SF Class:
1) DL-G711 20 ms VoIP rtPS.
2) PIR: Vonage VoIP DL; PIR Priority: 1.
3) PIR: Cisco VoIP DL; PIR Priority: 1.
3. G729 VoIP:
a. SF Class:
1) UL-G729 20 ms VoIP rtPS.
2) PIR: Vonage VoIP UL; PIR Priority: 1.
3) PIR: Cisco VoIP UL; PIR Priority: 1.
b. SF Class:
1) DL-G729 20 ms VoIP rtPS
2) PIR: Vonage VoIP DL; PIR Priority: 1
3) PIR: Cisco VoIP DL; PIR Priority: 1
4. 2Mbps Video:
a. SF Class:
1) DL-2Mbps Video.
2) PIR: Streaming Video (IP/TV); PIR Priority: 1.

2.03 WIRELESS BROADBAND ANTENNAS

A. High Performance 60cm x 40cm Parabolic Grid Antennas: High performance 60cm x 40cm parabolic grid antennas shall meet the following requirements:

1. Frequency Range: 5.725 –5.850 GHz.
2. Polarization: Vertical or horizontal feed.
3. Mid-band Gain: 27 dBi.
4. Horizontal Half-Power Beam width: 6 degrees.
5. Vertical Half-Power Beam width: 9 degrees.
6. Front to Back Ratio: 25 dB.
7. Maximum VSWR: < 1.5:1.
8. Radio Connector: N-type female.
9. Impedance: 50 Ohm.

B. Antennas shall be HyperLink Technologies Model HG5827G, or approved equal.

2.04 MOTOR OPERATED ANTENNA MOUNTS

A. The motor operated antenna mounts shall be a DMS international Products model SG2100, or approved equal.

2.05 MOTOR MOUNT POSITIONER

A. The motor mount positioner shall be a DMS international Products V Box 7 Positioner or approved equal.

2.06 LIGHTNING SUPPRESSORS

A. Polyphaser Model LSXL, or approved equal- shall be furnished for all coaxial cable terminating at all antennas except RTU panel mounted antennas. Suppressors shall be bulkhead or surface mounted as required at each site with Type N female connectors.

2.07 CABLES AND CONNECTORS

A. The cable shall be a coaxial cable manufactured for use in the 5.8 GHz frequency range. The cable shall be Times Microwave Type LMR-600-DB, or approved equal. Contractor shall supply and field install the Andrew cable connectors or approved equivalents and all necessary hardware and grounding kits. All cables, connectors, and in-line devices shall be installed according to the manufacturer's instructions and best practices.

2.08 PANEL ASSEMBLIES SHALL BE PER SECTION 13400

A. Component Arrangement: The Contractor shall generally follow the arrangements of components shown on the Contract Drawings; however, adjustments shall be made as necessary to allow each component to be mounted as recommended by the manufacturer, to facilitate easy installation, removal and in place maintenance of each component, and to allow normal operation of the component by operating and maintenance personnel. Component arrangements shall allow space for routing of wiring and cabling without kinking or bending around sharp edges and for free flow of air around and through equipment which requires ventilation for cooling.

2.09 COMMUNICATION CABLE

A. Ethernet Data Cables: The Ethernet data cable used to interconnect Ethernet devices shall be Category 6 unshielded twisted-pair (UTP) cable. Impedance shall be 100 ohms. Conductors shall be 24 AWG solid and the PVC jacket shall be rated for NEC CL2. Each connector shall be secured to the cable with a field installed molded hood. Reference specification section 13315 – PLC Network Requirements for cable requirement.

3 PART 3 EXECUTION

3.01 GENERAL

A. All Work shall be performed in accordance with the provisions of Division 13.

3.02 PRODUCT HANDLING

A. Preparation For Delivery:

1. Packaging: All final assemblies shall be wrapped in protective material so as to provide adequate protection during shipment.
2. Marking: All equipment shall be appropriately marked regarding function, handling and storage.

B. Shipping:

1. All equipment shall be shipped in a manner to assure timely delivery and protection of materials. Any equipment damaged during shipping or delivery shall be rejected and repaired or replaced by the Contractor, at the Owner's discretion, at no cost to the Utility.
2. No materials, goods or equipment shall be received or stored at the work site nor installed or incorporated into the work without a successfully reviewed shop drawing submittal.
C. Delivery: Upon delivery to the site, the equipment in this section shall be carefully unloaded and properly stored until installation. The equipment shall be handled and stored in strict accordance to the manufacturer's recommendations.

3.03 INSTALLATION

A. Installer Qualifications: The Contractor shall exclusively use wireless broadband equipment installers who meet the following requirements:

1. At least one (1) lead technician with a General Class FCC commercial license.
2. Installers must possess a NARTE or equivalent certification.

B. Communications Equipment Panels:

1. Enclosed panels shall be installed at Montopolis Pump Station as shown on the Contract Drawings.
2. Enclosed panels shall be anchored to the floor in a rigid and safe support to meet the bracing requirements for Seismic Zone for the City of Austin, Texas. At a minimum, four 3/8 x 4 inch bolts shall anchor each panel to the floor. Panels shall be anchored to the wall as required to prevent overturning.
3. The Contractor shall ship panels in a completely fabricated and assembled form to the Owner, except for the allowances specified herein. The Contractor may ship electronic equipment separately. However, field assembly shall be limited to simple mounting of equipment in the rack(s) and enclosed panel(s) via attachment of 12-24 bolts and the termination of cables. The Contractor shall not tap and/or drill holes in the rack(s) within the Owner's facility. Power tools shall be used in the communications area solely for the purpose of anchoring the rack(s) and enclosed panel(s).
4. The Contractor shall bond the new enclosed panels to the building grounds as shown on the Contract Drawings. All grounding surfaces shall be thoroughly cleaned before connecting grounding conductors.

C. Wireless Broadband Antenna Mounting, Installation and Alignment

1. Prior to the start of work at the wireless broadband radio site the Contractor shall verify the line of sight along the proposed paths. The Contractor is responsible for determining the precise antenna mounting locations to avoid any obstructions and interference.
2. Contractor shall provide and install two 6'-6" (78") long 3" RGS conduit antenna mast with lighting rod and clamp-on weather-head mounted to the handrail at the top of the water tank per contract drawing. Contractor is to verify that the proposed antenna mast locations and dish antenna orientation and line of sight will not be interfered by the tank's rainproof access door or any other tank structure. In the event there is a potential obstruction with the proposed location, Contractor is to propose an alternate location and/or mounting method to the proposed antenna mast to ensure adequate clearance. Any changes to the proposed location of the antenna mast must be reviewed and approved by Owner prior to performing the work.
3. Antenna mounts shall be attached to motor operated mounts mounted to the antenna RGS conduit support structure. The twist and sway requirements of the antenna with respect to the structure shall be in accordance to RS-222E standards. Freedom of movement shall be provided with plus 10 or minus 5 degrees or plus 5 or minus 10 degrees in the vertical plane as required by each antenna and at least 15 degrees in the horizontal plane. Fine adjustment screws for the elevation and azimuth alignment shall be part of the permanent antenna mounting support structure. Fine adjustments shall be provided with plus or minus 5 degrees of movement in both the elevation and the azimuth.
4. The Contractor shall determine antenna tilt angles.

D. Wireless Broadband Cable and Connector Installation:

1. A cable system shall be provided complete with connectors, supports, lightning suppression, grounding and all appurtenances required for a complete installation at each site. Each cable run shall be site fitted with the antenna-end connector and tuned for maximum return loss at its transmitting frequency on site with the results recorded on a frequency versus return loss plot over the 5.650 to 5.920 GHz band. A copy of the recorded site test data shall be provided to the Owner prior to installation of the cable and antenna system.
2. Contractor shall install the cable in accordance with manufacturer's recommended practices and supporting tools.
3. Furnish a set of installation and maintenance tools to the Owner prior to Final Acceptance of the work.
4. Contractor shall install the connectors in the field.
5. Cable shall be installed without kinks or dents. The bending radius shall not exceed the manufacturer's recommended radius. Connections shall be made using approved connectors, following manufacturers' recommendations and best practices.
6. All cable entrances from outside locations shall be installed with a sealed weatherproof entry port. The Contractor shall not perform cable entry installations without first receiving favorable approval of a cable installation submittal.
7. The attenuation shall be less than the length of the cable times its measured attenuation coefficient plus 1.0 dB allowance for connector losses (to include effects of VSWR).
8. Installation Hardware: Manufacturer approved clamps and supports shall be used to relieve stress on the cables and connectors. The installation of fittings, clamps and connectors

shall be performed using tools and procedures conforming to the manufacturer's recommendations.
9. Cable Grounding: Grounding fitting, designed specifically for the size and type of cable being used, shall be provided and installed within three feet of the antenna and within three feet of entry into each building. The fitting shall be bonded to a grounded metal part of the support structure using 1-1/2 inches (minimum) copper ribbon strap.
10. Site Specific Details:
a. Install all equipment and devices in accordance with the Contract Drawings. Antenna and Ethernet cabling shall be routed as shown on the Contract Drawings. A brief description is indicated below.
b. Two LMR-600 antenna cables shall be installed from the antennas mounted atop the water tank to the wireless broadband radios installed in the panel. Two category 6 Ethernet cables shall be installed from the wireless broadband radios to the communications panel located inside the pump station. Two (2) RG-6 coaxial cables, and positioner motor cables shall be installed from the antennas mounted atop the water tank to the radio panel located in the pump station to operate the motor operated antenna mounts. All cables shall be attached to the tower with manufacturer's recommended hardware.

E. Installation Approval: The shop drawings shall be the basis for the approval of the subsequent installation work and shall, if necessary, be corrected by the Contractor during the installation to indicate as built conditions. The Contractor shall be responsible for the accuracy of all final as-built job drawings.

3.04 TEST

A. All testing shall be performed in accordance with Sections 01650 and 01700.

B. Site Demonstration Tests.

C. The following Site Demonstration Tests shall be conducted:

1. Antenna System Tests.
a. The Contractor shall test each antenna system that is furnished and installed. Tests shall be performed after antenna cables have been connected.
b. Upon completion of installation of the antenna system and prior to alignment, the Contractor shall perform return loss and insertion loss tests between the frequencies of 5.7 and 5.9 GHz. The sweep shall have a 1 KHz or less resolution band over the sweep range and the sweep rate shall be less than or equal to 300 KHz per second. Contractor shall remedy, repair or replace the antenna system at his cost if the return loss and insertion loss objectives are not met.
c. Factory Data: The Contractor shall gather all factory VSWR records and identify them with the name of the site and path.
d. Minimum Test Equipment Requirements: The Contractor shall provide all test equipment to complete the test, using manufacturer's recommended test equipment. As a minimum, the following test equipment, or equivalent, for return loss measurements and alignment of antennas shall be provided by the Contractor:

1) HP8350B Sweep Oscillator equipped with 83592B Power Head and +20 dBm output option.
2) HP8756A Scalar Network Analyzer.
3) HP7470A Graphics Plotter opt. 002.
4) 5.4 to 5.9 GHZ Andrew 49000 90M-1 Hybrid T Reflectometer.
e. The Contractor shall provide all miscellaneous test cables, adapters, power splitters, etc. that are necessary to perform the tests.
f. Test Results: The Contractor shall provide the Owner or its representative plots during the test of the Return Loss vs Frequency for each antenna system. The number of plots per cable shall be as follows:
1) Wide Band Sweep 5.7 to 5.9 GHz.
2) Narrow Band Sweep Transmit Frequency + 3 MHz.
3) Narrow Band Sweep Receive Frequency + 3 MHz.
g. Typed on each plot shall be the name of the antenna, frequency band, operating frequency, units of X and Y axis, cable and antenna serial number, date of test, and name of technician running the test equipment.
h. Acceptance:
1) The measured return loss of each antenna system shall be 24 dB or greater. Test results where the return loss is less than 24 dB in the operating band of the radio shall require the Contractor to re-terminate the connectors on the antenna cable.
2) If the re-termination does not bring the antenna system into compliance, then the Contractor shall replace the faulty component at his own expense.
3) The insertion loss test shall result in an attenuation which is less than the total length of the antenna cable times its published attenuation coefficient plus 1.0 dB for all connector losses.
i. Test Report: The Contractor shall present the Owner's Engineer or Engineering Representative a copy of the return loss plots, the factory test plots and a report summary of the testing results in accordance with Section 01670.
2. Antenna Alignment Tests:
a. The Contractor shall align the antennas for each link. The antennas shall be aligned by orienting the dishes at the approximate azimuths as specified. The antennas (one at a time) shall then be swept up and down until the minor lobes are identified and recorded. Then each antenna shall be adjusted to the peak vertical reading and locked into vertical position. Each antenna shall then be swept in a horizontal direction such that the minor lobes on either side of path center are identified and the signal peak is recorded. Then each antenna shall be centered upon the peak reading and locked in position.
b. Alignments may be completed using the calibrated AGC curves provided by the factory. The Contractor shall calculate the expected receive signal level for each link and align the antennas within +/- 2 dB of the calculated receive signal level.
c. The Contractor shall provide two way communication between the two sites during path alignment and shall provide manpower and equipment to align the antenna systems.
3. Communications End-to-End Tests and Demonstration: The Contractor shall test each path in an end-to-end test that demonstrates no loss of throughput and a high quality performance meeting or exceeding the performance requirements defined in Paragraph 1.3 in this Specification.

4. Communications Quality Demonstration: Link margins, bit error rate, availability and reliability shall each be confirmed by controlled tests in accordance with the testing standards defined in this Section of the Specification.
5. Radio Field Tests: The Contractor shall include in his field test procedures the following tests:
a. Manufacturer's Recommended Startup, Periodic and Maintenance Tests: Contractor shall measure and record the standard test points indicated in manufacturer's standard startup, periodic and maintenance test procedures.
b. Alarm Functionality Tests: The functionality of each alarm provided shall be verified.
6. Coaxial Cable Tests: The Contractor shall test end-to-end each coaxial cable that is furnished. Tests shall be performed after each cable has been connected to the antenna. The voltage standing wave ratio (VSWR) and attenuation shall be measured for each cable. The equivalent measured return loss of each antenna/cable system shall be 20 dB or greater. The attenuation shall be less than the total length of the coaxial cable times its published attenuation coefficient plus 1.0 dB for all connector losses. Contractor shall remedy, repair or replace the antenna system at his cost if the return loss and attenuation objectives are not met.
7. Wireless Broadband Network Administration Tests: The configuration and monitor capabilities of the wireless broadband radio equipment software shall be demonstrated using a notebook computer interfaced locally to the switched Ethernet network. Remote alarm and configuration functions shall be tested and verified.
8. Configurability Demonstration: Contractor shall verify that the wireless broadband radio and network equipment are wired in accordance with configurations shown on Shop Drawings.
9. Power Distribution Tests: All power distribution circuit breakers, wire, and cable shall be tested in accordance with Division 16 of this Specification.
10. Communications Cabling Tests: The Contractor shall test end-to-end each communications cable that is furnished by the Contractor. Testing shall be performed after field connectors have been installed. The testing shall include testing for continuity, opens, and shorts.
11. UPS Backup System:
a. After installation and connection to the load of the UPS, the line power shall be removed for a period of 30 minutes. All system components shall be operational for the duration of the shutdown. Line power shall be restored without interruption to the load.
b. The UPS system alarm shall be tested and verified through the Water Distribution Control System located at the South Service Center Control Center. Each alarm condition shall be verified at the WDCS SCADA system operator console located at the South Service Center Control Center. Except for the AC Line Voltage Present alarm, alarm conditions may be simulated.
D. System Availability Demonstration: After completion of all Site Demonstration Tests for the Wireless Broadband Subsystem equipment shall be placed into permanent service.

3.05 TRAINING

A. Training Program shall be conducted by the Contractor for the Wireless Broadband system following the Site Demonstration Tests and prior to Final Acceptance of the Wireless Broadband system by the Owner.

B. The specific requirements for the Training Program on the Wireless Broadband system are as follows:

1. Number of Students: The Contractor shall provide a comprehensive training program for up to 12 technicians and up to 5 engineers at the Owner's facilities.
2. Scope: The Training Program shall consist of a minimum of two separate four hours courses and shall cover all of the equipment being installed by the Contractor as well as that manufactured by the primary wireless broadband system Contractor. Currently most (if not all) prospective students have primarily an analog technical background. The Contractor shall provide training on the network management systems and diagnostic and control systems appropriate for water treatment plant operators. The Contractor shall provide all test equipment and accessories required to perform the training.
3. Content: This course shall include the following items as a minimum:
a. Description of the Contractor's Documentation Structure, Numbering System and Configuration Control System.
b. Training on the Basic Principles of Digital Data Transmission.
c. Presentation and Training on the Wireless Broadband System Block Diagram and Block Diagrams and Circuit Description for All Units.
d. Presentation and Training on the Theory of Operation and Detailed Circuit Descriptions of All Critical Units.
e. Description and Training of the Installation and Turn-On Procedures
f. Description and Training for the Antenna and RF Equipment Alignment Procedures.
g. Description and Training of Trouble Diagnosis Procedures and Rationale to the Unit Level.
h. Description of all Unit Replacement Procedures.
i. Description and Training of the Wireless Broadband Network Administration System.
j. Description and Training for Operating, Safety and Traffic Continuity Procedures.
4. Hands-On Training: Items 3.a through 3.j shall be conducted with a substantial "hands-on" involvement using the equipment actually installed at the wireless broadband sites.

C. Instructor Qualifications: All training shall be provided by full-time professional training instructors with at least three years of experience as instructors. The Owner reserves the right to review the qualifications of prospective instructors and to approve the selection of same. The Contractor shall provide the names and resumes of the instructors to the Owner at least 45 days prior to the start of the scheduled Training Program.

D. Schedule: The Training shall be conducted immediately after the successful completion of the system installation and Site Demonstration Tests.

E. Use of Installed System: The Training Program shall include use of at least one hop of the installed system.

3.06 SYSTEM WARRANTY AND SPARE PARTS REQUIREMENTS

A. Reference specification 13400.

B. Spare Parts:

1. Spare Parts listing shall be provided for all elements of the Wireless Broadband System. These lists shall indicate the recommended Spare Parts Quantities to be retained for all Owner replaceable elements as well as for all those units which may require the services of a 3rd party wireless broadband system service provider.
2. The Spare Parts List shall indicate sufficient quantities to support the actual installed sets of equipment being provided in this project. The name of manufacturer and part number for each spare pare shall be provided. In addition a commercially available source for each spare part shall be provided. The Contractor shall furnish to the Owner a set of spare parts in accordance with the Spare Parts List.
3. Spare parts list shall contain at a minimum:
a. One (1) Proxim Wireless Broadband Base Unit Radio system of each type used. Base station radio pigtail cable length shall be 24 inches (2 feet) Proxim (Model 5054-BSUR-US) and (Model 5054-SUA-US).
b. Two (2) Power over Ethernet (PoE) Lightning Arrestors (Proxim wireless- 70251).
c. Two (2) 5.8 GHz lightning arrestors (Polyphaser–LSXL, N-Female, BFN Bracket).
d. Two (2) motor operated antenna mount units (DMS international Products model SG2100).
e. Two (2) motor mount position controller units (DMS international Products V Box 7 Positioner).
f. One (1) Hyperlink Technologies high-performance 60cm x 40cm parabolic grid antenna (Model HG5827G).
g. 100 feet of LMR-600 Cable.
h. 100 feet of RG-6 Cable.
i. Five (5) of each type of RG-6 Connector used.
j. Five (5) N-Male Crimp Hex Connector for LMR-600 Cable.
k. Five (5) N-Female Crimp Hex Connector for LMR-600 Cable.
l. Spare parts which are specified elsewhere.

C. System Maintenance Requirements: System maintenance shall be provided in accordance with Section 13400.

END OF SECTION

SECTION 13400
PROCESS INSTRUMENTATION AND CONTROL SYSTEM (PICS)

PART 1 GENERAL

1.01 SCOPE

A. Provide all labor, materials, and equipment to design, furnish, install, calibrate, test, adjust, and place in operation the facility monitoring and control system as specified herein and as shown on the Drawings.

B. The Drawings and Specifications show and specify those features required to illustrate and describe functional requirements of the monitoring and control system.

C. A single Instrument and Control System Contractor (ICS) shall furnish all services and equipment defined herein and in other Specification sections as listed below under Related Work. These services include but not limited to furnishing the design, equipment, installation, calibration, checkout, required documentation, maintenance, etc. for the entire instrumentation and control system as specified herein and in the Specifications. The Instrument and Control System Contractor is referred to herein and after as the ICS. The ICS shall have the qualifications as described in subsection 2.0, "Quality Assurance", this section of the Specifications.

D. The ICS shall also:

1. Terminate and tag all field wiring associated with the process instrumentation and control system shown on the Drawings and specified herein and in other Specification sections listed below under Related Work. This includes, but not limited to, termination and tagging of instrumentation and control system wiring within, inside and at:
   a. The Local Control Panel located in the Pump Station Control room.
   b. Field mounted pull boxes.
   c. I&C wiring field termination junction boxes.
   d. Field mounted instruments and control/sensing devices such as process variable indicators and sensors, process variable controllers, etc.
   e. All control system wiring and cables. Including extension and termination of the Ethernet network, remote I/O wiring, etc.
2. Tag Instrumentation and control wiring/cable per the requirements and methodology/scheme outlined in specifications Division 16.
3. Calibrate, set and test the PICS equipment, components, cables, hardware, and software.
4. For equipment and ancillaries required under PICS Subsystem sections:
   a. Required submittals.
   b. Equipment and ancillaries.
   c. Instructions, details, and recommendations to, and coordination with, all other installation entities for Certificate of Proper Installation.

d. Certifying readiness for operation.
e. Starting up.
f. Testing including all system tests designated here-in.
g. Use of testing/calibration equipment to facilitate calibration/testing of field sensors and instruments.

5. Provide special additional services during installation, including:
   a. Verifying that the following are furnished and installed:
      1) Correct type size, and number of signal wires with their raceways.
      2) Correct electrical power circuits and raceways.
      3) Correct size, type, and number of PICS related pipes, valves, fittings and tubes.
      4) Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.
   b. For equipment not provided by the ICS, but directly connected to the PICS:
      1) Obtain manufacturer's information regarding installation, interface, function and adjustment for equipment from the Contractor.
      2) Coordinate with Contractor to allow required interface and operation with PICS.
      3) Verify that installation, interfacing signal termination, calibration, and adjustments have been completed in accordance with the manufacturer's recommendations.
      4) Test to demonstrate the required interface and operation with the PICS.
      5) Examples of equipment in this category include, but are not limited to the following:
         a) Process/Mechanical Equipment
         b) Vendor Packaged Control Equipment
6. Provide equipment, software, and services for programming the control system at the Owner's representative's office.
7. Assist Owner / Engineer, as specified in applicable control subsystem specifications sections, in the PAT testing of the Applications Software which shall be developed by the Owner's Representative for the Programmable Logic Controller (PLC) of the PICS installed by the ICS.
8. The ICS shall furnish and install the radio communication network between the Reuse Pump Station and the City's other facilities, including the South Service Center and South Austin Regional Wastewater Treatment Plant, as shown on the Drawings.
   a. System startup testing, diagnosing, and resolving communication system issues, etc.
9. The ICS shall furnish and install the fiber optic network from the Local Control Panel to the GAATN network switch located on the Pump Station premises. The City will be responsible for the configuration of this network and the ICS shall provide assistance in testing this communication link.
10. The ICS shall install and configure the Autodialer to provide the signals over the City's telephone service shown on the Contract Drawings over the dial up system. The ICS shall coordinate with the City and the local telephone company to establish and test this functionality.

1.02 RELATED WORK AND EQUIPMENT SPECIFIED ELSEWHERE

A. The Drawings are complementary, what is called for by one is as binding as if called for by all.

B. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

C. Division 16, Electrical Specifications.

D. All other division of the Specifications related to the installation of the process mechanical equipment, etc. that are related to the operation of the instrumentation and control system.

E. All additional applicable sections including 01300, 01730, and 01740.

1.03 ACCEPTABLE INSTRUMENT AND CONTROL SYSTEM SUPPLIERS AND INSTALLERS (ICS)

A. Provide a complete, workable, and installed-in-place Process Instrument and Control System, hereinafter referred to as the PICS, as specified herein. The PICS shall be designed, installed, and started up by a single ICS firm.

B. Acceptable ICS firm shall have the following minimum qualifications:

1. ICS Firm: Minimum of five (5) years of experience providing, integrating, installing, testing and start-up similar systems as those required for this project.
2. ICS Firm Site Representative: Minimum of eight (8) years of experience installing similar systems as those required for this project.
3. ICS Firm Start-up and Testing Team Members: Minimum of three (3) years of experience in testing systems similar to those required for this project.
4. The ICS firms shall have in-house capability to prepare all necessary component drawings, system drawings (loop diagrams) and installation, operations and maintenance manuals.
5. The ICS firm shall have in-house capability to coordinate design and selection of all components in the instrument and control system. It is understood that the ICS firm shall understand and review the design of the entire process instrumentation and control system and not just trace the Drawings. It is also understood that the ICS firm shall review all the components, equipment, and software/hardware specifications and prepare detailed purchase orders that will assure the proper features are furnished on each component that will comply with the intent of the Specifications and function as required in the individual system as designed and specified by the Engineer.

6. The key personnel of the ICS firm that shall be directly engaged in the day-to-day activity of this project shall have a minimum number of years of experience, as aforementioned, in manufacturing and installing complete instrument and control systems for water and wastewater facilities that are similar in scope and value as that proposed for this project. At minimum, the experience of the key personnel of the ICS firm assigned to this project shall encompass specific expertise in instrumentation and control systems of water and wastewater facilities in various facets of the project including administration, management, equipment selection, equipment submittal preparation, proper procurement of equipment, instrument and control panel layout and integrated component/equipment arrangement and wiring, equipment installation and procurement, coordination with Owner/Engineer and equipment suppliers, production of detailed installation/loop/ wiring/etc. The ICS firm inclusive of its key personnel shall have the proper resources for the preparation and installation of all efforts and elements of work required to insure proper system setup, proper system operation, and successful completion of this Project.
7. The ICS shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within a 24 hour period.
8. ICS firms that wish to provide these services on this project shall prepare a qualifications package that shall be submitted with the Contractor's Bid. This qualification package must demonstrate ICS's experience in Paragraph 1.03 herein, which shall be subject to review by Owner/Engineer. The Owner will make the final determination of whether or not the ICS meets the minimum capabilities, experience criteria, and staff and facility requirements as specified herein. All decisions will be final. Contractor shall name the proposed ICS on the Bid Form.

1.04 SPECIAL CONDITIONS

A. All components used in the instrument and control systems shall be new (not used) and the current model produced by the manufacturer and if possible purchased simultaneously to ensure consistency between like equipment for the project.

B. All equipment of a common type shall be the product of a single manufacturer.

1.05 SUBMITTALS

A. General: Do not design, manufacture, or ship any PICS equipment until all related submittals have been reviewed by Engineer. Submit shop drawings and product data in complete functional packages; i.e., submit all shop drawings and product data for a given loop or subsystem together as a functional package. Piecemeal submittals not organized by systems or incomplete submittals for a given loop or subsystem will not be accepted.

B. Administrative Submittals:

1. Schedule of Values:
   a. Purpose: Project Schedule of Values to provide a basis for Partial Payment for Work completed.
   b. Content: Summary of major milestones and associated Partial Payments for Work provided under PICS Subsystems.
2. PICS Progress Schedule
   a. Purpose: Supplement the overall Project Progress Schedule to:
      1) Coordinate activities between Contractor and the ICS.
      2) Coordinate interactions with the Owner/Engineer for coordination meetings, submittal reviews, etc.
      3) Clarify required work sequences and major milestone prerequisites.
3. Statements of Qualification: Submit for PICS firm, site representative, start-up and testing team member.

C. Submit shop drawings and Operation and Maintenance (O&M) in accordance with Sections 01300 and 01730 of the Contract Specifications and as specified below:

1. Prior to the first shop drawing submittal, provide certification that ICS firm has completed the design and taken into account all interrelationships of the specific instruments proposed; and that the design accomplishes the functions described herein and shown on the Drawings.
2. Detailed product data, catalog cut sheets, cabinet exterior elevations, and cabinet interior elevations, bill of materials, and spare parts listing.
3. Point to Point Wiring Diagrams: Prepare Point-to-Point Instrument Loop Wiring Diagrams, ladder diagrams (control schematics), cabinet wiring, and other field wiring diagrams in accordance to the format shown on the Drawings. Drawings shall be neat, and legible, and on 11 inch x 17 inch sized sheets. Drawing to include all relevant information for equipment connected to the PICS, regardless if the equipment is provided by the ICS or not, i.e. include existing equipment, vendor packaged equipment, etc. Contractor shall also submit for approval a complete schedule of all wire tag numbers and equipment/instrument/field devices.
4. Ladder Diagrams and Control Schematics: Ladder diagrams shall also include interconnections with remotely located and/or existing devices such as motor starters, control valves, flow loops, etc. These diagrams shall be thorough and complete in all aspects. Diagrams shall present/show all control components, pilot devices, terminal block numbers, wire numbers, etc. that are part of the control logic of a single piece of equipment shall be controlled, yet, are not necessarily located in the main instrument control panel and/or the PLC cabinets. Example: control power transformer of each equipment, phase monitors, protective relays, motor space heater, starter coils, overloads, etc. Diagrams shall show these remote devices along with the actual terminal block numbers, wire number, etc., that are utilized within the remote cabinets/equipment in which they are installed and furnished by others. The ICS firm shall obtain all necessary information from the respective remote equipment supplier and/or existing field sensors/instrument which are scheduled for reuse to properly complete these drawings (such as wiring

diagrams from process/mechanical equipment manufacturer, motor control center manufacturer, HVAC equipment manufacturer, etc.). Prepare ladder diagrams and control schematics in accordance to the format shown on the Drawings.

5. All loop diagrams, ladder diagrams, control schematics, etc., shall be generated with terminal block numbers and wire numbers and be complete in all respects. It is anticipated that all wire numbers cannot be accommodated on the loop diagrams, ladder diagrams, control schematics, etc. format shown on the Drawings. As a minimum, to facilitate the depiction of the wire numbers on the loop diagrams, ladder diagrams, control schematics, etc., the Contractor shall generate and include uniquely identified alpha-numeric wire codes on the loop diagrams, ladder diagrams, control schematics, etc. The wire codes shall cross-reference tables of wire numbers shown on additional drawings that shall be generated by the Contractor. At minimum, the Contractor shall generate the wire codes and the cross-reference tables which depict the wire numbers associated with each wire code and shall group the cross-reference tables by specific equipment (Pump No. 1, Pump No. 2, etc.). As a minimum, the Contractor shall generate drawings to depict the wire code and wire tag cross reference tables and these drawings shall also be grouped by specific equipment (Pump No. 1 Pump No. 2, etc.). Additional requirements concerning the cross-reference table headings, table organization, wire code generation, formatting, etc., may be required by the Owner/Engineer during Submittal Reviews, and the Contractor shall incorporate these requirements at no additional cost to the Owner.
6. Testing Related Submittals:
   a. Submit factory and field calibration reports.
   b. Submit the following for each of type of test (ORT or PAT) required under Division 13 of the Specifications:
      1) Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed off test procedures when tests are completed.
7. Operation and Maintenance Manuals: Furnish and submit Operation and Maintenance manuals in accordance with Section 01300 and 01730 of the Contract Specifications, and as specified below:
   a. Content and Format:
      1) Complete sets of separately bound O&M manuals for each PICS Subsystem.
      2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PICS component
   b. Include approved shop drawing data in the Operation and Maintenance manuals with the following modifications to the shop drawing exhibits:
      1) Reflect “As-Built” conditions.
      2) Prints of exhibits, wiring diagrams, etc. shall be half size (11 x 17-inch).

c. Procedures for operating and shutdown.
d. Included approved Testing Related Submittals with final “As-Built” conditions.
e. Safety instructions.
f. Calibration instructions and factory test results of each instrument.
g. Maintenance and repair instructions.
h. Recommended spare parts list.
i. Name, address and phone number of instrumentation control system supplier's local representative.
j. Additionally, comply with the requirements of the Contract Documents.

8. Special Submittal Requirements – Applicable to Both Shop Drawing Submittals and Operations and Maintenance Manuals:
   a. All system layout drawings, cross sectional view drawings, wiring diagram drawings, Connection detail drawings, physical layout and detail drawings, etc. shall be developed electronically using “AUTO-CAD 2010”. Submittals shall include hard copies (of the quantity and format required by the Contract Documents) and electronic Version in “AUTO-CAD 2010”. This applies to all drawings requested in this Section of the Specifications and any other manufacturer’s product standard drawings required for submittal.
   b. All system equipment and associated component Bill of Material sheets and/or tables indicating product data, quantities, physical location and reference, catalog number, wire tags, reference, wiring diagram drawing number reference, cost, and any other field entered in the bill of materials sheet and/or any other spreadsheets and/or any other table and/or listings of references/etc. shall be electronically developed using Adobe Acrobat. In addition, a Hypertext Table of Contents shall be provided so when a word(s) in the Table of Contents is clicked, the cursor will go to where that information is found. This applies to all summary sheets, material listings, etc. to be submitted for this project. Submittals shall include hard copies (of the quantity and format required by the Contract Documents) and an electronic.

PART 2 QUALITY ASSURANCE

2.01 SYSTEM COORDINATION AND QUALITY

A. Coordinate installation of instrumentation with mechanical and electrical systems.

B. Coordinate subsystems to provide a complete operational and functional instrumentation system to the satisfaction of the Owner and Engineer.

C. Equipment, instruments, components, and materials for PICS components shall be new (not used) and of the current model.

D. Instrument and Control Components Furnished By Others: Certain items of instrumentation and controls shall be furnished by various equipment manufacturers. Coordinate the purchase orders of the items such that the resulting system will function properly.

E. Coordinate with others as required for the control system network programming and configuration (by others) for a properly operational and functional control system.

2.02 DESIGN CRITERIA

A. Design, construct, and install all PICS components in compliance with the applicable provisions of the following standards, codes, and regulations:

1. American National Standards Institute (ANSI) Standards.
2. American Institute of Steel Construction (AISC) Standards.
3. American Society for Testing and Materials (ASTM) Standards.
4. American Waterworks Association (AWWA) Standards.
5. Joint Industrial Council (JIC) Standards.
6. National Electric Code (NEC).
7. National Electrical Manufacturer's Association (NEMA) Standards.
8. Local and State Building Codes.
9. Occupational Safety and Health Administration (OSHA) Regulations.
10. Scientific Apparatus Manufacturer's Association (SAMA) Standards.
11. International Society of Automation (ISA).
12. Institute of Electrical and Electronics Engineers (IEEE).
13. National Fire Protection Association (NFPA).

2.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Enclose cabinets and subassemblies in heavy polyethylene envelopes to protect them from dust and moisture. Place corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

B. Storage: All materials and equipment shall be environmentally protected and stored in climate controlled (temperature and humidity, etc.) environment. The Instrument Control Panels and the field control and instrument/monitoring panels shall not be moved from climate controlled storage room to the project site until the construction of the electrical/control room is completed, and, the air-conditioning and heating system of the facility is in satisfactory operating condition to the Owner and Engineer.

2.04 CALIBRATION OF INSTRUMENTS

A. Each instrument used for calibrating PICS equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous twelve (12) months to a standard endorsed by the National Institute of Standards and Technology (NIST). At Owner’s request, ICS shall submit calibration certification report.

2.05 START DATE OF THE CONTROL SYSTEM WARRANTY (PICS SUBSYSTEM)

A. Start Date of the process instrumentation and control system and associated subsystem Warranty (PICS including Subsystems) shall commence the date in which the Warranty period commences for the overall project per the requirements of the Contract Documents.

PART 3 SEQUENCING AND SCHEDULING

3.01 GENERAL

A. All work provided under this section shall be in accordance with the Owner/Engineer-approved Schedule of Submittal Submissions and Schedule of Values.

B. Specification and Construction Implementation Plan requires phased installation of equipment and systems. Stage all PICS activities (submittals, fabrication, installation, testing, start-up, training, etc.) to support the construction sequencing requirements of the Project.

C. Wherever language in this section refers to the “PICS”, the entire installed PICS, the entire PICS, or similar language, it shall be interpreted to apply to the individual phases of the work; except the requirements for the Performance Acceptance Test PAT.

3.02 SCHEDULE OF VALUES

A. Purpose: Project Schedule of Values and Progress Schedule to provide a basis for Partial Payment for Work completed relative to the complete PICS and its deliverables including PICS O&M manuals and as-built drawings and record documents.

B. Content: Summary of major milestones and associated Partial Payments for Work provided under PICS Subsystems.

3.03 PREREQUISITE ACTIVITIES AND LEAD TIMES:

A. Start the following key Project activities when prerequisite activities and lead times listed below have been completed and satisfied:

1. PICS Hardware and DCS System Purchasing and Assembly Prerequisite: Completion and approval of shop drawing submittals.
2. Test Prerequisite:
   a. All associated process and mechanical equipment, controlled and monitored by the instrumentation and control system, complete in place.
   b. Associated test plan submittal completed. For ORT and PAT, notice of test schedule required 2 weeks prior to the start of the test.

3. PAT Prerequisite:
   a. ORT successfully completed and facility started up.
   b. One (1) month minimum elapsed time after delivery of Configuration System to Engineer's office.
4. O&M Submittal Prerequisite: PAT successfully completed.
5. Operator Start-Up Training: Completion of PAT.

3.04 PICS SUBSTANTIAL COMPLETION

A. When Engineer issues Certificate of Substantial Completion.

B. Prerequisites:

1. All PICS submittals have been completed.
2. PICS has successfully completed PAT.
3. All spares, expendables, and test equipment have been delivered to Owner.

3.05 PICS ACCEPTANCE

A. When Engineer issues a written notice of acceptance.

B. Prerequisites:

1. Certificate of substantial completion issued to PICS.
2. Instrumentation Installation Reports "IIR" are completed, and all deficiencies are corrected.
3. Punch-list items completed. Note: Punch list items will be used 15 Calendar days following the completion of the PAT.
4. Final revisions to O&M manuals accepted.

PART 4 PRODUCTS

4.01 GENERAL

A. Refer to the Supplements of this Specification for the details of the field instruments, the Instrument Index and the Input / Output list.

4.02 SOURCE QUALITY CONTROL

A. General:

1. Test all PICS elements, both hardware and specific software, to demonstrate that PICS satisfies all requirements.
2. On-Site Tests Described Under PART 5 - EXECUTION:
   a. Operational Readiness Test – "ORT"
   b. Performance Acceptance Tests "PAT".
3. Test Format: Cause and Effect
   a. Person conducting test innovates and input (cause)

b. Specific test requirement is satisfied if the correct result (effect) occurs.

4. Procedures, Forms, and Checklists:
   a. Conduct all tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists. All signed by Owner/Engineer and Contractor.
6. Conducting Tests:
   a. All special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
   d. Define simulation techniques in test procedures.
7. Owner/Engineer will actively participate in many of the tests.
8. Owner/Engineer reserves the right to test or retest all specified functions whether or not explicitly stated Test Procedures.
9. Owner's/Engineer's decision will be final regarding acceptability and completeness of all testing.

B. Maintenance of Configuration System:

1. Provide for maintenance of the Configuration System at the Engineer's office. Repair or replace failed equipment within two (2) days of notice by the Engineer.

PART 5 EXECUTION

5.01 EXAMINATION

A. Equipment furnished by Supplier or any other subcontractor and installed by the ICS/Contractor, requires Supplier to observe and advice on installation to extent required to certify that equipment has been properly installed and will perform as required.

B. For equipment not provided by Supplier, but that directly interfaces with the PICS, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of all instrumentation and control devices.
3. Correct control action.
4. Switch settings.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

5.02 INSTALLATION

A. General:

1. Material and Equipment Installation:
   a. Install all equipment in accordance with the Drawings.
   b. Follow manufacturer’s installation instructions, unless otherwise indicated or directed by the Owner/Engineer.
   c. Retain a copy of the manufacturer’s instructions at the project site, available for review at all times.
   d. Inspect each new instrument, control component, etc., before installation. Replace deficient items.
2. Instruments Installation Report(s) IIR: After installation, the manufacturer's non-sales type technical representatives shall inspect the installation and prepare a report or reports to include the following:
   a. A list of all deficiencies found.
   b. Recommended corrective action for all facilities.
   c. Certification that the item or system is properly installed, calibrated and tested except as noted.

B. Wiring:

1. All wiring connected to PICS components and assemblies shall be in accordance to the requirements of Division 13 and 16 of the Specifications.

5.03 FIELD QUALITY CONTROL

A. General: All requirements listed in Subsection Source Quality Control, above, also apply to this Subsection Field Quality Control.

B. Onsite Supervision:

1. The ICS Project Site Representative shall supervise and coordinate all onsite PICS activities.
2. The ICS Project Site Representative shall be On-Site during total period required to complete all On-Site PICS activities.

C. Startup and Testing Team:

1. Thoroughly check installation, termination, and adjustment for all PICS Subsystems and their components.
2. Completed On-Site tests.
3. Provide and conduct startup services.

D. Sequence of Work: Provide individual ORTs and PATs for individual process equipment where required to support the staged construction and startup of the facility. Closely and carefully coordinate the construction sequencing requirements with the Owner.

E. Operational Readiness Test (ORT):

1. Prior to start of the Performance Acceptance Test “PAT”, the ICS firm shall inspect, test the PICS equipment and systems, document the resulting tests performed, implement all corrective actions necessary, perform all associated re-testing, and document that the PICS is installed and ready for operation. Subsequent to the ICS documentation that the PICS is installed and ready for operation, perform jointly with the Owner an ORT on the associated PICS equipment to demonstrate that it is fully operable as required by the Contract Documents.
2. For PICS subsystems where the PLC application software is provided by the Owner, provide sufficient temporary software configuring to allow testing of these subsystems.
3. Loop/Component Inspections and Tests:
    a. Check PICS for proper installation, calibration, and adjustment on a loop-by-loop, and component-by-component basis.
    b. Develop and provide forms as required to document ORT. All forms generated shall have provisions for signature by PICS representative.
    c. Develop and provide test form hereinafter called the “Loop Status Report” to organize, track inspection, adjustment, and calibration of each loop. Loop Status Report shall include the following as a minimum:
        1) Project name.
        2) Loop number.
        3) Tag number for each component.
        4) Check off / signoffs for each component:
            a) Tag/identification.
            b) Installation.
            c) Wiring termination.
            d) Tubing termination.
            e) Calibration/adjustment.
        5) Check offs /signoffs for each loop:
            a) Panel interface termination.
            b) PLC I/O interface terminations.
        6) PLC I/O Signals are Operational: Received/sent, processed, adjusted.
        7) Total loop operational.
        8) Space for comments.
    d. Develop and provide test form hereinafter called the “Component Calibration Sheet” to organize, track inspection, adjustment, and calibration of each component (except hand switches, pilot lights, gauges, and similar items) and each PLCs I/O Module. The Component Calibration Sheet shall include the following as a minimum:
        1) Project Name.
        2) Loop Number.
        3) Component tag number or I/O module number.
        4) Manufacturer name.

5) Model number/serial number.
6) Summary of functional requirements. For example:
   a) Indicators.
   b) Transmitters/converters, input and output ranges.
   c) Computing elements' functions.
   d) Controllers, action (direct/reverse) and control modes (P&ID).
   e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
   f) PLC I/O modules: input or output.
7) Calibrations, for example, but not limited to:
   a) Analog devices: Actual inputs and output at 0, 25, 50, and 100 percent of span, rising and falling.
   b) Discrete Devices: Actual trip points and rest points.
   c) Controllers: Mode settings (P&ID).
   d) PLC I/O Modules: Actual inputs or outputs of 0, 25, 50, and 100 percent of span, rising and falling.
8) Space for comments.

e. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at the project site and make them available to the Owner at all times.

f. These inspections and tests, inclusive of the above described forms, will be spot checked by the Owner.

g. The ICS shall implement all corrective measures needed and perform re-test on any modified sub-system/component.

h. The Contractor shall claim and validate a thorough ORT was performed successfully and all resulting corrective action measures taken were performed successfully and re-tested successfully. Upon successful completion of the ORT, the Contractor shall submit letter notification to the Owner stating that the ORT has been successfully completed. The letter notification shall further state that the ICS is ready to begin the Performance Acceptance Test. Submit all forms upon completion of ORT as required by the Owner.

F. Performance Acceptance Tests "PAT":

1. Once the ORT has been successfully completed and equipment has been started up, perform jointly with the Owner a PAT on the associated PICS to demonstrate that it is operating as required by the Contract Documents. The PAT will employ the Owner's PLC application software developed for the Project.
2. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis based upon the operating description used by the Owner for PLC application software development.
3. Non-loop specific tests shall be the same as previously required except that the entire installed PICS shall be tested using actual process variables and all functions demonstrated.
4. Perform local and manual tests for each loop before proceeding to remote and automatic modes

5. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by Others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
6. Make updated versions of documentation required for PAT available to the Owner at the project site, both before and during tests.
7. Develop and provide PAT test forms that include the following, at minimum:
    a. Project name
    b. Lists the requirements of the loop
    c. Briefly describes the test
    d. Cites the expected results and the actual results
    e. Provides space for check off by witnesses.
8. Make one copy of all O&M manuals available to the OWNER at the site both before and during testing
9. The ICS shall implement all corrective measures needed and perform re-test on any modified system.
10. Minimum duration of the PAT shall be a cumulative total of five (5) calendar days. The cumulative total quantity of calendar days shall be consumed in association and in synch with the overall construction sequence for the project. Any Holidays that occur during the PAT shall result in a corresponding number of days being added to the duration of the PAT. The PAT encompasses startup and testing period of the instrumentation and control system and the associated process and mechanical equipment that are controlled and monitored by the instrumentation and control system. The PAT shall be conducted using application software developed by the Engineer. The ICS shall test functions installed and the hard-wired system and the entire associated instrumentation and control system including validating the operation and monitoring and control functions of the all instruments, all control devices, all instrument and control components, control functions, alarm function, monitoring function, calibration ranges, control/alarm set point operations, etc. Owner/Engineer shall test software functions. The ICS shall also test the control system.
11. Prolonged and Excessive Startup and Testing During the PAT (startup and testing period of the instrumentation and control system and the associated process and mechanical equipment that are controlled and monitored by the instrumentation and control system): If parts of a startup and testing of equipment fail and must be redone following the completion of the allotted PAT period and/or startup and testing extends past the PAT period as a result of deficiencies found in the installation of the PICS, and/or startup and testing extends past the PAT period due to prolonged test per piece of equipment resulting from Lack of complete readiness of the PICS and/or the Contractor as well as the associated systems to commence the PAT, and/or not being completely ready to perform the PAT, etc; Any additional time expended by the ICS shall reimburse the Owner for the additional time at the rate of $150.00 per hour. Additional time is defined as any-time in excess of the total number of allotted Calendar days, based on normal business working hours during the PAT period, for these costs the Engineer will document

work hours and other expenses required during the additional time.

5.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section, except as indicated below. Include cost of same in Contract price bid for work of which this is a component part.

5.05 SUPPLEMENTAL INFORMATION

A. Field Instrument Specifications and Index.

B. Input / Output List.

C. Radio Path Study.

END OF SECTION

COMPONENT SPECIFICATIONS

A. L10 Level Transmitter, Direct Sensing, Flange Mounted:

1. General:
   a. Function: Measure level in a process vessel.
   b. Type:
      1) Capacitive differential pressure cell.
      2) Diaphragm for process fluid isolation.
      3) Flange mounting.
      4) Smart electronics.
      5) Two-wire device.
   c. Service:
      1) Process Liquid: As noted.
      2) Process Temperature Range: Minus 20 degrees F to 400 degrees F, unless otherwise noted.
      3) Ambient Temperature Range: Minus 40 degrees F to 250 degrees F, unless otherwise noted.
      4) Humidity: 0 percent to 100 percent relative.
2. Performance:
   a. Range: As noted.
   b. Accuracy: Plus or minus 0.75 percent of span.
3. Features:
   a. Zero Suppression or Elevation: As noted.
   b. Damping: User-selectable; 0 second to 36 seconds time constant of analog output response to step change input.
4. Transmitter: Two-wire, powered from external power supply.
   a. Zero and Span Adjustments: Local, external, noninteractive, unless otherwise noted.
   b. Process Wetted Parts: Flanged Process Connection (Transmitter High Pressure Side):
   c. Flange Size/Type: 3-inch, Class 150, unless otherwise noted.
   d. Process Diaphragm: Type 316 stainless steel, unless otherwise noted.
   e. Mounting Flange: Stainless steel, unless otherwise noted.
   f. Mounting: Flush, unless otherwise noted.
   g. Extension Materials (if extension mount noted): Type 316 stainless steel, unless otherwise noted.
   h. Extension Length (if extension mount noted): As noted.
   i. Process Fill Fluid (High Pressure Side): Dow Corning Silicone 200, unless otherwise noted.
   j. Reference Process Connection (Transmitter Low Pressure Side) Configuration (Differential, unless otherwise noted):
   k. Drain/Vent: Type 316 stainless steel.
   l. Flange Adapter: Stainless steel.
   m. Diaphragm Material: Type 316 stainless steel, unless otherwise noted.

n. Sensor Fill Fluid (Low Pressure Side): Silicone, unless otherwise noted.
o. O-Ring: Glass-filled TFE.
p. Flange and Adapter Bolts: Type 316 stainless steel, unless otherwise noted.
q. LCD Meter: If noted.
r. Integral Transient Protection: If noted.
s. Signal Output Interface:
1) 4 mA to 20 mA dc for load impedance 0 ohm to 580 ohms minimum at 24V dc supply voltage without load adjustment.
2) Superimposed digital signal based on HART protocol.

5. Enclosure: NEMA 4X, polyurethane-covered aluminum, unless otherwise noted.
6. Manufacturers/Model:
a. Emerson Process Rosemount; 3051L, Liquid Level Transmitter.
b. Foxboro IGP20

B. L31 Level Switch, Integral Conductive Probe:

1. General:
a. Function: Actuate contact at preset liquid level.
b. Type: Probe with integral conductance type switch.
c. Parts: Probe; interconnecting cable; relay or indicating controller, as noted; accessories as noted.
d. Coordinate installing applicable parts within panel furnished by PIC Supplier.
2. Service: Reuse water, unless otherwise noted.
3. Performance:
a. Set points: As noted.
b. Relay Operating Temperature Range: 14 degrees F to 140 degrees F.
c. Indicating Controller Operating Temperature Range: 14 degrees F to 140 degrees F.
d. Intrinsically Safe Barrier Operating Temperature Range: 14 degrees F to 140 degrees F.
4. Parts and Features:
a. Probe:
1) Quantity: As noted on the Contract Drawing.
2) Materials: Cast Iron.
3) Length: As noted.
b. Switch Separation Distance: As noted.
c. Cable Length: As noted.
d. Signal Interface:
1) Relay: One set of contacts per relay.
2) Contact Rating: 5 amps resistive at 250V ac.
5. Accessories:
a. Probe Mounting Kit: Furnish, unless otherwise noted.

1) Integral cleaning device.
2) Stainless steel components.

6. Manufacturer and Products:
   a. B/W Controls
      1) Series 6012/6013 Electrodes.
   b. Or equal.

C. P7 Pressure Switch, Adjustable Dead Band:

1. General:
   a. Function: Monitor pressure, activate switch at setpoint, and deactivate switch at reset point.
   b. Type:
      1) Piston-actuated.
      2) Both setpoint and deadband (the differential between setpoint and reset point) adjustable.
2. Performance:
   a. Setpoint: As noted.
   b. Repeatability: Plus or minus 1 percent of range.
   c. Reset Point: As noted.
   d. Range: The noted setpoint shall fall between 20 percent and 80 percent of the range.
   e. Deadband: Adjustable within nominally 25 percent and 85 percent of range.
   f. Overpressure Proof Pressure:
      1) Pressure psi Ranges: At least 400 percent of rated maximum static pressure.
      2) Pressure Inches of Water Ranges: 20 psig.
   g. Compound Range: 250 psig.
   h. Vacuum Range: 250 psig.
   i. Operating Temperature Range:
      1) Dependent on actuator seal materials.
      2) For Buna-N seal, 0 degree F to 150 degrees F.
3. Features:
   a. Actuator Seal: Buna-N, unless otherwise noted.
   b. Adjustable deadband.
   c. Mounting: Surface, unless otherwise noted.
   d. Process Connection:
      1) 1/4-inch NPT female connections, unless otherwise noted.
4. Materials:
   a. Pressure psi Ranges: Type 316 stainless steel, unless otherwise noted.
   b. Pressure Inches of Water Ranges: Epoxy coated carbon steel, unless otherwise noted.
   c. Enclosure: NEMA 4X, unless otherwise noted.
5. Signal Interface:
   a. Contact Type:
      1) SPDT.

2) Rated for 10 amps minimum at 120V ac.

b. Hermetically Sealed Switch: If noted.

6. Manufacturers and Products:

a. Ashcroft; L or P Series.

b. United Electric; J6 Series.

c. Or Equal.

D. P9 Pressure Transmitter:

1. General:

a. Function: Measure pressure and transmit signal proportional to pressure.

b. Type:

1) Electronic variable capacitance or silicon strain gauge.

2) Two-wire transmitter; “smart electronics”.

c. Parts: Transmitter and accessories.

2. Performance:

a. Range: As noted.

b. Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.

c. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.

d. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.

e. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.

f. Humidity: 0 to 100 percent relative humidity.

g. Hazardous Location Certifications: If and as noted.

3. Features:

a. Type: Gauge pressure, unless otherwise noted.

b. Adjustable damping.

c. LCD indicator, unless otherwise noted.

d. Display in either percent or engineering units, field configurable.

e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.

f. Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.

g. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

h. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.

i. Fill Fluid: Silicone, unless otherwise noted.

j. Process Connections:

1) Line Size: 1/2 inch.

2) Connection Type: FNPT.

k. Direct/remote Diaphragm Seal: If and as noted.

4. Signal Interface:

a. 4mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
b. Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
c. FOUNDATION fieldbus protocol: If noted.
d. Profibus: If noted.

5. Enclosure:
   a. Type: NEMA 4X.
      1) Materials: Coated aluminum, unless otherwise noted.
      2) Mounting bracket, unless otherwise noted.
      3) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
6. Accessories:
   a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
7. Manufacturers and Products:
   a. Gauge Pressure Units:
      1) Rosemount; Model 3051 TG.
      2) Foxboro; Model IGP20.
   b. Absolute Pressure Units:
      1) Rosemount; Model 3051 TA.
      2) Foxboro; Model IAP20.

E. A18 Chlorine Leak Detector:

1. General:
   a. Function: Continuously monitor ambient air for chlorine gas.
   b. Sensor Type: Electrochemical gas diffusion.
   c. Parts: Sensor/transmitter(s); receiver/controller, automatic test generator (if noted), calibration kit, and ancillaries.
2. Performance:
   a. Range: 0 ppm to 10 ppm, unless otherwise noted.
   b. Temperature, Operating: 0 degrees F to 105 degrees F.
   c. Humidity, Operating: 0 percent to 99 percent relative humidity, noncondensing.
   d. Sensor (or Integral Sensor/Transmitter):
   e. Number of Sensor(s): One, unless otherwise noted.
   f. Gas Monitored: Chlorine gas.
   g. Sensor Type: Electrochemical gas diffusion.
   h. Mounting: Wall.
   i. Controller:
      1) Number of Channels/Receivers: One, unless otherwise noted.
      2) LCD or LED Display.
      3) Audible Alarm: Integral weatherproof horn, 85 dB.
3. Enclosure:
   a. Rating: NEMA 4X.
   b. Mounting: Wall.

4. Power:
    a. Controller: 85-255V ac, 50/60 Hz, unless otherwise noted.
    b. Backup Battery:
        1) Required, unless otherwise noted.
        2) 12V dc, 4-amp hour battery to maintain operation up to 12 hours to a single point unit.
5. Signal Interfaces, Controller:
    a. Analog Output:
        1) If noted.
            a) 4 mA to 20 mA dc analog output capable of driving 600 ohms at 24V dc; one per channel.
    b. Discrete outputs.
        1) SPDT relays rated for 230V ac at 5 amps resistive.
        2) Three per channel, plus one common fault.
    c. Cables: Provide cabling of required length between sensor/transmitter and controller.
6. Ancillaries:
    a. Automatic Test Gas Generator:
        1) If noted.
            a) Assembly includes a chlorine generator for automatic daily test of sensor.
            b) Calibration Kit: Complete with accessories, including regulator and zero and span cylinders of chlorine gas.
            c) Device to allow personnel to nonintrusively calibrate and adjust transmitter.
7. Manufacturers and Products:
    a. Evoqua; Acutec 35 Gas Detection System.
    b. MSA; Trigard Gas Sensor(s) and Monitor.

F. A30 Turbidity Meter

1. General:
    a. Function:
        1) Measure turbidity using using pulse scattered infrared light at 860nm at a 90° angle in accordance with/compliance with DIN EN ISO 7027.
        2) Transmit proportional analog (and, if noted, network) signal.
    b. Type: Nephelometric.
    c. Parts: Analyzer/transmitter, reagent, and accessories.
2. Performance Requirements:
    a. Range
        1) 0.0001 to 1000 FNU (1 FNU = 1 NTU)
    b. Resolution
        1) 0.0001 to 0.9999 / 1.000 to 9.999 / 10.00 to 99.99 / 100 to 1000 FNU (NTU)
    c. Precision

1) ±0.008 FNU or ±1% of reading (0 to 10 FNU)

d. Repeatability

1) ±0.003 FNU or ±5% of reading (0 to 2 FNU)

e. Response time

1) 1 to 60 seconds (user adjustable).

3. Certifications:

a. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits) when connected to an sc controller.

b. Safety: General Purpose UL/CSA 61010-1 with cETLus safety mark when connected to an sc controller

c. IP 65 Enclosure Rating

4. Environmental Requirements:

a. Operating Temperature: 36 to 104 °F (2 to 40°C)

b. Sample Temperature: 122 °F (50 °C) maximum

c. Sample Pressure: 87 psi at 68°F (6 bar at 20°C)

d. Sample flow rate

1) Minimum: 0.2 L/min

2) Maximum: 1L/min

5. Wetted Materials:

1) Measuring window: Quartz

2) Measuring Chamber: Noryl GFN2

3) Wiper axle: Stainless Steel 1.4571

4) Wiper profile: Silicone

6. Warranty: The sensor includes a one-year warranty from the date of shipment.

7. Maintenance Service:

a. Scheduled Maintenance

1) Every 1200 Cycles: Replace wiper profile (only on plus and seawater versions)

2) Every Two Years: Replace desiccant and monitor test equipment with CVM Dry Calibration

b. Unscheduled Maintenance

1) Clean measuring chamber: Dependent on substances contained in the water

2) Check Zero Point: Dependent on substances contained in the water

3) Check Gradient: At least once per year

8. Manufacturer:

a. Hach-Lange GmbH, Berlin, Germany: Ultraturb sc Basic/Plus/Seawater Turbidimeter, with the Hach Model SC200 or SC1000 Controller

9. Manufactured Unit:

a. The Ultraturb sc Turbidimeter consists of an 860nm LED light source, detection system, and internal light trap. Sample chamber wiper available for plus and seawater versions.

G. A24 Chlorine Residual Analyzer, Amperometric:

1. General:
    a. Function:
        1) Measure and indicate total and / or free chlorine.
        2) Transmit proportional analog (and, if noted, network) signal.
    b. Type: Amperometric titration.
    c. Parts: Analyzer/transmitter, and accessories.
2. Performance Requirements
    a. Measurement range: 0 to 20 ppm chlorine for either free or total chlorine
    b. Total Chlorine
        1) Low Limit Of Detection (LOD): 30 ppb (0.03 ppm) or better
        2) Limit Of Quantitation (LOQ): 90 ppb (0.09 ppm) or better
        3) Repeatability/precision: 30 ppb or 3%, whichever is greater
        4) Response time: ~100 s for 90% change (T90) (At a stable T and pH)
        5) Interference: Chlorine Dioxide, Ozone, and chalk deposits
    c. Free Chlorine
        1) Low Limit Of Detection (LOD): 30 ppb (0.03 ppm) or better
        2) Limit Of Quantitation (LOQ): 90 ppb (0.09 ppm) or better
        3) Repeatability/precision: 30 ppb or 3%, whichever is greater
        4) Response time: ~140 s for 90% change (T90) (At a stable T and pH)
        5) Interference: Monochloramine, Chlorine Dioxide, Ozone, and chalk deposits
    d. Drift: <10% within one week of calibration at a minimum (application dependent)
    e. Specificity/Selectivity: Non-specific to a certain chlorine form, responds to any chlorine species and other oxidizers as noted in the interference section
    f. Calibration method: Customer has the option to use one (zero or slope) or two point (zero and slope) calibration. Two point calibration with chemical zero is recommended for chlorine concentration <0.5 ppm
    g. Verification procedure: One-point process calibration (slope) against a standard reference method.
3. Environmental Requirements
    a. Operational Criteria
        1) Operating temperature: 5 to 45 °C (41 to 113 °F)
        2) Relative humidity: 0-95%, non condensing
    b. Sample Requirements
        1) Maximum back pressure the chlorine sensor can manage without failure:
        2) 0.5 bar, no pressure impulses and/or vibrations
        3) Temperature: 0 to 45 °C (33 to 113 °F)
        4) Temperature compensation range: 5 to 45 °C (41 to 113 °F)
        5) Flow: 30-50 L/hr, 40 L/hr - optimal (7.9-13.2 g/hr, 10.6 g/hr - optimal)
    c. Storage Requirements

1) Electrolyte: 15 to 25°C (59 to 77°F)
2) Chlorine sensors: 0 to 50°C (32 to 122°F) dry without electrolyte
3) Panel: -20 to 60°C (-4 to 149°F)F.

4. Components:
   a. Stainless Steel Mounting Panel
   b. Chlorine Sensor with Membrane and Electrolyte
   c. Chlorine Sensor flow cell
   d. Flow meter with control valve
   e. Digital gateway to sc controller with cable
   f. User Manual
5. Controller: Hach SC200 or SC1000.
6. Signal Interface:
   a. Analog Output:
      1) 4 mA to 20 mA dc isolated output suitable for a load impedance up to 500 ohms.
      2) Minimum and maximum span values operator programmable.
   b. Discrete Outputs:
      1) Two alarm outputs.
      2) Each with SPDT contacts rated at 5 amp resistive at 230V ac.
   c. Process Connections:
      1) Sample Inlet: 1/4-inch OD tube, quick-disconnect fitting.
      2) Drain Connection: 1/2-inch flexible hose and hose barb.
      3) Air Purge: If noted.
      4) 1/4-inch OD tubing.
7. Power: 115/230V ac, 50 Hz, switch selectable.
8. Manufacturer and Product: Hach Company; Model CLT10sc with the Controller.

H. F9 Flow Element, Insert Type Venturi:

1. General:
   a. Function: Provide differential pressure signal proportional to the square of flowrate.
   b. Type:
      1) Differential pressure producers.
      2) Inserts into process pipe by means of a mating center flange.
      3) Includes inlet and recovery cones.
   c. Parts: Insert type venturi assembly, gaskets, static inlet tap kit (if noted).
2. Service:
   a. Process Fluid: Water, unless otherwise noted.
   b. Process Fluid Temperature: Minus 60 to 150 degrees F, unless otherwise noted.
   c. Pressure:
      1) Process Pressure: as noted.
      2) Insert tube rated from full vacuum to process piping pressure limit.
      3) Meets or exceeds flange rating of process pipe.

3. Performance:
    a. Process Flow Range: As noted.
    b. Pressure Differential at Full Scale Flow: Approximately as noted.
    c. Maximum Nonrecoverable Head Loss at Flow:
        1) Approximately as noted.
        2) Nominally not to exceed 10 percent of maximum pressure differential.
    d. Accuracy (Excluding Secondary Instrument Inaccuracy): Plus or minus 0.75 percent of actual reading, uncalibrated.
    e. Compliant with ASME fluid meter codes MFC-3M-1985, ISO 5167, BS-7045.
    f. Supporting Calculations: Using actual line size, provide comprehensive calculations, including (but not limited to):
    g. Pressure differential/flow calculations.
    h. Nonrecoverable head loss calculations.
    i. Reynolds number analysis.
    j. Flashing/cavitation analysis.
4. Features:
    a. Materials:
        1) Body: Fiberglass polyester reinforced resin.
        2) Throat: Type 304 stainless steel or integrally molded fiberglass, unless otherwise noted.
        3) Center Flange: Epoxy coated carbon steel or fiberglass polyester reinforced resin, unless otherwise noted.
        4) Nameplate: Permanent stainless steel engraved with tag number, pipe inside diameter, throat inside diameter, flange size, pressure rating, and flow direction.
        5) Available Beta Ratios (Nominal): 0.50, 0.60, and 0.70, plus custom beta ratios.
        6) Process Connections:
            a) Line Size: As noted.
            b) Connection Type:
            c) Center flange of venturi insert mates with process pipe flange.
            d) Center flange compatible with raised face, flat faced, ring joint or van stone flanges of any flange rating of either U.S. or foreign standards.
            e) Center Flange Rating: 125 to 150 psi, unless otherwise noted.
        7) Pressure Tap Connections:
            a) On center flange.
            b) 1/4-inch NPT.
        8) Nameplates to identify high and low taps.
        9) Static Inlet Tap Kit: If noted.
5. Manufacturers and Products:
    a. Primary Flow Signal; Model HVT-PI.
    b. BIF; UVT Model 20182.

Tag	Code	Dwg No.	Description	Component Options	Surge Suppressor Detail	Installation Detail
LIT-003		I-3	Water Storage Tank Level Transmitter, Direct Sensing, Flange Mounted	Range: 0 – 50 feet		
LE-003		I-3	Water Storage Tank Level Switches, Conductance	Range: Process Connection:		
FE/FIT-005		I-3	Pump Bypass Line Flow Element and Transmitter, Venturi	Size: 16” diameter Range: 0 – 10,000 gpm		
PIT-007		I-3	Pump Main Discharge Line Pressure Indicating Transmitter	Range: 0 – 150 psi	N/A	4091-304A 4091-401
AE/AIT-004		I-3	Pump Bypass Line Chlorine Residual Element and Transmitter	Range:0 – 5 mg/L Total Chlorine		
PIT-101		I-5	Pump 1 Suction Pressure Indicating Transmitter	Range: 0 – 50’ Water	N/A	4091-304A 4091-401
PIT-104		I-5	Pump 1 Discharge Pressure Indicating Transmitter	Range: 0 – 150 psi	N/A	4091-304A 4091-401
PSH-105		I-5	Pump 1 Discharge High Pressure Switch	Scale: Set Point: 120 psi	N/A	4091-304C 4091-401
FE/FIT-110		I-5	Pump 1 Discharge Flow Element and Transmitter, Venturi	Size: 6” diameter Range: 0 – 500 gpm		
TE/TIT 102		I-5	Pump 1 Pump Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 112		I-5	Pump 1 Motor Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 114		I-5	Pump 1 Motor Winding Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
VT 103		I-5	Pump 1 Pump Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		

Tag	Code	Dwg No.	Description	Component Options	Surge Suppressor Detail	Installation Detail
VT 113		I-5	Pump 1 Motor Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
PIT-201		I-5	Pump 2 Suction Pressure Indicating Transmitter	Range: 0 – 50' Water	N/A	4091-304A 4091-401
PIT-204		I-5	Pump 2 Discharge Pressure Indicating Transmitter	Range: 0 – 150 psi	N/A	4091-304A 4091-401
PSH-205		I-5	Pump 2 Discharge High Pressure Switch	Scale: Set Point: 120 psi	N/A	4091-304C 4091-401
FE/FIT-210		I-5	Pump 2 Discharge Flow Element and Transmitter, Venturi	Size: 8" diameter Range: 0 – 1300 gpm		
TE/TIT 202		I-5	Pump 2 Pump Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 212		I-5	Pump 2 Motor Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 214		I-5	Pump 2 Motor Winding Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
VT 203		I-5	Pump 2 Pump Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
VT 213		I-5	Pump 2 Motor Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
PIT-301		I-5	Pump 3 Suction Pressure Indicating Transmitter	Range: 0 – 50' Water	N/A	4091-304A 4091-401
PIT-304		I-5	Pump 3 Discharge Pressure Indicating Transmitter	Range: 0 – 150 psi	N/A	4091-304A 4091-401
PSH-305		I-5	Pump 3 Discharge High Pressure Switch	Scale: Set Point: 120 psi	N/A	4091-304C 4091-401
FE/FIT-310		I-5	Pump 3 Discharge Flow Element and Transmitter, Venturi	Size: 12" diameter Range:		

Tag	Code	Dwg No.	Description	Component Options	Surge Suppressor Detail	Installation Detail
TE/TIT 302		I-5	Pump 3 Pump Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 312		I-5	Pump 3 Motor Bearing Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
TE/TIT 314		I-5	Pump 3 Motor Winding Temperature Element and Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
VT 303		I-5	Pump 3 Pump Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
VT 313		I-5	Pump 3 Motor Vibration Transmitter	Range: Per Pump Manufacturer (See Section 11211)		
PIT-401		I-5	Pump 4 Suction Pressure Indicating Transmitter	Range: Future	N/A	
PIT-404		I-5	Pump 4 Discharge Pressure Indicating Transmitter	Range: Future	N/A	
PSH-405		I-5	Pump 4 Discharge High Pressure Switch	Range: Future	N/A	
FE/FIT-410		I-5	Pump 4 Discharge Flow Element and Transmitter, Venturi	Range: Future		
TE/TIT 402		I-5	Pump 4 Pump Bearing Temperature Element and Transmitter	Range: Future		
TE/TIT 412		I-5	Pump 4 Motor Bearing Temperature Element and Transmitter	Range: Future		
TE/TIT 414		I-5	Pump 4 Motor Winding Temperature Element and Transmitter	Range: Future		
VT 403		I-5	Pump 4 Pump Vibration Transmitter	Range: Future		
VT 413		I-5	Pump 4 Motor Vibration Transmitter	Range: Future		
AE-043		I-4	Chlorine Leak Detector	Set Point:		
TT-017		I-4	Electrical Room Temperature Element and Transmitter	Range:		

Tag	Code	Dwg No.	Description	Component Options	Surge Suppressor Detail	Installation Detail
TT-010		I-4	Pump Room Temperature Element and Transmitter	Range		
AE/AIT-018		I-3				

Dist Area	Site ID	Equip	Function	Unique I	Qualifier	IO Tag (WDCS)	Type
WR	MOPR	DSP001	FIT	110	HI	WR_MOPR_DSP001_FIT_110_HI	AI
WR	MOPR	DSP001	PIT	101	HI	WR_MOPR_DSP001_PIT_101_HI	AI
WR	MOPR	DSP001	PIT	104	HI	WR_MOPR_DSP001_PIT_104_HI	AI
WR	MOPR	DSP001	TIT	114	HI	WR_MOPR_DSP001_TIT_114_HI	AI
WR	MOPR	DSP001	TIT	112	HI	WR_MOPR_DSP001_TIT_112_HI	AI
WR	MOPR	DSP001	TIT	102	HI	WR_MOPR_DSP001_TIT_102_HI	AI
WR	MOPR	DSP001	VIT	103	HI	WR_MOPR_DSP001_VIT_103_HI	AI
WR	MOPR	DSP001	VIT	113	HI	WR_MOPR_DSP001_VIT_113_HI	AI
WR	MOPR	DSP002	FIT	210	HI	WR_MOPR_DSP002_FIT_210_HI	AI
WR	MOPR	DSP002	PIT	201	HI	WR_MOPR_DSP002_PIT_201_HI	AI
WR	MOPR	DSP002	PIT	204	HI	WR_MOPR_DSP002_PIT_204_HI	AI
WR	MOPR	DSP002	TIT	214	HI	WR_MOPR_DSP002_TIT_214_HI	AI
WR	MOPR	DSP002	TIT	212	HI	WR_MOPR_DSP002_TIT_212_HI	AI
WR	MOPR	DSP002	TIT	202	HI	WR_MOPR_DSP002_TIT_202_HI	AI
WR	MOPR	DSP002	VIT	203	HI	WR_MOPR_DSP002_VIT_203_HI	AI
WR	MOPR	DSP002	VIT	213	HI	WR_MOPR_DSP002_VIT_213_HI	AI
WR	MOPR	DSP003	FIT	110	HI	WR_MOPR_DSP003_FIT_110_HI	AI
WR	MOPR	DSP003	PIT	301	HI	WR_MOPR_DSP003_PIT_301_HI	AI
WR	MOPR	DSP003	PIT	304	HI	WR_MOPR_DSP003_PIT_304_HI	AI
WR	MOPR	DSP003	TIT	314	HI	WR_MOPR_DSP003_TIT_314_HI	AI
WR	MOPR	DSP003	TIT	312	HI	WR_MOPR_DSP003_TIT_312_HI	AI
WR	MOPR	DSP003	TIT	302	HI	WR_MOPR_DSP003_TIT_302_HI	AI
WR	MOPR	DSP003	VIT	303	HI	WR_MOPR_DSP003_VIT_303_HI	AI
WR	MOPR	DSP003	VIT	313	HI	WR_MOPR_DSP003_VIT_313_HI	AI
WR	MOPR	DSP004	FIT	410	HI	WR_MOPR_DSP004_FIT_410_HI	AI
WR	MOPR	DSP004	PIT	401	HI	WR_MOPR_DSP004_PIT_401_HI	AI
WR	MOPR	DSP004	PIT	404	HI	WR_MOPR_DSP004_PIT_404_HI	AI
WR	MOPR	DSP004	TIT	414	HI	WR_MOPR_DSP004_TIT_414_HI	AI
WR	MOPR	DSP004	TIT	412	HI	WR_MOPR_DSP004_TIT_412_HI	AI
WR	MOPR	DSP004	TIT	402	HI	WR_MOPR_DSP004_TIT_402_HI	AI
WR	MOPR	DSP004	VIT	403	HI	WR_MOPR_DSP004_VIT_403_HI	AI
WR	MOPR	DSP004	VIT	413	HI	WR_MOPR_DSP004_VIT_413_HI	AI
WR	MOPR	TNK001	LIT	003	HI	WR_MOPR_TNK001_LIT_003_HI	AI

WR	MOPR	AIT001	AIT	004	HI	WR_MOPR_AIT001_AIT_004_HI	AI
WR	MOPR	DSP001	FIT	005	HI	WR_MOPR_DSP001_FIT_005_HI	AI
WR	MOPR	DSP001	PIT	007	HI	WR_MOPR_DSP001_PIT_007_HI	AI
WR	MOPR	DSP001	TIT	010	HI	WR_MOPR_DSP001_TIT_010_HI	AI
WR	MOPR	DSP001	TIT	017	HI	WR_MOPR_DSP001_TIT_017_HI	AI
WR	MOPR	CLST01	ST	050	HO	WR_MOPR_CLST01_ST_050_HO	AO
WR	MOPR	AIT002	AIT	018	HI	WR_MOPR_AIT002_AIT_018_HI	AI
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	
WR	MOPR					WR_MOPR____	

Description	Card/Rack/Slot	Equip	P&ID	Range	Eng Units
Reuse Pump 1 Discharge Flow		PLC-PMP1	I-5	0-500	GPM
Reuse Pump 1 Suction Pressure		PLC-PMP1	I-5	0-50	FT H2O
Reuse Pump 1 Discharge Pressure		PLC-PMP1	I-5	0-150	PSI
Reuse Pump 1 Motor Winding Temperature		PLC-PMP1	I-5	Pump Manufacturer	
Reuse Pump 1 Motor Bearing Temperature		PLC-PMP1	I-5	Pump Manufacturer	
Reuse Pump 1 Pump Bearing Temperature		PLC-PMP1	I-5	Pump Manufacturer	
Reuse Pump 1 Pump Vibration		PLC-PMP1	I-5	Pump Manufacturer	
Reuse Pump 1 Motor Vibration		PLC-PMP1	I-5	Pump Manufacturer	
Reuse Pump 2 Discharge Flow		PLC-PMP2	I-5	0-1300	GPM
Reuse Pump 2 Suction Pressure		PLC-PMP2	I-5	0-50	FT H2O
Reuse Pump 2 Discharge Pressure		PLC-PMP2	I-5	0-150	PSI
Reuse Pump 2 Motor Winding Temperature		PLC-PMP2	I-5	Pump Manufacturer	
Reuse Pump 2 Motor Bearing Temperature		PLC-PMP2	I-5	Pump Manufacturer	
Reuse Pump 2 Pump Bearing Temperature		PLC-PMP2	I-5	Pump Manufacturer	
Reuse Pump 2 Pump Vibration		PLC-PMP2	I-5	Pump Manufacturer	
Reuse Pump 2 Motor Vibration		PLC-PMP2	I-5	Pump Manufacturer	
Reuse Pump 3 Discharge Flow		PLC-PMP3	I-5		
Reuse Pump 3 Suction Pressure		PLC-PMP3	I-5	0-50	FT H2O
Reuse Pump 3 Discharge Pressure		PLC-PMP3	I-5	0-150	PSI
Reuse Pump 3 Motor Winding Temperature		PLC-PMP3	I-5	Pump Manufacturer	
Reuse Pump 3 Motor Bearing Temperature		PLC-PMP3	I-5	Pump Manufacturer	
Reuse Pump 3 Pump Bearing Temperature		PLC-PMP3	I-5	Pump Manufacturer	
Reuse Pump 3 Pump Vibration		PLC-PMP3	I-5	Pump Manufacturer	
Reuse Pump 3 Motor Vibration		PLC-PMP3	I-5	Pump Manufacturer	
Reuse Pump 4 Discharge Flow	Future				
Reuse Pump 4 Suction Pressure	Future				
Reuse Pump 4 Discharge Pressure	Future				
Reuse Pump 4 Motor Winding Temperature	Future				
Reuse Pump 4 Motor Bearing Temperature	Future				
Reuse Pump 4 Pump Bearing Temperature	Future				
Reuse Pump 4 Pump Vibration	Future				
Reuse Pump 4 Motor Vibration	Future				
Reuse Tank 1 Level			I-3	0-50	FT

Reuse Tank 1 Chlorine Residual			I-3	0-10	mg/L
Reuse Bypass Pump Flow			I-3	0-10K	GPM
Reuse Pump Common Discharge Pressure			I-3	0-150	PSI
Reuse Pump Room Temperature			I-4	32-120	Deg F
Reuse Electrical Room Temperature			I-4	32-120	Deg F
Reuse Pump Station Chlorine Feed Control			I-3	0-100	%
Reuse Pump Station Turbidity			I-4		

SECTION 13410
INSTRUMENTATION AND CONTROL CABINETS AND ASSOCIATED EQUIPMENT

PART 1 GENERAL

1.01 SCOPE

A. This section covers the instrument and control cabinets shall be furnished, installed and put into satisfactory service which at minimum includes the following:

1. The Local Control Panel in the Pump Station Control Room.

B. The product/labor/material requirements of this section of the Specifications applies to all the various types of instrumentation and control cabinets/boxes described/shown in the Contract Documents.

1.02 RELATED REQUIREMENTS

A. The Contract Documents are complementary, what is called for by one is as binding as if called for by all.

B. It is the Contractor's responsibility for scheduling coordinating the Work of the subcontractors, suppliers, and other individuals or entities performing or furnishing any of the Contractor's work.

1.03 SUBMITTALS

A. Submit the following in accordance with the Section 01300 and 01730 of the Contract Specification and Specification Section 13400:

1. Shop drawings and product data. Include paint color selection chart for selection of paint color by Owner.
2. Operation and maintenance manuals.

1.04 TOOLS AND SPARE PARTS

A. Furnish the following spare parts in conformance with the specifications:

1. One set (minimum 3) of fuses for each type and size used.
2. One set (minimum 3) of Circuit Breaker Overcurrent Protection Devices for each type and size used.
3. Twenty (20) terminal blocks of each color and type used.
4. Four (4) control relay assemblies for each type used. Each assembly shall be fully assembled and furnished complete with:
   a. The relay coil,
   b. Four (4) Normally Open (N.O.) contacts, and

c. Four (4) Normally Closed (N.C.) contacts.
d. Relay Manufacturer's Transient Voltage Suppression Module.

5. One (1) Timing relay, complete with the relay socket base assembly for each type used.
6. 25 percent spare push-buttons, selector switches, indication light assemblies for each type used (minimum of 2 per type).
7. 50 percent of spare lenses and lamps for each type, color, and size used (minimum of 4 per type).

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION REQUIREMENTS FOR EXISTING INSTRUMENT AND CONTROL CABINETS/PANELS

A. The various instrument and control cabinets/panels shall be constructed to the approximate dimensions and instrument arrangement as shown on the Drawings. The Engineer will review alternate arrangements and recommendations.

B. Hinges and doors shall be capable of supporting the weight of new equipment to be mounted on the existing doors.

C. If not installed, furnish and install ground bars for each cabinet. Furnish and install for each ground bar: Required number of terminal for proper wiring in addition to 20 percent spare terminals for future connection.

D. Wire entering the cabinets shall enter through the floor, the side and/or the top of the cabinets via conduits with bushings or hubs. All wiring shall be terminated on terminals located on an interior panel prior to being connected to any instrument or switch. All wiring and terminals shall be clearly marked and wiring schematics furnished. All wiring shall be neatly bundled, laced together and routed as required throughout the cabinet.

E. Mounting channels and interior panels shall be provided in the cabinets for mounting proposed hardware, terminals, relays, etc.

F. Mark all proposed wiring (power, control, instrument, alarm, data, ground, shield, etc.) at each end of each wire. Use Flame-Retardant, Heavy-Duty Industrial Grade and Heat Shrinkable type wire tags approved for this use and as manufactured by "Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat-Shrinkable Marking Sleeves". All wire tags shall be YELLOW in color except the color used for branch-circuit lighting, convenience receptacle circuits, and 120 volts AC power circuits to instrument/devices shall be WHITE. Heat shrink all wire tags. All wire tags must be typed with an indelible marking process. Utilize "Raychem" Portable- Marking-System" complete with wire tag cartridges. Character size shall be a minimum of 1/8 inch in height. Handwritten tags will not be accepted. Maximum length of each wire tag shall be 2-inches long. Tag each wire in a

Multi-Conductor cable in addition to the overall cable itself. Wiring must be tagged the same as the terminal block terminal designation. Wiring of each equipment (such as Pump No. 1, Control Valve No. 1, etc.) within the facility must be tagged different from any other equipment, and easy to identify even without schematic DRAWINGS at hand. Power, Control and Instrumentation wiring/cable tagging shall be per the requirements and methodology/scheme outlined in specifications Section 16200 “Wiring (600 volt and Below) subsection 3.03 “Wire Tagging Methodology”.

G. Each piece of equipment shall have its individual control wiring terminal block/strip segregated and isolated from terminal block/strip of any other equipment. Example: Control wiring terminal block/strip for the Pump No. 1 shall be physically isolated and mechanically separated from terminal block/strip utilized for control wiring for Sludge Return Flow; i.e., one long and continuous terminal block/strip for both equipment and/or any other equipment (such as Pump No. 2, etc.) will not be accepted. Additionally, signal wiring to PLC cabinet/racks shall be terminated to terminal blocks/strips segregated and isolated from terminal blocks/strips of any other equipment. This requirement also applies to discrete and analog signal wiring to multiple remote instrument and control panels/cabinets. All field wiring shall be terminated at terminal blocks located on the back panel which is installed on the rear or side of the interior of the control cabinet enclosure. Field wiring termination at terminal blocks located on a movable surface, such as a hinged door, is not permissible.

H. Do not connect/terminate more than one (1) ground wire to a single terminal point on a ground bar/bus.

2.02 INSTRUMENT AND CONTROL WIRING

A. General Wiring: All control wiring shall be extra flexible 41-strand, #14 AWG, copper conductor, 600v insulation, SIS wire manufactured by Anaconda, Cyprus (Rome), General Electric, I.T.T., Okonite, or equal. Color coding shall be as follows:

FUNCTION	**COLOR CODE**
120Vac control/status signal wiring. This does not apply to control/status signal wiring that are scheduled for interface with Programmable Logic Controller (PLC) and Alarm wiring	Red
120Vac control wiring to relay coils (L1 & L2 terminals or H&N terminals) that are not generated from a PLC Discrete Output point (DO)	Gray
120Vac power supply wiring to instrumentation and control devices that are not generated from a PLC Discrete Output point (DO)	Gray

FUNCTION	COLOR CODE
Alarm wiring	Yellow
Wiring to instrument control cabinet interior lights / receptacle / exhaust-fans	Red = Hot (phase-A) Black = Hot (phase-B) Blue = Hot (phase-C) White = Neutral
Control/status signal wiring to Programmable Logic Controller (PLC) -Discrete Input Modules (as shown on the DRAWINGS)	Violet
Control/status signal wiring from Programmable Logic Controllers (PLC's) –Discrete Output Modules (DO's as shown on the DRAWINGS)	Pink
Ground Wires	Green
24Vdc instrument loop power wiring	Blue = Positive (+) Brown = Negative (-)

B. 4-20 Milliamp Signal wiring: Twisted pair, #16 AWG stranded copper conductors with PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum-mylar shield and an outer PVC jacket. Samuel Moore and Company, Dekoron Division, Cat. No. 1852 or equal. *Color* of the twisted pair shielded cable jacket shall be GRAY. The color of the positive (+) and negative (-) conductors within the each cable shall be BLACK and WHITE respectively.

C. Resistance Temperature Detector "RTD" Signal wiring: Twisted triad, #16 AWG stranded copper conductors with PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum-mylar shield and an outer PVC jacket. Samuel Moore and Company, Dekoron Division, Cat. No. 1862 or equal. Color of the twisted pair shielded cable jacket shall be BLACK. The color of the sense (+), negative (-), and common (-) (conductors within the each cable shall be BLACK, WHITE, and RED respectively

D. Modbus Digital Data Communication System Wiring: All Modbus Digital Data Communication System Wiring shall be twisted pair, #16 AWG stranded copper conductors with 600 volt PVC insulation over each conductor, a tinned copper drain wire, an overall aluminum myler shield and an outer PVC jacket. Instrument wiring cables shall be manufactured by "Samuel Moore and Company, DeKoron Division, Cat. No. 1852". Color of the twisted pair shielded cable jacket shall be ORANGE. The color of the *SEND* and receive conductors within the each cable shall be RED and BLACK respectively.

E. Ethernet Data Communication Cable and Fiber Optic Cable: Refer to Section 13430, Distributed Control System.

2.03 INSTRUMENT AND CONTROL CABINET EQUIPMENT

A. Cabinet 120V ac Wiring, Lighting and Receptacles Overcurrent Protection: Each cabinet uninterruptible power supply load distribution branch circuiting, lighting, convenience receptacle and 120V ac/20A incoming main control/instrument power circuit shall be individually protected with thermal magnetic circuit breaker, as shown on the Drawings. Circuit breakers shall be UL and CSA Listed, and shall be DIN-rail mounted, complete with visible trip indicator, as manufactured by Allen-Bradley Series 1492-GH. Size each circuit breaker to provide proper protection for instrument and/or control device served by the respective circuit breaker. Mount the DIN-rail mounted circuit breakers on a separate rail and independent of the rail used for mounting wiring terminal blocks. Tag each circuit breaker similar to the terminal blocks, as defined under Paragraph 2.05E of this section of the Specifications.

B. Instrument Control Cabinet General Interior Lighting Fixture: Furnish interior lighting fixture where shown on the Drawings. Each lighting fixture shall be fluorescent lighting fixture, suitable for 120-volts ac operation. Each fixture shall be 2-feet long utilizing two (2) 2-feet long rapid start and cool white fluorescent lamps. Each lighting fixture furnished shall also be furnished with an integral door activated switch wired to switch the light based upon the cabinet section door position.

C. Instrument and Control Devices - Overcurrent Protection: Each cabinet instrument and/or control device (controller, indicator, control device, power supply, PLC I/O, etc.) and process signal instrument loop power supply shall be individually protected as shown on the Drawings. Tag each circuit breaker/fused terminal block similar to the terminal blocks (as defined under Paragraph 2.05D of this section of the Specifications) AND by identifying the tag-name of the load/instrument loop/ etc. that the circuit breaker/fused terminal block is serving/protecting/isolating. Also, comply with the requirements of the Drawings.

1. 120-Volts ac Circuit Breakers: Circuit Breakers shall be UL and CSA Listed, and shall be DIN-rail mounted, complete with visible trip indicator. Circuit Breakers shall be as manufactured by Allen-Bradley Series 1492-SP, Phoenix Contact, or approved equal. Size each circuit breaker to provide proper protection for instrument and/or control device served by the respective circuit breaker. Mount the DIN-rail mounted circuit breakers on a separate rail and independent of the rail used for mounting wiring terminal blocks.
2. 24-Volts dc Circuit Breakers: Circuit Breakers shall be U.L. listed and shall be DIN-rail mounted, complete with visible trip indicator. Circuit Breakers shall be high-density type as manufacturer by Allen-Bradley Series 1492-GH, Phoenix Contact, or approved equal. Size each circuit breaker to provide proper protection for instrument and/or control device served by the respective circuit breaker. Mount the Din-rail mounted circuit breakers on a

separate rail and independent of the rail used for mounting wiring terminal blocks.

D. Instrument Control Cabinet convenience receptacle:

1. Receptacles shall be specification grade and shall have one-piece brass mounting strap with integral ground contacts as manufactured by Hubbell No. HBL53621, or equal by Bryant, Pass and Seymour, our approved equal. Receptacles shall be duplex, 3-wire, polarized grounding type, rating 20 amp, 125 volt, 60 Hertz. Refer to Drawings for quantity required and additional requirements. Install receptacle inside control panel in NEMA-1 enclosure.

E. Pushbuttons, Selector Switches and Pilot Lights:

1. Indicating lights shall be NEMA Style, full size 30-millimeter (30mm), Transformer Type Light Emitted Diode (LED), NEMA 4/13 oil tight and watertight, full size, push to test type, rated at 120V ac, with legend plate marked as shown on the Drawings. Lens color shall be as shown on the Drawings. Refer to Drawings control schematics and details for the exact color requirements. Pilot lights shall be as manufactured by Allen-Bradley Bulletin 800T NEMA Type 4/13, oil tight and water tight. Miniature size pilot lights will not be accepted.
2. Pushbuttons and Selector Switches shall be Heavy duty NEMA 4/13, oil tight/ water tight, NEMA Style full size 30-millimeter (30mm), pushbuttons and selector switches as required by the Drawings. The number of contact blocks shall be as required by the Drawings. The selector switches and pushbutton contacts shall be rated 10-amperes minimum at 120 volts ac. The selector switches shall be furnished with Black Knob Lever Operators. The color of the pushbutton operator shall be as shown on the Drawings, Black otherwise. Selector switches and pushbutton operators and contact blocks shall be Allen Bradley Bulletin 800T. Miniature size control devices will not be accepted.
3. Mushroom Head Push Buttons: NEMA style, heavy duty, NEMA 4/13 watertight/oiltight mushroom head pushbutton with the number of contact blocks required by the schematic diagrams. Mushroom head pushbutton contacts shall be rated 10 amps at 120V ac. The contact blocks shall be provided with finger-safe guards (guards on contacts). The mushroom head pushbuttons shall be the two-position “Push- Pull/twist release” type with RED mushroom head button. The mushroom head pushbuttons shall be as manufactured by Allen-Bradley Bulletin 800T. Miniature size stations will not be accepted.

F. Legend Plates for Control Stations/Cabinets:

1. Provide legend plates for each control station/cabinet, and each pilot device installed in a control station per details shown on the Drawings. Additionally, the legend plates shall be the Manufacturer's standard with lettering indicated on the Drawings. Legend plates shall be of the same manufacture as the respective pushbuttons, selector switches and pilot lights.

G. Control Relays:

1. Control relays shall be provided as required by the schematic diagrams. Refer to the Drawings. Mount control relays on the backpanels (device panels/subpanels) located inside the cabinets. As also shown on the wiring schematics shown in the Drawings, multiple types of control relays are required for this Project. Refer to the Drawings. The minimum requirements for the different types of relays are as described below:
   a. Relays with 120V ac rated coils: Relays shall be 600 volts ac Heavy-Duty industrial type with 120V ac coils. Minimum contact rating shall be 10A, continuous, at 120 volts ac. One additional normally open (N.O.) and one additional normally closed (N.C.) contact, over the number required by the schematic diagrams. Relays shall be furnished with visual mechanical latch-unlatch indicators. Additionally, coil of each relay shall be furnished with Relay Manufacturer’s Transient Voltage Suppression Module. Relays shall be **b**, or approved equal. So called "International" and IEC rated relays will not be accepted. All relays shall be standard NEMA size.
   b. Relays with 24V dc rated coils: The use of these relays has been specifically noted on the Drawings. Refer to the Drawings. Relays shall have 24V dc rated operating coil and 4 (four) pole double throw 120V ac, 5 ampere rated contacts. Relay shall be provided with the relay manufacturer’s standard din rail mounted relay socket with relay retaining clip. Relays shall be as manufactured by "Square D", catalog 8501-rsd14m1-v53, complete with relay socket catalog number 8501-rsd14-nr45 and relay retaining clip catalog number 8501-rsd14-nh3, or approved equal.

H. Timing Relays:

1. Time delay relays shall be the solid state type, with field selectable multi-time ranges and multi-function modes. Minimum relay contract rating shall be 10 amps, continuous, at 120V ac. Coils shall be 120V ac. Timing relays shall be Square D Class 9050 model No. JCK70 complete with Type NR61 din rail mountable Socket, or approved equal. One additional normally open spare contact and one additional normally closed spare contact shall be provided for each relay, in addition to those contacts shown on the schematic diagrams. Mount relays on the backpanels (device panels/subpanels) located inside the cabinets.

I. Elapsed Time Meters: Non-Resettable type, cyclometric types reading at least to 9999.9 hours and at least to nearest one-tenth of an hour. Eagle Signal/Danaher Controls series HK410.

J. Digital Indicator Instrument:

1. Indicator digital display shall have 7-segment, 0.56-inches high bright Light Emitted Diode (LED) display. Four digits and a floating decimal point, plus extra zero. The indicators shall be calibrated in engineering units (applicable to the specific system and measured variable) in order to indicate and control the process variable in the same units. The engineering units shall be permanently marked on the surface of the indicators/controllers/ transmitters.
2. Each indicator shall be of the indicator/controller/transmitter type.
3. Each indicator shall a receive 4-20mA signal (input signal) that is proportional to the process variable measured. Each indicator shall also provide 4-20mA output signal (retransmitted) that is proportional to the process variable measured (calibrated to the same range as the 4-20mA input signal). Additionally, the indicator shall be capable of driving the 4-20mA input signal loop without the need for an external 24V dc power source.
4. The indicator shall be designed so that all trip/reset set-points and display configurations can be easily accomplished by use of pushbuttons located on the face of the indicators.
5. The indicators shall have four (4) relay outputs for any combination of high or low setpoints. Each set-point shall have user selectable deadband of 0-to-100 percent (in the range of the 4-20mA input signal). Each output relay shall have single pole double throw (SPDT) form-C dry contacts rated 5-amp, inductive, at 120V ac).
6. The indicator output relays shall be set for fail-safe operation. The relay coils shall be energized in the non-alarm condition (reset condition). In the case of power failure, the output relays will change state and go to alarm state (set condition).
7. The readout and control accuracy of the indicators shall be ☐ 0.05 percent of calibrated span.
8. The indicators shall have splash-proof and corrosion resistant housing (NEMA-4X enclosure).
9. The input power to the indicators shall be 120V ac.
10. Indicators shall be manufactured by Precision Digital (microprocessor-based digital process meter/controller/ transmitter) Model PD690-3-18, or approved equal.

K. Single Input, Dual Output Instrument Loop Current Isolators (I/I Converters)

1. Furnish single input, dual output instrument loop isolators (I/I Converters) where required.
2. The loop current isolators shall be designed for one 4-20mA input and two 4-20 mA isolated output signals and equipped with a built-in load trimmer.
3. The loop current isolator shall be powered from an external 24 volts dc supply.
4. The output loop current accuracy shall be plus or minus 0.1 percent of full span. The loop isolator shall be equipped with RFI/EMI protection such that less than plus or minus 0.1 percent of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
5. The loop isolator shall be of the high-density type with DIN-style housing. The isolators shall be mounted on a rail (DIN-rail mounting) in the control panel where shown on the Drawings. Each loop isolator shall be tagged by loop number and loop process identifier.
6. The loop current isolators shall be as manufactured by MOORE Industries Model ECTDIN with TX option, or approved equal.

L. Single Input, Single Output Instrument Loop Current Isolators (I/I Converters):

1. Furnish single input, single output instrument loop isolators (I/I Converters) where required.
2. The loop current isolators shall be designed for one 4-20mA input and one 4-20 mA isolated output signals and equipped with a built-in load trimmer.
3. For proposed signal isolators, the loop current isolator shall be powered from an external 24 volts dc supply. Exception: If replacing an existing looped powered signal isolator, the loop current isolator shall be powered from the input signal loop current as shown on the Drawings.
4. The output loop current accuracy shall be plus or minus 0.1 percent of full span.
5. The loop isolator shall be equipped with RFI/EMI protection such that less than plus or minus 0.1 percent of span error is incurred when tested against a reference signal of 30 volts per meter over the frequency range of 20 to 1000 MHz, inclusive.
6. The loop isolator shall be of the high-density type with DIN-style housing. The isolators shall be mounted on a rail (DIN-rail mounting) in the control panel where shown on the Drawings. Each loop isolator shall be tagged by loop number and loop process identification, as also shown on the Drawings.
7. The loop current isolators shall be as manufactured by MOORE Industries Model ECTDIN with TX option, or approved equal.

M. Terminal Blocks and Routing/Termination of Wiring:

1. Terminate all incoming wiring on terminal blocks. As also shown on the Drawings, all incoming wiring shall terminate on terminal blocks located on the interior back/side panel of the control panel. Under no circumstances shall incoming wiring terminate on terminal blocks mounted on the door of the control panel.
2. Terminal blocks shall be 600V, 30A rating, nylon or polypropylene, snap together type with tubular contacts. Terminals to have slots for installing multi-character marking surface complete with multi-character marking surface. Terminal blocks shall be manufactured by Allen-Bradley catalog No. 1492-HM1 (50 terminals per foot), Phoenix Contact, or approved equal with 1492-SMN81 slots for detachable multi-character marking surface (holder) extending the full width and height of the terminals as well as detachable multi-character Snap-in Marker Card, AND manufacturer's insulated side jumpers, or approved equal.
3. Provide separate terminal blocks for power wiring, from control/discrete signal wiring, and from analog/instrument wiring. Tag each terminal. Each terminal shall have the same tag as the tag of the wire connected to the respective terminal. All tags must be typed and neatly attached to the marking surface (utilize adhesive tags). Also, identify each strip/string of terminal blocks with 3-ply phenolic "White-Black-White" identification nameplate. Utilize manufacturer's plated copper terminal-to-terminal insulated side jumpers for making connections between adjacent terminal blocks and/or between terminal blocks located on the same terminal strip. Use of wire as jumpers between terminal blocks will not be accepted. The color of each Terminal Blocks located in all cabinets shall be based on function and type of the wiring terminated to the block. The color coding of the terminal blocks located in all cabinets shall be as follows:

FUNCTION	**COLOR CODE**
TERMINAL BLOCKS for 120Vac control/status/alarm signal wiring. This applies to all control/status signal wiring and including 120Vac control/status signal interface wiring with Programmable Logic Controller (PLC) and Alarm wiring	RED
TERMINAL BLOCKS for 120Vac control wiring to relay coils (L1 & L2 terminals or H&N terminals) including those that are generated from a PLC Discrete Output point (DO)	RED
TERMINAL BLOCKS for 120Vac power supply wiring to instrumentation and control devices and communication instruments	BLACK
TERMINAL BLOCKS for wiring to instrument control cabinet interior lights/receptacle/ exhaust-fans	BLACK

FUNCTION	COLOR CODE
TERMINAL BLOCKS for Ground Wiring, including shield wiring terminal blocks within the 4-20mAdc signal wiring terminal strip	GREEN
Terminal Blocks for 24VDC power and 4-20mAdc process signal wiring POSITIVE (+) and NEGATIVE (-) terminals	WHITE
Terminal Blocks for Modbus and Modbus+ communication wiring	ORANGE

4. Route all wiring from an instrument through the terminal block to the other instrument rather than directly from one instrument to the other. This also applies to wiring between pushbutton selector switches, relays, relay contacts, and pilot lights. Also, refer to the Drawings.
5. Route power supply wiring or wiring common to more than one device or instrument individually from the terminal strips to each device. Do not loop wiring between devices.
6. Group all wiring where possible and neatly wrap with a clear polyethylene flexible spiral wrapping by Electrovert Spiraband, or approved equal. Wiring routed against back panel of the control panel may be installed in plastic wireways by Panduit, or approved equal. However, where wiring is routed on inside face of control panel access door and where not possible to route in plastic wireway installed on the back panel, waxed twine or spiral wrapping must be used.
7. Route wiring to equipment on doors (if applicable) so that the doors can be opened to the fullest extent of travel without stressing the wiring.
8. Terminate shield wire of each shielded cable to a terminal point (block) on the terminal strip (i.e., treat as current carrying conductor). Do not terminate more than one shield wire to a single terminal block (point). i.e., each shielded cable should have three termination points independent/isolated from termination points of neighboring cables. Extend #14 AWG insulated green ground wire from each shielded cable shield termination terminal point to the main ground bar of the cabinet (shield/drain wire ground).

9. Terminal point on a device, relay, instrument, etc. will not be considered the same as terminal located on a terminal block. Terminal blocks, terminal symbols, etc. shown on the Drawings are in reference to terminal blocks, terminals, etc. independent of any terminal strip and/or termination point furnished with/on the device, relay, instrument, etc. by the device, relay, instrument, etc. Manufacturer. Additionally, spare contacts of each device (i.e., control relays, timing relays, selector switches, indicating/controlling instruments/devices, etc.) must also be pre-wired (in same fashion) to terminal blocks, although they shall serve as spare points. Wiring and termination points of spare points of all equipment must be treated the same as any other active point and must follow the same format described under wiring/terminal block tagging scheme/strategy/method.

N. Multi-Outlet Power Strip: Furnish and install where shown on the Drawings.

1. Shelf Mounted: Provide white color unless specified otherwise. Multi-Outlet Power Strip shall have six 15 ampere, 120 volt NEMA 5-15R receptacles, UL Listed, main circuit breaker and integral on/off switch and indicator light and integral 4 foot power cord. Furnish and install as manufactured by Kensington Model 50688 or approved equal.
2. 19 inch rack mounted (for free-standing open racks): Provide Multi-Outlet Power Strip shall have eight 15 ampere 120 volt NEMA 5-15R receptacles, transformer spaced, UL Listed, main circuit breaker and integral on/off switch and indicator light and integral 10 foot power cord. Metal enclosure suitable for mounting on EIA standard 19 inch wide rack complete with rack mounting brackets and mounting hardware. Furnish and install as manufactured by Geist Manufacturing Model BRX080-10 or approved equal.
3. Free-Standing Computer Server Cabinet mounted: Provide Multi-Outlet Power Strip shall have a total twenty 20 ampere 120 volt NEMA 5-50R receptacles (arranged as 10 duplex receptacles), UL Listed, vertically oriented, 66 inches long, main circuit breaker and integral on/off switch, indicator lights, LED total power meter display having 2 percent accuracy that displays voltage, current, watts, and power factor, surge suppression, and integral 10 foot power cord. Metal enclosure suitable for mounting on EIA standard rack complete with rack mounting brackets and mounting hardware. Furnish and install as manufactured by Geist Manufacturing Model SVRBC204-10210 or approved equal.

2.04 PROGRAMMABLE LOGIC CONTROLLER'S "PLCS" AND ASSOCIATED EQUIPMENT

A. Refer to Specifications Section 13430, Distributed Control System (DCS) of this Division of the Specifications.

2.05 INSTRUMENT AND CONTROL DEVICES IDENTIFICATION

A. Instrument and Control Devices Identification:

1. General:
   a. The device designations shall agree with those shown on the Drawings.
   b. Each device shall be provided with permanent type identifying nameplate.
   c. Nameplates, unless otherwise specified, shall be constructed of 3-ply “White- Black-White” laminated phenolic material having engraved letters approximately 1/4 inch high (and/or of size shown on the Drawings) extending through the white face into the black layer.
2. Devices located on the face of, on the back, or inside of instrument control cabinets/panels:
   a. Devices which penetrate the door shall be provided with two nameplates, one located on face of the door and one located on the rear of the door.
   b. Nameplates located on the panels/cabinets face shall be secured with two Type 304 stainless steel screws.
3. Field mounted control and instrument devices: Securely hang nameplates from each instrument/control device by a flexible stainless steel snap-on type hanger/key-chain cord (neatly drill a hole through the top of the identification nameplate for this purpose).

B. Wire Tag:

1. Rating: Flame-Retardant.
2. Style: Heavy-Duty Industrial Grade.
3. Type: Heat Shrinkable type.
4. Character Height: 1/8 inch.
5. Maximum Length: 2 inches.
6. Text Type: Typed with indelible marking process. Handwritten shall not be accepted.
7. Color: Yellow. Exception: Use White for 120 volts ac power circuits to instrument/devices, and branch circuit lighting and convenience receptacle circuits.
8. Manufacturer: “Raychem type Heavy-Duty Industrial Grade ShrinkMark Heat- Shrinkable Marking Sleeves”, or approved equal. Utilize "Raychem" Portable-Marking- System” complete with wire tag cartridges, or approved equal.

PART 3 EXECUTION

3.01 SHIPMENT AND STORAGE

A. Cabinets shall be prepared for shipment in weatherproof and crush-proof containers.

B. Handling of cabinets shall be accomplished with extreme care, especially after removal from shipping containers.

C. Storage: Refer to Section 13400.

3.02 INSTALLATION

A. Cabinets shall be installed in the locations shown on the Drawings.

B. All wiring shall be connected as shown on Drawings and all systems shall be thoroughly checked out.

C. Install all equipment in accordance with the Drawings and instructions furnished by the manufacturer.

D. Inspect each new instrument, control component, etc., before installation. Replace deficient items.

3.03 INSTALLATION REPORT

A. After installation, the manufacturer's representatives shall inspect the installation and prepare a report or reports to include the following:

1. A list of all deficiencies found.
2. Recommend corrective action for all deficiencies.
3. Certification that the item or system is properly installed, except as noted.

3.04 FIELD CALIBRATION AND TESTING

A. Calibrate instruments and prepare calibration reports. All calibration shall be performed by factory-trained technical personnel. Calibration shall be witnessed by Owner's Personnel and Engineer.

B. The complete system shall be tested by an experienced factory-trained technical person. All system tests shall be witnessed by Owner's Personnel and Engineer.

C. Perform the following tests using simulated inputs:

1. Check the overall system and each subsystem to see that they function as specified based on simulated inputs at each sensor and at each set of field

contacts monitored. This check to include the testing of all automatic functions, sounding of alarms, shutdowns, etc.

2. Check the overall accuracy of each new and modified instrument loop to ensure that it is within acceptable tolerance.

D. If defects are found under simulated conditions, make corrections and retest.

E. After start-up, test the complete system under actual conditions to determine that all specified functions can be performed.

F. After completion of testing, submit a System Test Report. This report to include:

1. Certification that the system is operating correctly and within tolerances.
2. Listing of calculated tolerances for each new and modified instrument loop.

3.05 OPERATION TRAINING

A. Start-up Training: Provide required instruction to the Owner's personnel during start-up period.

3.06 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

SECTION 13430
DISTRIBUTED CONTROL SYSTEM (DCS)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required, and shall install complete, ready for operation, and test the distributed control system, hereinafter termed the System as shown on the Drawings and as specified.

B. The Instrument and Control System Contractor (ICS) shall provide equipment, materials, software, calibrations, training, and services that are required to successfully interface and interconnect the System and associated equipment that are specified or designated in the Drawings or provisions of these specifications for the purpose of providing a fully integrated and functional control systems as specified.

C. The ICS shall furnish and install cabling and cable accessories, including tools necessary for connecting the system and peripherals, PLCs, data highway, and input/output devices. The ICS shall furnish startup assistance, training, and system check-out services.

D. The ICS shall be responsible for furnishing and installing the Communication System for the Distributed Control System (DCS) as required and specified hereinafter.

1.02 DISTRIBUTED CONTROL SYSTEM DESCRIPTION

A. General:

1. The Distributed Control System (DCS) as shown on the Drawings and specified herein, includes, but is not limited to, the following:
   a. Programmable Logic Controller (PLC) Subsystem.
   b. Communication System Application and System Software,
   c. PLC networking/data communications over existing and proposed Ethernet TCP/IP network.
2. The Distributed Control System (DCS) as shown on the Drawings and specified herein, includes the Local Control Panel located in the Pump Station Building. The work shall include the furnishing and installation of a PLC subsystem. The DCS does not include, but shall interface with, the Owner’s existing Top-End computer system.
3. Refer to requirements of Section 13400, Process Instrumentation and Control Systems (PICS).

1.03 RELATED SPECIFICATIONS

A. Refer to Section 13400, Process Instrumentation and Control Systems (PICS).

B. This section covers work related to the Distributed Control System DCS and its Subsystems. Note that this Section does not stand alone. Many key technical definitions, functional requirements, training, submittals, etc. requirements for the DCS are given in Section 13400, Process Instrumentation and Control Systems (PICS) “Instrumentation and Control System General Requirements”.

1.04 DISTRIBUTED CONTROL SYSTEM (DCS) SUBMITTALS

A. General: Submit the following in accordance with the Section 01300, Submittals of the Specifications.

B. Hardware General:

1. Shop drawings, product data, bill of materials.
2. Control system architecture block diagram.
3. Wiring diagrams.
4. Spare Parts Listing.

C. Hardware PLCs: Provide the following for all elements of the PLCs:

1. Block Diagram: A diagram showing all major PLCs components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
2. Bill of Materials: A list of all PLCs components. Group components by type and include:
   a. Component manufacturer, model number, and part number.
   b. Component description.
   c. Quantity supplied.
   d. Reference to component catalog information.
3. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PLCs. Clearly mark all options and features proposed for this Project.
4. Interconnecting Wiring Diagrams: Diagrams shall show all PLCs elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. The I/O point numbers and terminations for circuits extending outside the PLCs shall be numbered/labeled the same as those shown on the Drawings.
5. Installation Details: Any modifications or further details as may be required to supplement the Contract Documents and adequately define the installation of the PLCs elements.

6. Input / Output List: As a minimum, provide for each I/O point type, tag number of the source or final control element, equipment description, PLC number, PLC terminal identification and PLC address.
7. List of spare parts and expendables provided.
8. List of additional spare parts recommended.

D. Fiber Optic Cable System Design: Submit fiber-optic cable types, installation procedure, and fiber flux budget/gain margin calculations.

E. Fiber Optic Cable Testing Submittal: Provide a complete set of fiber optic cable test results for the testing required under Specification Section 13315. Format and quantity of reports shall be per the requirements of Section 01300, Submittals of the Contract Specifications. Provide the Owner with typewritten results of all tests, including a description of the equipment tested, the date and time of day tested, test values, results. Test reports shall be signed by the ICS representative.

F. Pre-software Development Submittal: Provide a complete set of standard user's manuals for the PLCs. These manuals shall cover all aspects of programming, documenting, and using the PLCs equipment. In particular, the documents shall include information about the NOE Ethernet module.

G. Operations and Maintenance O&M Manuals:

1. Hardware: As minimum, provide the following:
   a. Final approved versions of all shop drawing submittals.
   b. Component Manufacturers' O&M Manuals including manuals to cover installation, operation, maintenance, troubleshooting, and calibration.
   c. List of spare parts and expendables provided and list of spare parts recommended.

1.05 SPARES, EXPENDABLES, AND TEST EQUIPMENT

A. Provide the following spares, expendables, and test equipment at minimum:

1. Provide the following SPARE equipment, complete with accessories:
   a. Provide one (1) spare PLC CPU Module (processor unit) module for each type used.
   b. Provide one (1) spare PLC power supply module for each type used.
   c. Provide 20 percent, minimum of one (1), spare of each type of PLC I/O module (AI, AO, DI, DO) for each type used.
   d. Provide one (1) spare PLC rack for each type used.
   e. Provide one (1) spare Ethernet Switch for each type used.

f. All spare parts shall be of the same manufacturer, model and software revision as the installed components, and shall be provided complete with ALL accessories.

1.06 REFERENCE STANDARDS

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

1.07 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

1.08 FINAL SYSTEM DOCUMENTATION

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

PART 2 PRODUCTS

2.01 GENERAL

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

B. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

C. Equipment shall be designed to operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

D. All components and interconnecting wiring shall be provided as required to satisfy the functional and operational requirements of this Specification.

E. All equipment to be installed in a control panel, or on a rack, including switches, etc., and the equipment shall be tagged according to the guidelines outlined in Section 13410, Instrumentation and Control Cabinets of these Specifications.

F. Communication Cables: Provide all cables for interconnection between all components of the DCS inside the and/or in duct/conduit banks, as applicable, and as shown on the Drawings. All equipment cabling, including fiber optic cables, copper Ethernet cable, all patch cords, etc. shall be tagged according to the guidelines and tagging labeling system outlined in Section 13400. For tagging of cables with manufacturer pre-connected cable ends, e.g. patch cords, power cords, etc. furnish and install SP self-laminating polyester labels (minimum 2 inches long along length of cable) with thermal transfer printable, low provide

translucent polyester film with a permanent acrylic adhesive as manufactured by Tyco, or approved equal, with respective printer and ribbon type by label manufacturer. Tag all S.O. type power cords with the tag of the equipment served.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. General:

1. The PLC shall be used for data acquisition and control. The operations described hereinafter are intended to identify minimum acceptable performance.
2. Provide all hardware and software features required to make the PLC totally operational.
3. The PLC shall include, but not be limited to, the equipment components called for on the Drawings and in these Specifications. Capacities and/or quantities shown are minimum. Provide additional capacity or units as necessary to meet the functional requirements.
4. A suggested Process Control System block diagram including Programmable Logic Controller location is shown on the Drawings.

B. Availability:

1. Subsystem Availability Calculation: The Subsystem availability (A) for the PLC is defined as average of the individual PLC availabilities (Ai) times the nonspecific availability (NA). That i, A = NA*(Al*A2*A3 ... *An)/n, where n is the number of PLC's.
2. Availability Requirements: The PLCs availability shall be at least 99 percent.
3. Component and Backup Definitions: For purposes of the availability calculations, each PLC, each PLC power supply, its process I/O, and data highway interface is considered to be an individual component. There are no backup components.

C. Communications:

1. General:
   a. Provide a high speed peer-to-peer communications system to link a Programmable Logic Controller (PLC) to the existing City SCADA system.
   b. Failure of any PLC or DCS component connected to the communications system network shall not affect the ability of the remaining components on the network to communicate with each other.
2. PLC Communications:

a. The communications system shall link the PLC and the central processing units (CPU) via a system of communication controllers, cables, and connectors as shown on the Drawings.
b. That portion of the communications system that links the PLCs and all network communications equipment is referred to as a “Data Highway,” DH herein.
c. Data Highway DH Link Requirements:
    1) Gigabit Ethernet (1000BaseFX), as minimum.
    2) Minimum operating distance: 10,000 feet.
    3) Rate: 10/100/1000 Mbps.
d. Fiber Optic Link Requirements:
    1) Minimum gain margin: 4dB: The Flux Budget/Gain margin is the difference between the system gain of the fiber-optic transmitter/receiver and the calculated loss budget of the fiber-optic link (fiber optic cable, connectors, patch cords, and splices) when both are expressed in decibels (dB)).
    2) Rate: 1 Gbps.
e. All copper Ethernet cables shall have a category 6A RJ-45 connector and category 6A cable. The connector end shall be the Boot type connector and preinstalled by the Ethernet patch cable manufacturer. The Ethernet cable outer jacket shall be the color Blue.
f. All communication cabling, including Ethernet, Remote I/O, etc., shall be tagged at both ends, similar to the wire tagging methodology described under Section 16205 of the Specification. The tagging for the communication cables shall be the Thermal Transfer, Industrial Rated, Self-laminating Type, as manufactured by Raychem (Tyco Electronics Identification). The tag length shall be a minimum of 2-inches. Provide the necessary thermal transfer printer for the printing of tags. Refer to Section 16205 for further detail regarding tagging.

D. Programmable Logic Controllers PLCs:

1. Each programmable logic controller shall consist of central processor, power supply, memory, input/output, interconnecting cables, and optional items as specified.
2. All IO signals shall be wired to field terminal blocks and the PLC components shall accommodate for 20% spare IO of each type.
3. Power Supply:
    a. Manufacturer: MODICON M580, No Equal.
4. Central Processor:
    a. Memory: 11 MB, at minimum
    b. Ports: 1 mini B Universal Serial Bus (USB) port, 1 Modbus communication port, 1 Modbus Plus communication port and 1 Ethernet Modbus TCP/IP port

c. Accessories: Provide a 8 MB FLASH Memory Card, as manufactured by the CPU manufacturer.
d. Manufacturer: Schneider Electric Model MODICON BMEP582020, No Equal.

5. Discrete Input Module DI:
   a. Manufacturer: MODICON Model number BMXDAI1604 No Equal
6. Discrete Output DO:
   a. Manufacturer: MODICON Model number BMXDAO0805 No Equal.
7. Analog Input Module AI
   a. Manufacturer: MODICON Model number BMXAMI0810 No Equal.
8. Analog Output Module AO:
   a. Manufacturer: MODICON Model number BMXAMO0410 No Equal.
9. Network Option Ethernet (NOE):
   a. Manufacturer: Modicon BMXNOC0402 Module, No Equal.
10. PLC Power Supply:
   a. Manufacturer: MODICON Model Number BMXCPS2000 No Equal.

E. Operator Interface Terminal (OIT):

1. Each OIT shall have the following features in the front panel, rear panel and pre-installed software.
2. Front panel screen:
   a. A 15-inch XGA active matrix color TFT LCD screen with a high-definition touchscreen panel.
   b. 2 USB type A Master Ports.
   c. A stainless steel 304 “Scotch brite” brushed finish front panel enabling an IP 65 degree of protection of the front panel when mounted on a panel or an enclosure door.
3. Rear panel:
   a. A battery.
   b. 2 pushbuttons: 1 for power supply and 1 for resetting.
   c. A slot for the Compact Flash memory card.
   d. A SD card reader for user data.
   e. 4 status and power supply LEDs.
4. Underside:
   a. A removable screw terminal block for connecting 24V power supply.
   b. 2 USB 2.0 ports.
   c. 2 RJ45 connectors for Ethernet link, 10/100 base-TX/1GB.
   d. One 9-way male SUB-D connector marked COM1 for RS 232 serial link.
5. Pre-installed software:
   a. Vijeo Designer Run-Time, unlimited use, supplied with activation code.
   b. Vijeo Citect Web Client dll.

c. Internet Explorer.
d. Acrobat Reader.
e. Word/Excel/PowerPoint viewer.
f. Framework.Net.

6. Model and Manufacturer: Magelis XBTGT7340 from Schneider Electric.

2.03 ETHERNET COPPER CABLES AND CONNECTORS GENERAL SPECIFICATIONS REQUIREMENTS

A. General:

1. Provide and install copper cables, connectors, and cords for the Distributed Control System DCS. The ICS shall schematically design the routing and specify component make and model. The components herein shall be provided as minimum for bidding purposes.
2. Ethernet Copper Connectors: All copper Ethernet cables shall have a Category 6A boot type RJ-45 connector.
3. The installed Ethernet copper media system (including cable, connectors, patch cords, etc.) shall at minimum meet the TIA/EIA-568-C.2-10 Category 6A standards.

B. Ethernet Copper Patch Cords:

1. The Ethernet Copper Patch Cord shall be used to connect devices directly to one another. At minimum, furnish and install copper patch cords for all Ethernet cabling between devices within the same cabinet. Refer to Drawings for required interconnections.
2. Each patch cord connector end shall be RJ-45 and shall be the Boot type connector. The connectors at each end shall be preinstalled by the Ethernet patch cord manufacturer.
3. The Patch Cord shall be unshielded twisted pair and shall be rated Category 6A.
4. The Ethernet copper cable outer jacket shall be Blue.

C. Copper Ethernet Cable System Testing: After installation of Copper Ethernet Cable System, ICS shall perform testing of the cable system to assure compliance of the installed system with the TIA/EIA-568-C.2-10 Category 6A requirements. Testing shall be performed for all installed copper cable systems, including used and unused links, from end-to-end, including all connectors, patch cords, etc.

D. Copper Ethernet Cable System Test reports shall be submitted to the Engineer and Owner for review and approval. The test report shall document, for each copper data link, description of the link and components therein, the testing method used, test results, and demonstrate compliance with TIA/EIA-568-C.2-10 of the link. If any installed link does not meet the TIA/EIA-568-C.2-10 Category 6A

requirements, ICS shall repair/modify link to assure it is compliant with TIA/EIA-568-C.2-10 Category 6A standard at no additional cost to the Owner.

2.04 LAPTOP PROGRAMMING COMPUTER

A. Mother Board:

1. A minimum of Intel Core i7-2640M Dual Core (2.80GHz, 4M cache, Upgradeable to Intel vPro technology).
2. 8.0GB, DDR3-1333MHz SDRAM, 2 DIMMS.
3. The PCMCIA adapter on the computer shall be 32 bit Cardbus and 16 bit compatible, accepting 2 full and 2 half Mini-Cards.

B. Hard Drive (HDD):

1. Minimum 256 GB solid state hard drive.
2. The hard drive shall be partitioned with the NTFS file system type.

C. Pointing Device and Keyboard:

1. Keyboard: Anti-microbial keyboard with number pad and backlight feature.
2. The laptop shall consist of integrated dual pointing device:
   a. Touchpad pointer AND track stick pointer.
   b. Multi-touch touchpad with three buttons.

D. Graphics Display: The integrated laptop display type shall be 15.6-inch UltraSharp FHD(1920x1080) Wide View Anti-Glare LED-backlit.

E. Peripheral Ports:

1. 1 – VGA.
2. 2 - USB 3.0.
3. 2 - USB 2.0.
4. 1 - RJ-45 (Ethernet).
5. 1 – DisplayPort.
6. 1 - IEEE 1394.
7. 1 - eSATA / USB 2.0.
8. 1 – Microphone.
9. 1 – HDMI.
10. 1 – Headphone.
11. 1 - 10-in-1 media card reader (SD, SD-XC, legacy - SD, SDIO, MMC, XD, MS, MS Pro, Mini-MMC, MMC+).
12. 1 - SmartCard reader.
13. 1 - 54mm ExpressCard slot.

F. Video:

1. NVIDIA Quadro 3000M with 2GB GDDR5.
2. The Computer shall have a special function key that enables the video card signal to be sent to the Laptop's LCD display, the VGA output port, or both.

G. Audio:

1. The laptop shall consist of a minimum of Stereo: 20-bit stereo-digital to analog and 18-bit stereo analog to digital 16 bit integrated audio card
2. The laptop shall be equipped with two (2) integrated stereo speakers
3. The laptop shall have the following accessible audio jacks
   a. Stereo output jack.
   b. Stereo Microphone input jack.

H. Optical Drive: The optical drive shall be a rewriteable DVD drive of the type 8X DVD+/-RW.

I. Communication:

1. The laptop shall at minimum have the following communication devices
   a. Wireless 375 Bluetooth 3.0module.
   b. Intel Centrino Ultimate-N 6300 3x3 wireless communication
      1) Laptop shall have Wireless switch to disable wireless LAN communication.
   c. Integrated 10/100/1000 BASE-TX Gigabit Ethernet communication with RJ-45 port interface.
2. All communication drivers for each communication device shall be installed on the laptop.

J. Battery:

1. The Laptop battery shall be user accessible and replaceable
2. The Battery type shall be a 9 cell Lithium Ion, 97Wh, inclusive of 1 year of battery service, plus 2 Years Extended Battery Service for Years 2 and 3 of System Life.
3. The laptop is to have a charging unit to fully charge the battery while providing full power to the laptop.
4. The charging means shall also be a means of providing power to the laptop in the event that the battery is fully discharged.

K. Software:

1. Each software installed on the laptop shall be legally licensed to the Owner.

2. Operating System: Microsoft Windows® 7 Professional, 32-bit, with service packs and media.
3. Drivers and Lap Top Maintenance Utilities:
   a. All drivers and lap top maintenance and diagnostic utilities including battery percent charged, estimate of laptop remaining operation time when powered only by the battery source, shall be Windows 7 Professional compatible.
   b. Drivers for the following shall be installed on Windows 7 professional system are:
      1) Ethernet card and the Modem.
      2) Audio card.
      3) Video card.
      4) Battery time of operation estimation and battery percent charged.
      5) Laptop suspend (sleep) mode.
4. Office Suite: Install Microsoft Office 2013 Professional Edition for Windows 7 Professional operating systems.
5. Provide the media (CD-ROM) and installation guide for all software, including the operating system and all media for complete system recovery to the Laptop system state as initially provided out of the package by the Laptop manufacturer.

L. USB Flash Drives: Provide two (2) 16 gigabyte USB 2.0 removable Flash Drive Units.

M. Carrying Case:

1. Provide Nylon Deluxe carrying case sufficiently large to house the lap top unit.
2. The case should have additional pouches/pockets for storage of cables, CD-R disks, etc.

N. The Laptop shall include a five (5) year manufacturer’s warranty covering parts and labor and next business day on site support as well as ProSupport and 3 Year CompleteCare Accidental Damage Protection

O. The Laptop shall be manufactured by Dell and shall be the most current version of the Dell model Latitude series laptops.

P. The Laptop Programming Computer shall be turned over to the City of Austin, Austin Water Utility by the programmer at the end of the Performance Acceptance Testing (PAT).

2.05 CONFIGURATION SYSTEM

A. Provide a configuration system, including hardware, system software, and other software necessary to allow Owner's representative configuration of and programming of the PLC system. PLCs equipment provided as part of the Configuration System shall be fully compatible with the DCS equipment provided for this system.

B. Ship and temporarily install the Configuration System at the Owner's representative's designated facility.

C. Include at least the following components for the Configuration System:

1. All proposed Programmable Logic Controllers (PLCs), including all racks, power supplies, microprocessor modules, I/O modules, communication modules, remote I/O modules, etc.
2. All proposed Communications interface hardware (including Ethernet switches), cabling, and fiber optics electronics for PLCs to programmer PC interface. Furnish one LC Duplex to LC-Duplex single mode fiber optic patch cord.
3. All necessary cabling to interconnect the equipment at the Owner's representative's site. The programming cabling between the PLC and the laptop shall, at minimum, consist of four (4) USB programming cables, each of 12 foot length minimum.
4. One (1) spare PLC configuration rack, where each spare configuration rack shall consist of the following:
   a. One (1) PLC CPU module, one (1) eight (8) slot PLC rack, one (1) PLC power supply, one (1) digital input (DI) module, one (1) digital output module, and one.
      1) Analog input module that shall be independent of the PLC equipment to be installed in the field and shall in no way impede the ICS progress of work in wiring to the PLC modules. These may be counted among the spare PLC equipment to be purchased.
5. Provide one (1) CPU memory cards of the type SRAM Memory Card; up to 2MB for Application Storage; and up to 1.8MB for Data Storage.
6. Provide all laptop programming computers
7. Provide 19-inch rack(s) and install PLC racks and other configuration equipment on 19-inch rack(s). For each 19-inch rack, secure rack to base with four (4) lockable, caster wheels that shall allow the cabinet to be pushed/carted forward, backward, and rotated at least 90 degrees. Overall rack assembly height shall not exceed 60 inches.
8. Prior to assembly and delivery of configuration system, submit to Owner's representative a drawing detailing the front and back elevations of proposed

arrangement of PLC equipment on 19-inch rack(s). Upon approval of submittal, contractor is to then configure rack according to approved submittal and ship configuration system to Owner's representative's location.

9. When directed by the Owner's representative, recreate and ship Configuration System from the Owner's representative's designated facility to Owner's facility.
10. Provide property and shipping insurance and include the Owner's representative and Owner as insured. Insure against fire and all-risk for physical loss and damage. The Owner and Owner's representative will not provide insurance for the Configuration System.

D. The Configuration System may contain equipment not required as part of the final installed system. Such additional equipment need not be supplied to the Owner as part of the final installed PLCs, but shall be made available for software development until final acceptance of the Distributed Control System DCS. The expendables itemized above as part of the development system are in addition to expendables listed elsewhere.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. The ICS shall furnish labor, materials, equipment, and incidentals required to install the system in accordance with specification section 13400, Process and Instrumentation Controls Systems (PICS) and 13410, Instrumentation and Control Cabinets.

B. The ICS shall be responsible for ensuring that field wiring for power and signal circuits is correct and wired in accordance with best industry practice. Also, the ICS shall be responsible for providing all necessary system grounding to insure a satisfactory functioning installation.

3.02 TESTS (GENERAL)

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

3.03 INITIAL ON-SITE DEMONSTRATION TESTS "ISDT"

A. Programmable Logic Controllers PLCs:

1. Test all loop-specific functions and demonstrate all I/O Points.
2. Test all non-loop-specific functions including, but not limited to, the following:

a. Failure Mode and Backup Procedures: Power failure, auto restart, retentive outputs.
b. Communication with existing PCs.

3. Refer to Section 13400 for additional test requirements.

3.04 OPERATIONAL READINESS TEST (ORT) AND PERFORMANCE ACCEPTANCE TESTS (PAT)

A. Refer to Section 13400, Process and Instrumentation Controls Systems (PICS).

3.05 MEASUREMENT AND PAYMENT

A. No separate measurement or payment for work performed under this section, except as indicated below. Include cost of same in Contract price Bid for Work of which this is a component part.

END OF SECTION

SECTION 14630
OVERHEAD CRANES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B30.2, Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).
   b. B30.10, Hooks.
   c. B30.11, Monorails and Underhung Cranes.
   d. B30.17, Overhead and Gantry Cranes (Top Running, Single Girder).
   e. HST 1M, Performance Standard for Electric Chain Hoists.
   f. HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
   g. HST 4M, Overhead Electric Wire Rope Hoists.
2. Crane Manufacturer's Association of America (CMAA):
   a. 70, Electric Overhead Traveling Cranes.
   b. 74, Top Running & Under Running Single Girder. Electric Overhead Traveling Cranes.
3. National Electrical Manufacturer's Association (NEMA):
   a. MG 1, Motors and Generators.
   b. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Occupational Safety and Health Act (OSHA).
6. Underwriters Laboratory (UL): 674, Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.02 DESIGN REQUIREMENTS

A. Top-Running Multiple-Girder Overhead Traveling Crane: CMAA No. 70 and ASME B30.2 and B30.17.

B. Top-Running and Underhung Single-Girder Overhead Traveling Cranes: CMAA No. 74, and ASME B30.11.

C. Crane Service Class: CMAA No. 74.

D. Trolley Service Class: CMAA No. 70.

E. Wire Rope Hoist Service Class: ASME HST 4M and CMAA No. 70 or No. 74.

F. Chain Hoist Service Class: ASME HST 1M and CMAA No. 70 or No. 74.

G. Hook: ASME 30.10.

H. Building Clearances: CMAA No. 70 and No. 74. Where bridge span exceeds 40 feet, increase clearance to 6 inches.

I. Stress and Safety Factors: CMAA No. 70 and No. 74. Properly select materials of construction for stresses to which subjected.

J. Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ASME B30.2.0 and OSHA requirements. Design equipment for environment operated.

K. Provide system, equipment, and components, including supports and anchorages, designed in accordance with Section 01740, Common Product Requirements.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, runway stops, footwalks and platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.
   c. Structural design calculations for runway beams and support system and calculations of deflection and loads on building steel stamped by a registered professional engineer.
   d. Detail Shop Drawings of crane runways, brackets, hangers, and their attachments to building structural steel.
   e. Power and control wiring diagrams, including terminals and numbers.
   f. Motor nameplate data in accordance with NEMA MG 1 and include any motor modifications.
   g. Factory finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions.
3. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
4. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Data.
7. Manufacturer's Certificate of Proper Installation, in accordance with Section 01670, Manufacturers' Field Services and Training.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Maximum 110 degrees F; minimum 25 degrees F.

B. Humidity: 100 percent.

C. Ventilation: Yes.

1.05 EXTRA MATERIALS

A. Furnish for each remote control crane:

1. One transmitter.
2. One battery.

PART 2 PRODUCTS

2.01 GENERAL

A. Crane manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, control panel, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.

B. Where adjustable speed drives or remote control systems are required, crane manufacturer to furnish a coordinated operating system.

2.02 SUPPLEMENTS

A. See supplements to this section for additional requirements.

2.03 RUNWAY

A. Furnish runway beams, brackets, and associated framework in accordance with Section 05120, Structural Steel.

B. Runway rails shall conform to cross-sections and weights per yard as specified in CMAA No. 70 or No. 74. Furnish rails, crane stops, and conductors by crane manufacturer.

C. Support underhung crane runway rails by a suspension system of hanger rods and joints which will permit runway rails to adjust to normal fluctuations of weight occurring as crane travels along rails. Design suspension system for minimal support rod bending stresses. Furnish slotted holes and shims for lateral and vertical rail adjustment. Brace one rail laterally to prevent excess motion of runway. Brace both rails longitudinally.

2.04 BRIDGE

A. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.

B. Construct bridge end trucks in accordance with CMAA No. 70 or No. 74. Furnish end trucks with rail sweeps and impact-absorbing bumpers.

C. Furnish runway stops attached to resist force applied when contacted and locate at limit of travel of bridge. Runway stops shall not engage the wheels.

D. Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA No. 70 or No. 74. Wheel axles of alloy steel, machined and ground to receive inner bearing races. Use rotating axles and wheels mounted by press fit and keys. For under-running cranes provide fixed axles with wheels accurately machined and ground to receive inner bearing races.

E. Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit.

F. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

G. Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.

H. Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA No. 70 or CMAA No. 74.

2.05 TROLLEY

A. Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.

B. Drive shall consist of trolley drive shaft, driven by an electric motor through a gear reduction unit.

C. Furnish roller assembly stabilizers on single-girder trolley units to prevent tipping during load pickup.

D. Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.

E. Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

F. Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

G. Brakes: Suitable for service class and rated torque capacities as specified in ASME B30.11. Furnish stops on trolley rails or beams.

H. For bridge spans greater than 40 feet provide trolley travel limit switches, located approximately 6 feet to 8 feet from each end of trolley rails/beams, or as required such that trolley travel speed is reduced to low speed prior to trolley engaging the trolley end-stops. Trolley drive speed past the limit switch locations shall be limited to low speed.

2.06 HOIST

A. Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position. Furnish reeving as specified on supplement located at end of section. Provide right and left-hand grooved drum when two-part double reeving is specified.

B. Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.

C. Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.

D. Brakes: Mechanical and electric load brake and controls, designed in accordance with ASME 4M, and adjustable to compensate for wear.

2.07 ELECTRICAL

A. Furnish electrical equipment including motors, motor starters, pendant control**,** control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by crane supplier.

B. Electrical: In accordance with NFPA 70, NEC Article 610.

C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120-volt ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.

1. Manufacturers and Products:
   a. P & H Smartorque, or approved equal.

D. Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

E. Enclosed Bus Bar Conductors: Galvanizedsteel strip enclosed in insulation. Collector sliding shoe type, with adjustable spring tension arms for contact between bus bar and controls.

F. Grounding: External in accordance with NFPA 70, NEC Article 250.

2.08 CONTROLS

A. Furnish electric cranes with pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

B. Controls: Fully magnetic, plain reversing type, housed in NEMA 250, Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.

C. Bridge and Trolley Drives: Soft start controls, 460/230-volt ac series device, installed in between drive motor and motor starter with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.

D. Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, with control transformers to supply 120-volt ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 6-foot intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.

2.09 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location. Mounted on separate components of each crane assembly, to facilitate assembly in the field.

B. Lifting Lugs: Equipment weighing over 100 pounds.

2.10 FACTORY FINISHING

A. Prepare and prime coat in accordance with Section 09900, Painting and Coating.

2.11 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Provide lubrication and lubrication fittings.

3.02 FIELD FINISHING

A. Equipment as specified in Section 09900, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each crane.

1. Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

B. Performance Test:

1. Conduct on each crane.
2. Load tests in compliance with OSHA, ASME B30.11, and ASME B30.16.

3.04 MANUFACTURER'S SERVICES

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

1. 3 person-days for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 1 person-day for facility startup.

B. See Section 01670, Manufacturers' Field Services and Training and Section 01650, Facility Startup/Commissioning.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this Specification.

1. Crane Data Sheet.
2. Crane Dimension Sheet: Building Clearances for Under-Running Cranes.
3. Induction Motor Data Sheet.

END OF SECTION

CRANE DATA SHEET

Project: Montopolis WRI Storage Reservoir and Pump Station

Owner: Austin Water

Service: Reclaimed Water Pump Station

Equip. Tag Number(s): _____

Manufacturer.: _____

Model No.: _____

Number of Units: One (1)

Rev/Date/By: _____/_____/_____

GENERAL REQUIREMENTS

Equipment Capacity: 5 tons

Method of Control: Pendant

Location of Control: Trolley

Equipment Location:

☒ Indoors ☐ Outdoors

Factory Testing:

☒ Required ☐ Not Required

Field Testing: ☐ Not required

☒ Required, functional and Performance

Power Supply: _____

Voltage 460

Phase 3

Frequency 60 Hz

BRIDGE

Type:

☒ Single Girder ☐ Double Girder

☐ Top Running ☐ Underhung

Service Class (ANSI):

☐ A (standby) ☒ B (light)

☐ C (moderate) ☐ D (heavy)

☐ E (severe) ☐ F (continuous)

Speed (fpm): _____ to _____

☐ Constant Speed

☒ Variable Speed ☐ Hand Operated

Motor hp: _____

Main Runway Electric Conductors:

☒ Bus Bar ☐ Festoon

Bridge Drive System (CMAA):

☐ A1 ☐ A2 ☐ A3

☒ A4 ☐ A5 ☐ A6

TROLLEY

Type:

☐ Top Running ☒ Underhung

Service Class (ANSI):

☐ A (standby) ☒ B (light)

☐ C (moderate) ☐ D (heavy)

☐ E (severe) ☐ F (continuous)

Speed (fpm): _____ to _____

☐ Constant Speed

☒ Variable Speed ☐ Hand Operated

Motor hp: _____

Electric Conductors:

☒ Bus Bar ☐ Festoon ☐ _____

☐ Cable Reel

HOIST

Type:

☒ Electric, Wire Rope

☐ Hand Operated, Chain

Service Class (ANSI):

☐ H1 (standby) ☒ H2 (light)

☐ H3 (standard ☐ H4 (heavy)

☐ H5 (severe)

Speed (fpm): _____ to _____

☐ Constant Speed ☐ Two Speed

☒ Variable Speed

Motor hp: _____

Hook: See Crane Dimension Sheet

Hook Manufacturer: _____

Reeving: _____

SPECIAL REQUIREMENTS

Accessories:

☐ Service Platform

☐ Central Lubrication System

☐ OSHA Operating and Safety Devices

Remote Controls:

☐ Infrared, line-of-sight

☐ Frequency Modulated (FM)

Manufacturer: _____

☐ Extended Grease Fittings

Special Electrical Requirements:

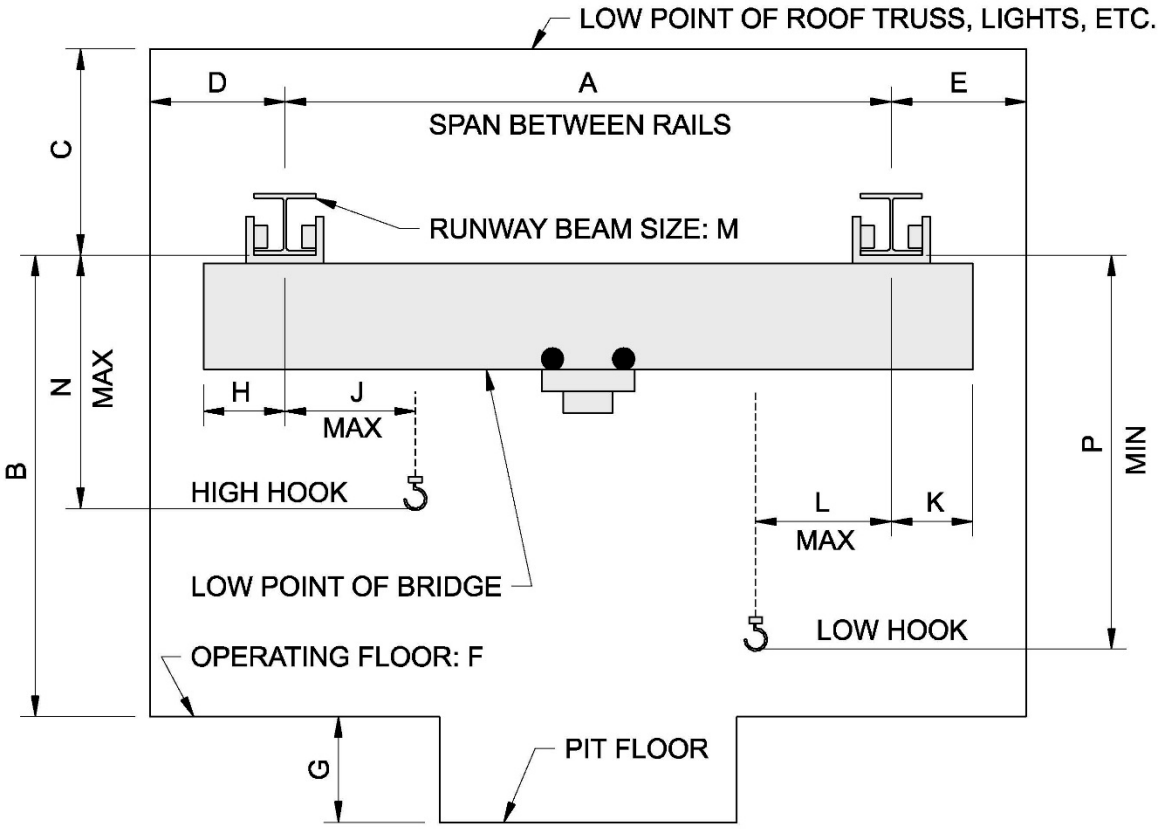
See Crane Dimension Sheet for clearances, lift distances, and details.

CRANE DIMENSION SHEET
Building Clearances for Under-Running Cranes

Project: Montopolis WRI Storage Reservoir and Pump Station

Owner: Austin Water

Equip. Tag No.: WR-MOPR-BRC001



A: _____ F: 0 (594 plan elevation) K: _____

B: _____ G: 7 (587 plan elevation) L: _____

C: _____ H: _____ M: See Drawings

D: _____ I: _____ N: _____

E: _____ J: _____

Notes: Need hook at 13 ft above operating floor to clear valves over pump headers.

1. Runway Length: _____

2. Bridge Wheelbase, Centered on Bridge, Maximum: _____

INDUCTION MOTOR DATA SHEET

Project: Montopolis WRI Storage Reservoir and Pump Station

Owner: Austin Water

Equipment Name: Montopolis Pump Station Building Overhead Bridge Crane

Equipment Tag Number(s): WR-MOPR-BRC001

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer.

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.

Motor Horsepower:_____

Voltage: 460

Phase: 3

Frequency: 60 Hz

Synchronous Speed:_____ rpm

☐ Thermal Protection: _____

☐ Space Heater: _____ volts, single-phase

Guaranteed Minimum Efficiency at Full Load: _____ percent

Guaranteed Minimum Power Factor at Full Load: _____ percent

Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☐ 1.15

Enclosure Type:_____

☐ Multispeed, Two-Speed: _____ / _____ rpm

Winding: ☐ One ☐ Two

Mounting Type: ☒ Horizontal ☐ Vertical

☐☐ Vertical Shaft: ☐ Solid ☒ Hollow

☐☐ Vertical Thrust Capacity (lb): Up _____ Down _____

☐ Adjustable Speed Drive: See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

Operating Speed Range: _____ to _____% of Rated Speed

☐ Variable Torque

☐ Constant Torque

Additional Motor Requirements: ☒ See Section 16220, Low-Voltage AC Induction Motors.

Special Features:

_____

_____

_____

SECTION 15052

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Sleeves.
4. Escutcheons.
5. Grout.
6. Plumbing demolition.
7. Equipment installation requirements common to equipment sections.
8. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

1.3 QUALITY ASSURANCE

A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

C. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

D. Welding Filler Metals: Comply with AWS D10.12.

E. Solvent Cements for Joining Plastic Piping:
   1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, or plain end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. PVC Pipe: ASTM D 1785, Schedule 40.

2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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 above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Plastic 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 Nonpressure Piping: Join according to ASTM D 2855.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15052

SECTION 15053

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Grout.
7. HVAC demolition.
8. Equipment installation requirements common to equipment sections.
9. Supports and anchorages.

B. See Division 16 for electrical requirements.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, closets, and chases.

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. All electrical and conduit should follow 16000 standard specifications.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 250 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 15 piping Sections for special joining materials not listed below.

B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. PVC Pipe: ASTM D 1785, Schedule 40.

2.5 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC RELOCATION

A. Contractor shall be responsible for maintaining existing integrity of equipment during temporary relocation.

B. Provide and install temporary requirements as noted on plans for use during temporary relocation.

C. Reroute and reconnect piping, ductwork, and electrical disconnect and power as necessary to properly operate temporary relocated equipment.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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 above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

P. Verify final equipment locations for roughing-in.

Q. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 15053

SECTION 15060
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number. For piping 4 inches and smaller provide catalog information.
2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

1.04 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
3. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
   b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

A. Clevis: MSS SP 58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:

1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports: MSS SP 58, Type 44:

1. Anvil; Figure 175, sizes 2 inches through 30 inches.
2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000-pound rating.
2. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” hanger MSS SP 58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.

4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP , Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. B-Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:

1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

A. Type: Spider.

B. Manufacturers and Products:

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS

A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.

B. Manufacturers:

1. Mason Industries.
2. B-Line.
3. Anvil.

2.13 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: Sized by Contractor for required loads, and as specified in Section 05500, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers:

1. Plastic coated hangers, isolation cushion, or tape.
2. Manufacturer and Products:
   a. B-Line; B1999 Vibra Cushion.

b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
   a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
   b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
   a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
   b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05500, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:
      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.
   b. Floor Mounted Channel Supports:
      1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
      2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
      3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:
   a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
   b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
   c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
   a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
   b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
      1) These lines include air operated diagram pumps and other lines, if any, as identified below:
         a) None.
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
   a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
   b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
      1) These lines include air operated diagram pumps and other lines, if any, as identified below:
         a) None.
3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or

concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09900, Painting and Coating.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Table 1: Nonchemical Areas.
2. Table 2: Chemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	**Support Material**
Office Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Shops and Warehouse Areas	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Pipe Galleries	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper or stainless steel piping
Headworks	Stainless steel or FRP
Process Areas: High Humidity or Hydrogen sulfide	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP
Pipes conveying chemicals listed in Table 2	Provide with corresponding support per Table 2.

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2 Chemical Areas		
Exposure Conditions	**Support for Direct Exposure**	**Support for Remote Exposure**
Alum	FRP	Precoated steel
Aqua Ammonia	Stainless steel	Precoated steel
Coagulants	FRP	Precoated steel or galvanized steel
Ferric Chloride	FRP	Precoated steel
Ferric Sulfate	FRP	Precoated steel
Hydrofluorosilic Acid	FRP	Precoated steel
Lime	Stainless steel, FRP, precoated steel	Stainless steel, FRP, precoated steel
Methanol	Galvanized steel	Galvanized steel
Polymers	FRP	Precoated steel
Potassium Permanganate	Precoated steel	Precoated steel
Powdered Activated Carbon	Precoated steel	Precoated steel
Sodium Carbonate	Stainless steel	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite or Calcium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

SECTION 15061

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing 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 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, 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 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

G. Install hangers and supports to allow controlled thermal and seismic 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.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. 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.

K. 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. 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. 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.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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.

3.3 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.

3.4 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use thermal-hanger shield inserts for insulated piping and tubing.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

H. 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.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

J. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

K. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 15061

SECTION 15062

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC 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 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.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, 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 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

G. Install hangers and supports to allow controlled thermal and seismic 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.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. 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.

L. 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. Option: Thermal-hanger shield inserts may be used.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used.

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.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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.

3.3 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.

3.4 PAINTING

A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use thermal-hanger shield inserts for insulated piping and tubing.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

H. 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.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

J. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

K. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 15062

SECTION 15077

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

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: Black.
3. Background Color: White.
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-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. 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), plus the Specification Section number and title where equipment is specified.

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 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

END OF SECTION 15077

SECTION 15080

PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
   d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   g. C552, Standard Specification for Cellular Glass Thermal Insulation.
   h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.1 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.1 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:
1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:
1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:
1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.

6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.2 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1 inch thick.

2.3 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 15060, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.4 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
   a. Knauf Insulation; Proto 1000.
   b. Johns Manville; Zeston 2000 or 300.
   c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:
1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   a. Manufacturer and Product: Armacell; WB Armaflex finish.
2. Type 2 Insulation: In accordance with Section 09900, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
   a. RPR Products; Insul-Mate.
   b. ITW, Pabco-Childers.

D. Type F4—Foamglass Jacketing:
1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.

2. Type 3 Insulation—Greater that 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.1 APPLICATION

A. General:
1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in drawings.

3.2 INSTALLATION

A. General:
1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:
1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

H. Vapor Barrier:
1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

I. Aluminum Jacket:
1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.3 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):
1. Aluminum or color coded PVC jacketing does not require painting.

2. If insulated piping system is indicated to be painted in Section 510S Pipe, piping shall receive the following:
   a. Prime coat in accordance with Section 09900, Painting and Coating.
   b. Finished insulation (and not pipe) shall be painted in accordance with Section 09900, Painting and Coating.

3.4 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this specification:
   1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees F)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
Sodium Hypochlorite (SHC)	SHC	1 inch	50 to 100	Type 1	None	NA		NA
HT–Piping requiring heat tracing.		Pipe Size: Insulation Thickness Inches: 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5		Type 2 Insulate and heat trace outside lines	None		F3	NA
Potable Water Pipes Less than 3 inches in diameter	W1	1 inch	50 to 100	Type 1	None	NA	F3	NA
Reclaimed Water Pipes Less than 3 inches in diameter	RW	1 inch	50 to 100	Type 1	None	NA	F3	NA

SECTION 15082

PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.

2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Sealants.
6. Factory-applied jackets.
7. Tapes.
8. Securements.
9. Corner angles.

B. Related Sections include the following:

1. Division 25 Section "HVAC Insulation."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

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 Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA Inc.; Aeroseal.

b. Armacell LCC; 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 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: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.4 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
b. Compac Corp.; 120.
c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.5 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Wet Insulation: Any insulation that is found to be wet shall be removed from the project immediately and replaced with equal, as specified, submitted and approved. Wet insulation shall be removed and replaced any time through the end of the warranty period.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. 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.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. 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 as recommended by insulation material manufacturer 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.

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.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.

5. Handholes.
6. Cleanouts.

3.3 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.

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems."

3.4 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, and Unions:

1. Install insulation over fittings, valves, strainers, 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 valves 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 two 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. 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, 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.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 MINERAL-FIBER INSULATION INSTALLATION

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 but 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 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 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 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

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.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold, Hot, Water: Insulation shall be one of the following:
   1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.10 ABOVEGROUND PIPING INSULATION SCHEDULE

B. Refrigerant Piping: Insulation shall be the following:
   1. Flexible Elastomeric: One inch thick.

END OF SECTION 15082

SECTION 15083

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Mineral fiber.
2. Adhesives.
3. Mastics.
4. Sealants.
5. Factory-applied jackets.
6. Tapes.

B. Related Sections:
1. Division 250 Section "Plumbing Insulation."

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Owens Corning; All-Service Duct Wrap.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; Commercial Board.
b. Johns Manville; 800 Series Spin-Glas.
c. Knauf Insulation; Insulation Board.
d. Owens Corning; Fiberglas 700 Series.

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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.
b. Foster Products Corporation, H. B. Fuller Company; 85-20.
c. ITW TACC, Division of Illinois Tool Works; S-90/80.
d. Marathon Industries, Inc.; 225.
e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Wet Insulation: Any insulation that is found to be wet shall be removed from the project immediately and replaced with equal, as specified, submitted and approved. Wet insulation shall be removed and replaced any time through the end of the warranty period.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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. 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 as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 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 similar to butt joints.

P. For above ambient services, do not install insulation to the following:
1. Testing agency labels and stamps.
2. Nameplates and data plates.
3. Cleanouts.

3.3 PENETRATIONS

Q. 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.

R. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

S. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

3.4 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. In first subparagraph below, many manufacturers do not recommend 100 percent coverage of adhesive because of the effect on the overall insulation system's fire-performance characteristics. Verify application coverage recommendations with insulation manufacturer.

C. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

D. Revise first subparagraph below to allow adhesive to be omitted from top surface of horizontal rectangular ducts.

E. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

F. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

G. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

H. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

I. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   1. Do not overcompress insulation during installation.
   2. Impale insulation over pins and attach speed washers.

3. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

J. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

K. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

L. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

M. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

N. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

O. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

P. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. In first subparagraph below, many manufacturers do not recommend 100 percent coverage of adhesive because of the effect on the overall insulation system's fire-performance characteristics. Verify application coverage recommendations with insulation manufacturer.

2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

3. Revise first subparagraph below to allow adhesive to be omitted from top surface of horizontal rectangular ducts.

4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

Q. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

1. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
2. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

3. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

DUCT INSULATION SCHEDULE, GENERAL

B. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

END OF SECTION 15083

SECTION 15140

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Flexible connectors.
4. Escutcheons.
5. Sleeves and sleeve seals.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. 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 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

B. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 SPECIALTY VALVES

A. Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 15 Section "Domestic Water Piping Specialties" for drain valves, and vacuum breakers.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Couplings:

1. Description:

a. Galvanized-steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

D. Dielectric Nipples:

1. Description:

a. Electroplated steel nipple complying with ASTM F 1545.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Male threaded or grooved.
d. Lining: Inert and noncorrosive, propylene.

2.6 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

2.7 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Stamped Steel: Chrome-plated finish with setscrew or spring clips.

C. Split Plate, Stamped Steel: Chrome-plated finish with concealed hinge, setscrew or spring clips.

2.8 SLEEVES

A. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

2.9 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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 domestic water piping level without pitch and plumb.

C. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

E. 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.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

G. Install piping adjacent to equipment and specialties to allow service and maintenance.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

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.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 15 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smallerInstall drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 15 Section "Domestic Water Piping Specialties."

C. Install transition couplings at joints of dissimilar piping.

D. Transition Fittings in Aboveground Domestic Water PipingNPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples [**unions**].

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

3. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 15 plumbing fixture Sections for connection sizes.

3.7 ESCUTCHEON INSTALLATION

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

B. Escutcheons for New Piping:

   1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, stamped steel with set screw.
   3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, stamped steel with set screw.
   4. Bare Piping in Unfinished Service Spaces: One piece, stamped steel with set screw or spring clips.

3.8 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

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

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 7 Section "Joint Sealants" for joint sealants.

H. Seal space outside of sleeves in concrete slabs and walls with grout.

I. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

J. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Gypsum-Board Partitions:

a. PVC pipe sleeves for pipes smaller than NPS 6.
b. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestop materials and installations.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. 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:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. 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.
3. 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.
4. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
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 for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. 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. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 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 domestic water piping, NPS 2 and smaller, shall be the following:
1. Hard copper tube, ASTM B 88, Type L ASTM B 88, Type M; cast- or wrought-copper solder-joint fittings; and soldered joints.

3.12 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 or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Drain Duty: Hose-end drain valves.

END OF SECTION 15140

SECTION 15145

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Hose bibbs.
   2. Water hammer arresters.
   3. Trap-seal primer valves.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:
   1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 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 or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.2 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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

   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   g. Tyler Pipe; Wade Div.
   h. Watts Drainage Products Inc.
   i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.3 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install water hammer arresters in water piping according to PDI-WH 201.

C. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Provide access panels for trap-seal primer valves concealed in walls. Provide trap-seal primer valves for every floor drain and hub drain.

D. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties.

E. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.2 FIELD QUALITY CONTROL

A. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION 15145

SECTION 15150

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following soil and waste, sanitary drainage and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

1.2 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.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. 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-drain" for plastic drain piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Hub-and-Spigot, Cast-Iron Pipe and Fittings: ASTM A 74, Service class.

1. Gaskets: ASTM C 564, rubber.

B. Hubless Cast-Iron Pipe and Fittings: ASTM A 888 or CISPI 301.
1. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

a. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.

C. Solid-Wall PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.

1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
2. Solvent Cement and Adhesive Primer:

a. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Special pipe fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
2. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, hub-and-spigot, cast-iron soil pipe and fittings; gaskets; and compression joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3.2 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 15 Section "Basic Mechanical Materials and Methods."

D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. 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. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 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 Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

I. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

J. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

   1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
   2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:

   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:

      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

B. Install supports according to Division 15 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.

2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.

H. Install supports for vertical PVC piping every 48 inches.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

B. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Specialties."
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Specialties."

3.6 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 drainage and vent piping according to procedures of authorities having jurisdiction.

1. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
2. Prepare reports for tests and required corrective action.

3.7 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains 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.

3.8 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 15150

SECTION 15155

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Miscellaneous sanitary drainage piping specialties.
   5. Flashing materials.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      a. Josam Company; Josam Div.
      b. MIFAB, Inc.
      c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
      f. Zurn Plumbing Products Group; Specification Drainage Operation.

   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.

3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. Oatey.
   c. Sioux Chief Manufacturing Company, Inc.
   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.

4. Body: as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Commercial Enameling Co.
    b. Josam Company; Josam Div.
    c. MIFAB, Inc.
    d. Prier Products, Inc.
    e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    f. Tyler Pipe; Wade Div.
    g. Watts Drainage Products Inc.
    h. Zurn Plumbing Products Group; Light Commercial Operation.
    i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
3. Pattern: Area drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Not required.
11. Sediment Bucket: Not required.
12. Top or Strainer Material: Bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Round.
15. Top Loading Classification: Medium Duty.
16. Funnel: Not required.
17. Trap Material: Cast iron.
18. Trap Pattern: Standard P-trap.
19. Trap Features: Trap-seal primer valve drain connection.

2.3 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 15 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

G. Install deep-seal traps on floor drains, hub drains, and other waste outlets, if indicated.

H. Install floor-drain, trap-seal primer fittings on inlet to floor drains and hub drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

J. Install vent caps on each vent pipe passing through roof.

K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 7 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 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 15155

SECTION 15205
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Metal Bellows Field Finishing:
   a. Manufacturer’s recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.
   b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.

c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09900, Painting and Coating.

3. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

B. Informational Submittals:

1. Coupling Harness:
   a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
   b. Weld procedure qualifications.
   c. Load proof-testing report of prototype restraint for any size coupling.
2. Basket Strainer:
   a. Manufacturer's written/printed installation instructions.
   b. Manufacturer's Certificate of Proper Installation, in accordance with Section 01670, Manufacturers' Field Services and Training.

C. Operation and Maintenance Data as specified in Section 01730, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

A. Teflon Bellows Connector:

1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 214.
   b. Resistoflex; No. R6904.
   c. Unisource Manufacturing, Inc.; Style 112.
   d. Proco Products, Inc.; Series 442.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Goodall Rubber Co.; Specification E-1462.
   b. Garlock; Style 204.
   c. Unisource Manufacturing, Inc.; Style 1501.
   d. Proco Products, Inc.; Series 220.

C. Metal Bellows Connector:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ANSI 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied Expansion Joint.
   b. Metraflex; Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.

2. Material: Bronze.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.
6. Manufacturers:
   a. U.S. Hose Corp.; Series 300.
   b. Anamet Industrial, Inc.
   c. Unisource Manufacturing, Inc.
   d. Proco Products, Inc.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 38.
      2) Smith-Blair, Inc.; Style 411.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 253.
      2) Smith-Blair, Inc.; Style 441.

C. Transition Coupling for Steel Pipe:

1. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 62.
   b. Smith-Blair, Inc.; Style 413.

D. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.
2. Manufacturers and Products:
   a. Steel Pipe:

1) Dresser Piping Specialties; Style 128.
2) Smith-Blair, Inc.; Style 913.

b. Ductile Iron Pipe:
1) Dresser Piping Specialties; Style 128.
2) Smith-Blair, Inc.; Style 912.

E. Restrained Flange Adapter:

1. Pressure Rating:
a. Minimum Working Pressure Rating: Not less than 150 psi.
b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.
2. Thrust Restraint:
a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

F. Restrained Dismantling Joints:

1. Pressure Rating:
a. Minimum working pressure rating shall not be less than rating of the connecting flange.
b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
a. Dresser Piping Specialties; Style 131.
b. Smith Blair, Inc.; Model 975.

G. Exposed Metallic Piping Plain End Couplings:

1. Plain end pipe couplings shall be self-restrained against hydrostatic thrust forces equal to not less than two times the working pressure rating of the coupling. Couplings shall accommodate 4 degrees angular deflection at the time of installation and subsequent to pressurization.
2. Casing, bolts, and nuts shall be Type 304 or Type 316 stainless steel. The sealing sleeve shall be EPDM or NBR elastomer as best suited for the fluid service.
3. Couplings manufacturer and products shall be Straub Couplings, Grip-L or Metal Grip, or equal.

2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.

2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: **250**degrees F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: 3/4 inch, minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	**Deflection (inch)**	**Pressure (psig)**
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.

B. Teflon Bellows:

1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 215.
   b. Resistoflex; No. R6905.
   c. Unisource Manufacturing, Inc.; Style 113.
   d. Proco Products, Inc.; Series 443.

C. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
3. End Connections: ASME 150-pound carbon steel flanges.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.

5. Length: Minimum of eight convolutions and minimum axial compression of 3/4 inches.
6. Manufacturers and Products:
   a. U.S. Bellows, Inc.; Universal Tied expansion joint.
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Copper Pipe Expansion Compensator:

1. Material: Stainless steel bellows with female copper solder joint ends.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model HB.
   b. Hyspan; Model 8510.
   c. Unisource Manufacturing, Inc.; Style EC-FFS.

E. Galvanized and Black Steel Pipe Expansion Compensator:

1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 175 psig, minimum.
3. Accessories: Anti-torque device to protect bellows.
4. Manufacturers and Products:
   a. Senior Flexonics; Model H.
   b. Hyspan; Model 8503.
   c. Unisource Manufacturing, Inc.; Style EC-MMT.

F. Flexible Metal Hose:

1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3 Inches and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2 Inches and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70 degrees F for 12 inches and smaller.
5. Length: Provide hose live-length equal to lengths shown on Drawings.
6. Manufacturer:
   a. U.S. Hose Corp.; Series 401M.
   b. Anamet Industrial, Inc.; BWC21-1.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:

1. Ball and socket type for earth settlement compensation.

2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
3. Assembly shall accommodate up to 4 inches of expansion in length.
4. Ductile iron conforming to AWWA C153/A21.53.
5. Rated for 350 psi.
6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
8. Joint connecting to mechanical joint shall be thrust restrained.
9. Bonding:
   a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
   b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
   c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.

2.06 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
   a. Body: Malleable or ductile iron.
   b. Straps: Galvanized steel.
   c. Hex Nuts and Washers: Steel.
   d. Seal: Rubber.
5. Manufacturers and Products:
   a. Smith-Blair; Series 317.
   b. Dresser; Style 291.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.

2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
   a. Body: Nylon-coated iron.
   b. Seal: Buna-N.
   c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315.

2.08 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: As shown.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
   a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
   b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
   c. Continuously fillet weld on each side all around.
3. Factory Finish:
   a. Galvanizing:
      1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
      2) Electroplated zinc or cadmium plating is unacceptable.
   b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09900, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
   a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
   b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:

1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable Pipe Data Sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 psi.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:

1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

2.11 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
3. Manufacturers and Products:
   a. Armstrong International; Inc.; Model F.
   b. Mueller Steam Specialty; Model 351M.

B. Strainers, Water Service, 2-1/2 Inches and Larger:

1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.
3. Manufacturer and Product: Armstrong International, Inc.; Model A7FL 125.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

D. Water Hose:

1. Furnish two 50-foot lengths of 1-inch and two 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
   a. Goodyear.
   b. Boston.

E. Hose Nozzles:

1. Furnish two 1-inch and two 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
2. Manufacturers:
   a. Croker.
   b. Elkhart.

F. Pump Seal Water Sight Flow Indicators:

1. Bronze body, 3/8-inch, horizontal, ball action with tempered glass.
2. Rated 125 psi with NPT screwed ends.

3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
   a. Eugene Ernst Co.; Series E-57-4.
   b. Jacoby Tarbox Co.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 510S, Piping.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:

1. Install 18 inches or less from face of structures; joint may be flush with face.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer’s instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:

a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
b. Clean pipe surface before placing closure collars.
c. Wet nonmetallic pipe thoroughly prior to pouring collars.
d. Prevent concrete from entering pipe.
e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
f. Make entire collar in one placement.
g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Weld-End Metal Bellows Installation:

1. Field Weld: Stainless steel bellows beveled ends joined to ALP carbon steel piping in accordance with approved welding procedures.
2. Lining:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09900, Painting and Coating.
   b. Field apply lining to protect bellows and piping from rust at welded joint.
   c. Line both ends inside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot inside length of the carbon steel pipe.
3. Coating:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09900, Painting and Coating.
   b. Field apply coating to protect bellows and piping from weather and rust at welded joint.
   c. Coat both ends outside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot outside length of the carbon steel pipe.

D. Anchors: Install as specified in Section 15060, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE

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

3.07 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Do not remove pipe coating. If damaged, repair before joint is made.
4. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. Compressor and Blower Discharge: Metal bellows connector.
4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

A. Application:

1. As specified in Section 510S, Piping.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement .
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

END OF SECTION

SECTION 15208
HYDROPNUEMATIC TANK AND CONTROL SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. The work under this Section includes the furnishing and installation of a hydropnuematic tank system, including hydropneumatic tank, air compressors, air piping, valves, mounting for tank controls, pressure gauges, and all appurtenances, fully tested, as indicated on the drawings, as herein specified.

1.02 REFERENCES

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

1. National Electrical Manufacturers Association (NEMA): ICS 1, General Standards for Industrial Control and Systems.
2. ASME Code for Unfired Pressure Vessels.
3. ICSI, General Standards for Industrial Control and Systems.
4. National Fire Protection Association (NFPA).
5. Occupational and Safety Health Act (OSHA).

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Descriptive data for hydropnuematic tank control system appears on Hydropnuematic tank Control System Data Sheet (appears at the end of this Specification) and Contract Drawings.
2. System conditions shown represent maximum operating conditions.
3. Arrange hydropnuematic tank control system so operational errors are minimized and failures in automatic operation are detected before damage can result.

1.04 SUBMITTALS

A. Action Submittals: Shop Drawings:

1. Complete dimensional fabrication drawings of hydropnuematic tank accessories and piping.
2. Complete piping schematic drawings showing air and liquid piping, and flows directly associated with hydropneumatic .
3. Fabrication drawings of hydropnuematic control tank panel, including schematic and wiring diagrams.

4. Complete electrical elementary diagrams and electrical interconnection diagrams for hydropnuematic control tank. Diagrams in accordance with NEMA ICS 1.

B. Informational Submittals:

1. Statements of Qualification:
   a. Tank supplier.
   b. Tank welders.
2. Contractor's written plan for installation.
3. Certificate of Compliance, in accordance with Section 01740, Common Product Requirements, that tank is certified and stamped in accordance with American Society of Mechanical Engineers (ASME) Section VIII, Division 1.
4. Test Reports:
   a. Date and time of testing.
   b. Description of method of testing, including pumping combinations and pressure records.
   c. Description of observed leaks and method and date of repair.
   d. Description of catastrophic failures.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01670, Manufacturers' Field Services and Training.

1.05 QUALIFICATIONS

A. Tank Welders and Weld Inspectors: ASME certified.

PART 2 PRODUCTS

2.01 HYDROPNUEMATIC TANK SYSTEM SUPPLIER

A. A single supplier shall be responsible for the hydropnuematic tank system specified herein so as to maintain unit responsibility for the complete system. This supplier shall supervise the fabrication and assembly of component equipment and systems into the package system. The supplier shall supervise installation of mechanical equipment, electrical wiring and conduit, and instrumentation and control system components. The supplier shall also be responsible for site services including interconnection, testing, startup, and certification of the installation.

B. Like items of equipment specified herein shall be the end products of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

2.02 HYDROPNEUMATIC TANK

A. Physical Data:

1. Actual Net Tank Volume: Not less than 2000 cubic feet.
2. Configuration: Horizontal cylindrical shape with elliptical heads.
3. Diameter: Approximately 10 feet.
4. Overall Length: Approximately 25 feet.
5. Design Pressure: Rated for 200 psi.
6. Design Temperature: 120 degrees F.

B. Design Basis/Criteria:

1. Shell Thickness: Computed according to ASME Pressure Vessel Code, Division 1, Section VIII, UG-27, Equation 1, Page 19.
2. Minimum Weld Efficiency: E = 0.85.

C. The tank shall have the following connections:

1. 24-inch manway.
2. Two 2-inch threaded connections for level probe well.
3. 1-inch air connections.
4. 1-inch secondary air connections (for initial charging).
5. 16-inch force main connections.
6. 2-inch flanged drain.

D. Provide support brackets on hydropnuematic tank for air piping, electrical conduit, the level control panel, and all accessories.

E. Flanges shall be perpendicular to the axis of the pipe. Flange face drilling shall conform to ANSI/ASME B16.1, Class 250.

F. Level Control Systems:

1. The hydropnuematic tank shall be provided with a level control system to control the water level in the tank within the designated range.
2. The level control system shall consist of the following components:
   a. Probe well and probe holder.
   b. B/W electrodes.
   c. 1-inch check valves.
   d. 1-inch solenoid valves (NEMA 4X enclosure) for adding/venting air.
   e. 1-inch air safety relief valve tank mounted.
   f. 1-inch valves for isolation/bypass of solenoid valves and sight glass drain.
   g. Level control panel.
3. Above the normal operating range, air shall be added through a solenoid valve from the air compressor system. Below the normal operating range, air shall be vented from the surge arrestor through a solenoid valve. High and low alarm signals shall be generated when the water level is out of range.

4. Time delays shall be used to prevent adding or venting air during transient and minor fluctuation.
5. Level Control Panel:
   a. Control panel shall meet the requirements of City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment.
   b. The level control panel shall house all relays, time delays, and alarm contacts.
   c. The level control panel shall be housed in a NEMA 4X, 316 stainless steel enclosure.
   d. Electrical service shall be 120 volt, 60 Hz, single phase.
   e. Dry contacts shall be provided for generating a remote general fault alarm in response to alarms indicated above.
   f. Level control panel shall be mounted on the hydropnuematic tank.

2.03 COMPRESSED AIR SYSTEM

A. General:

1. Two reciprocating (piston type) air compressors shall be furnished and installed. Compressors shall be mounted on the air receiving reservoir. Each compressor capacity shall be 5 acfm at 155psig, with maximum pressure capacity of at least 250 psig.
2. The air compressors, receiving tank and control panel shall be mounted on a common skid requiring only a 480 volt, 3 phase power connection and a hook-up to the air piping.
3. The compressed air system shall be suitable for indoor installation. Compressor shall be sound attenuated to not exceed 70 dba.

B. Compressors: Compressors shall be two-stage, oil-lubricated, air-cooled, motor-driven compressors. Compressors shall be splash-lubricated with low oil level switch and high temperature switch to shut down the compressor. Drives shall be V-belt type with means for easy adjustment of belt tension. Compressors shall be complete with centrifugal or magnetic unloader and air intake filter-silencer. Furnish sound attenuation to reduce sound levels below 70 dba. Furnish valves where shown on the Drawings, associated with the high pressure air piping including gate valves, check valves and pressure relief valves. Pressure gauges shall also be a part of this system. Provide machine guarding in accordance with OSHA Standard 29 CFR Part 1910, Subpart 0, 1910.211 to 219.

C. Spare Parts and Oil Supply: Furnish the following spare parts for each compressor:

1. Three filter-silencer elements.
2. Sufficient oil for the initial filling of the compressor plus an amount sufficient for two complete oil changes.

3. Two sets of V-belts.

D. Motors: Motors shall be continuous duty and shall meet the requirements of the following:

1. Horsepower: 10 (maximum).
2. Enclosure: TEFC.
3. Service Factor: 1.15.
4. Power Supply: 480 volt, 3 phase, 60 Hz.
5. Speed: 1,800 rpm maximum.
6. 120 volt space heater.
7. Provide motor high temperature switch.

E. A minimum 120 gallon air reservoir shall be provided with the compressors. Vessel shall be designed and inspected in accordance with ASME Code for Unfired Pressure Vessels. The receiver shall be equipped with a condensate drain with solenoid controlled by the control panel.

F. Control Panel:

1. Control panel shall meet the requirements of City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment.
2. Furnish and install a factory control panel for the two air compressors. The panel shall include a control power transformer. Power to the panel shall be 480 volts, 3-phase with a main circuit breaker rated 22,000 AIC. All controls shall operate on a 120 volt, single phase power source.
3. The panel shall contain a Hand-Off-Auto selector switch for each compressor, and an alternator. In Hand, a compressor shall operate continuously. Three dry contacts shall be provided for compressor control: one for Lead Compressor On, one for Lag Compressor On, and one for All Compressors Off. If the lag compressor is turned on, a common fault alarm shall be initiated. If the switch for either compressor is in the Auto position and the switch for the other compressor is in the Off position, the compressor whose switch is in the Auto position will start each time the input signal to start the compressor is received at the panel.
4. Provide starters for compressors. Starters shall be NEMA rated, circuit breaker combination type, with overcurrent protection in each phase. Interrupting capacity is a minimum of 22,000 AIC amperes symmetrical. Equip each starter with loss of phase/phase unbalance relay for single phase protection.
5. All time delays, thermal and oil interlocks, and other devices required to operate the compressors to the manufacturer’s requirements shall be provided in this panel.

6. The compressor shall automatically shut down on low oil level, high compressor temperature, and upon other critical faults as determined by the manufacturer. The control panel shall include a red indicator light for each shut down condition to indicate the cause of the shut down.
7. Panel enclosure shall be NEMA 4, 316 stainless steel, and shall be mounted on a common skid with the receiver and compressors at the factory.

G. Insulate small diameter piping (less than 3 inches) for freeze protection.

2.04 FACTORY CONTROL PANELS

A. Factory control panels shall be fabricated from the following components:

1. Control panel shall meet the requirements of City Standard Technical Specification S16700, Common Control Panel Requirements for Equipment.
2. Circuit Breakers: Molded case, thermal magnetic, minimum interrupting capacity as noted. Acceptable manufacturers are GE, Siemens, Square D, and Cutler-Hammer.
3. Starters: NEMA rated, circuit breaker combination type, with overcurrent protection in each phase. Interrupting capacity as noted. Acceptable manufacturers are Allen-Bradley, Furnas, GE, Siemens, and Cutler-Hammer.
4. Relays: Relays which interfere with motor controls or external components shall be heavy duty industrial control type, 10 amp 600 volt reversible contacts, equal to Square D Class 8501 Type X.
5. Selectors and Pushbuttons: 30.5 mm, heavy duty, NEMA 4X rated; contacts rated 10 amps continuous, 6 amps break at 120 VAC, equal to Allen-Bradley type 800H.
6. Timers: Solid state, microprocessor based. SqD JCK70.
7. Indicating Lights: 30.5 mm, heavy duty, NEMA 4X rated, 6 volt transformer type with LED lamp, equal to Allen-Bradley type 800H.
8. Provide lamp or lens colors as follows:

Color	**Function**
Red	Motor Run Valve Closed
Green	Motor Stop Valve Open
Amber	Alarm Fault
White	Control Power On

B. Panel Construction: Route all wiring in Panduit or similar wireways and separate into categories (i.e. 480 volt power, 120 volt control, etc.). AC or DC power wiring shall not run in any raceway with any type instrument wiring. Protect all wiring across panel hinges. Provide numbered terminal strips for all field wiring terminations. Must follow City of Austin Standard Technical Specifications, S16200 General Wiring Methods and S16205 Wire Tagging.

C. Surge Protection: All instrument signal wiring, control wiring and AC power wiring shall be protected against lightning spikes and other transient surges at all control panel termination points.

2.05 LIFTING LUGS

A. Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

2.06 EQUIPMENT IDENTIFICATION PLATES

A. Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification**.**

2.07 ANCHOR BOLTS

A. Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05500, Metal Fabrications. Coat in accordance with Section 09900, Painting and Coating.

PART 3 EXECUTION

3.01 PAINTING

A. Except for touchup, all painting shall be done in the factory. Painting shall be in accordance with and as specified in Section 09900, Painting and Coating, System No. 5. All atmospherically exposed ferrous metal surfaces of the package, including hydropnuematic tank exterior, air compressors, receiver, motors, baseplate, etc., shall be coated as specified. Coat all related equipment and accessory items to hydropnuematic tank and air compressor similarity.

B. All interior ferrous metal surfaces of the hydropnuematic tank and accessories exposed to plant water shall be coated with System No. 1 as specified in Section 09900, Painting and Coating.

3.02 INSTALLATION

A. Install tank on tank support pedestals in accordance with manufacturer’s written instructions.

B. Level tank and grout saddles as specified in Section 03600, Nonshrink Grouting, before anchoring.

C. Assemble Accessories: Make process, control, and electrical connections.

D. Make piping connections such that misalignment stresses are not induced in tank nozzles.

3.03 FIELD QUALITY CONTROL

A. Field Static Test:

1. Hydrostatically test installed hydropnuematic tank for 4 hours minimum at 1.3 times design pressure, before dynamic testing.
2. Repair leaks detected during testing.

B. Functional Test:

1. Simulate normal operational cycle to demonstrate system operation. Simulate alarm conditions and control system response to simulated conditions.
2. Dynamic Test: Perform in response to flow startup and stoppage.
3. Testing with Multiple Pumps: Increase number of pumps, one at a time.
4. Record pressures for dynamic operation of each pump combination in startup and shutdown of flow.
5. Inspect and test components for alignment, operation, and connection, and performance.

3.04 MANUFACTURER'S SERVICES

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

1. 1 person-day for installation assistance and inspection.
2. 1-1/2 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1/2 person-day for prestartup classroom or Site training.

B. See Section 01670, Manufacturers' Field Services and Training and Section 01650, Facility Startup/Commissioning.

3.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Hydropnuematic Tank Control System Data Sheet.

END OF SECTION

HYDROPNUEMATIC TANK CONTROL SYSTEM
DATA SHEET

	CRITERIA	COMMENTS
Hydropnuematic Tank Design Pressure	200 psig	
Tank Volume	2,000 cubic feet	Minimum Volume
Operating Pressure	155 psig	15 mgd
Approximate Elevation	596	Reference datam for pressures
Operating Flowrate (gpm) at instant of power failure	3,500 gpm	Maximum flowrate
Connecting Pipe Size	12-inch diameter	Water flow in and out of chamber goes through 12-inch pipe
Static Pressure	55 psig	Discharge point elevation 600 feet
Maximum Pressure at Hydropnuematic Tank	155 psig	Maximum pressure occurring during a power outage.
Minimum Pressure at Hydropnuematic Tank	9.7 psig	Minimum pressure occurring during a power outage
Level Controls	**Air Volume – cubic foot**	
High High	640	Emergency Level, Alarms (82-inch water level)
High	700	Compressor On (80-inch water level)
Middle	765	Target operation point (78-inch water level)
Low	824	Compressor Off (75-inch water level)
Low Low	882	Emergency Level, Alarms (73-inch water level

SECTION 15410

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Faucets for lavatories and sinks.
2. Toilet seats.
3. Protective shielding guards.
4. Fixture supports.
5. Water closets.
6. Lavatories.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.

F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
5. Stainless-Steel Residential Sinks: ASME A112.19.3.
6. Vitreous-China Fixtures: ASME A112.19.2M.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Faucets: ASME A112.18.1.
2. Hose-Connection Vacuum Breakers: ASSE 1011.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Potable-Water Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Supply Fittings: ASME A112.18.1.
8. Brass Waste Fittings: ASME A112.18.2.

H. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

2. Faucets: ASME A112.18.1.
3. Hand-Held Showers: ASSE 1014.
4. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Manual-Control Antiscald Faucets: ASTM F 444.
7. Pipe Threads: ASME B1.20.1.
8. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Plastic Tubular Fittings: ASTM F 409.
4. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Flexible Water Connectors: ASME A112.18.6.
2. Grab Bars: ASTM F 446.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets,:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. American Standard Companies, Inc.
b. Bradley Corporation.
c. Chicago Faucets.
d. Delta Faucet Company.
e. Eljer.
f. Elkay Manufacturing Co.
g. Fisher Manufacturing Co.
h. Just Manufacturing Company.

i. Kohler Co.
j. Moen, Inc.
k. Royal Brass Mfg. Co.
l. Sloan Valve Co.
m. T & S Brass and Bronze Works, Inc.

2. Description: Sensor activated with thermostatic mixing valve. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.
b. Finish: Polished chrome plate.
c. Maximum Flow Rate: 0.5 gpm.
d. Mounting: Deck, exposed.
e. Inlet(s): NPS 1/2 male shank.
f. Spout Outlet: Spray, 0.5 gpm.
g. Operation: Sensor activated, minimum 6 sensor beams.
h. Drain: Grid.
i. Tempering Device: Thermostatic.

2.2 TOILET SEATS

A. Toilet Seats,:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. American Standard Companies, Inc.
b. Bemis Manufacturing Company.
c. Church Seats.
d. Kohler Co.

2. Description: Toilet seat for water-closet-type fixture.

a. Material: Molded, solid plastic.
b. Configuration: Open front without cover.
c. Size: Elongated.
d. Class: Heavy-duty commercial.
e. Color: White.

2.3 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Plumberex Specialty Products Inc.
e. TCI Products.
f. TRUEBRO, Inc.
g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.4 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Lavatory Supports,:

1. Description: Per manufacturers requirements

2.5 WATER CLOSETS

A. Water Closets,:
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. American Standard Companies, Inc.
b. Crane Plumbing, L.L.C./Fiat Products.
c. Eljer.
d. Kohler Co.

2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flush valve operation.
3. Style: Close coupled.

a. Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
b. Height: Standard or Accessible as shown on the Drawings.
c. Design Consumption: 1.28 gal./flush.
d. Trip Mechanism: Lever-handle actuator.
e. Color: White.

4. Supply: NPS 1 chrome-plated brass or copper.

2.6 LAVATORIES

A. Lavatories,:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. American Standard Companies, Inc.
   b. Eljer.
   c. Kohler Co.
   d. Crane Plumbing, L.L.C./Fiat Products.

2. Description: Accessible, wall-mounting, vitreous-china fixture.

   a. Type: With back.
   b. Size: See Plumbing Schedule
   c. Faucet Hole Punching: See Plumbing Schedule
   d. Faucet Hole Location: Top.
   e. Pedestal: Not required.
   f. Color: White.
   g. Faucet: Sensor-activated with trim plate as required to match faucet hole punching.
   h. Supplies: NPS 3/8 chrome-plated copper with stops.
   i. Drain: See faucet.

      1) Location: Near back of bowl.

   j. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap; NPS 1-1/2, 0.032-inch- thick tubular brass waste to wall; and wall escutcheon.
   k. Protective Shielding Guard(s): See Plumbing Schedule
   l. Fixture Support: Wall-hung lavatories

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   2. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

D. Install wall-mounting fixtures with tubular waste piping attached to supports.

E. Install fixtures level and plumb according to roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

I. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

J. Install toilet seats on water closets.

K. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

L. Install traps on fixture outlets.

   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

M. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 15 Section "Basic Mechanical Materials and Methods."

N. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.4 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 15410

SECTION 15738

SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting.

1.2 SUBMITTALS

A. Product Data: For each unit indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace split-system air-conditioning units that fail in materials and workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Daikin: Basis of design
2. Carrier Air Conditioning; Div. of Carrier Corp.
3. Lennox Industries Inc.
4. Mitsubishi Electronics America, Inc.; HVAC Division.
5. Trane Co. (The); Unitary Products Group.
6. York International Corp.
7. LG

2.2 EVAPORATOR-FAN UNIT

A. Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

1. Insulation: Faced, glass-fiber duct liner.
2. Drain Pans: Galvanized steel, with connection for drain; insulated.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

D. Fan Motor: Multispeed.

E. Filters: 1 inch thick, in fiberboard frames.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER UNIT

A. Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed inverter type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor. Variable speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

1. Refrigerant: R-410A

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0 deg F.

H. Mounting Base: Polyethylene.

I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1. Minimum Insulation Thickness: 1 inch thick.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

B. Install ground-mounted, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.

D. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch.

3.2 CONNECTIONS

A. Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B. Connect supply and return water coil with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

C. Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

D. Install piping adjacent to unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 15738

SECTION 15838

POWER VENTILATORS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Requirements of the following Division 15 Sections apply to this section:
   1. "General Requirements."
   2. "Basic Methods."

1.2 SUMMARY

A. This Section includes the following types of power ventilators:
   1. In-line centrifugal fans.
   2. Wall-mounted exhausters.
   3. Ceiling-mounted ventilators.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Series 0 Specification Sections:
   1. Product data for selected models, including specialties, accessories, and the following:
      a. Certified fan performance curves with system operating conditions indicated.
      b. Certified fan sound power ratings.
      c. Motor ratings and electrical characteristics plus motor and fan accessories.
      d. Materials gages and finishes, including color charts.
      e. Dampers, including housings, linkages, and operators.
   2. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
   3. Coordination drawings, in accordance with Division 15 Section "Basic Mechanical Requirements," for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:
      a. Roof framing and support members relative to duct penetrations.
      b. Ceiling suspension members.
      C. Method of attaching hangers to building structure.
      d. Size and location of initial access modules for acoustical tile.

e. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.

4. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field- installed wiring.
5. Product certificates, signed by manufacturers of air-handling units, certifying that their products comply with specified requirements.
6. Maintenance data for air-handling units, for inclusion in Operating and Maintenance Manual specified in Series 0 and Division 15 Section "Basic Mechanical Requirements.

1.4 QUALITY ASSURANCE

A. UL Compliance: Fans shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the installation of roof curbs, equipment supports, and roof penetrations specified.

B. Coordinate the size and location of structural steel support members.

1.7 EXTRA MATERIALS

A. Furnish one additional complete set of belts for each belt-driven fan.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. In-line Centrifugal:
   a. ACME.
   b. Cook (Loren) Co.
   c. Greenheck Fan Corp.
   d. Penn Ventilator.
2. Propeller Wall Ventilators:
   a. ACME.
   b. Cook (Loren) Co.
   c. Greenheck Fan Corp.
   d. Penn Ventilator.
3. Ceiling-Mounted Ventilators:
   a. ACME.
   b. Cook (Loren) Co.
   c. Greenheck Fan Corp.
   d. Penn Ventilator.

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:
1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, sound, and efficiency by factory tests and ratings in accordance with

AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.
   1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor: 1.4.

D. Belts: Oil-resistant, nonsparking, and nonstatic.

E. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 BP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
   1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

F. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA (L(50)) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard I I for roller bearings.

G. Factory Finish: The following finishes are required:
   1. Sheet Metal Parts: Prime coating prior to final assembly.
   2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 CEILING-MOUNTED VENTILATORS

A. General Description: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Painted aluminum, 1/2" x 1/2" x 1/2" cube core face exhaust grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Remote Fan Speed Control: Solid state, capable of controlling fan speed from full speed to approximately half speed.

G. Accessories: Manufacturer's standard roof jack, wall cap, and transition fittings as indicated, hanging brackets with rubber-in-shear vibration isolators.

2.5 WALL-MOUNTED VENTILATORS

A. General Description: Wall propeller fan designed for exhausting large area, mounted in wall housing.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Propeller wheel, belt driven from fan motor. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

E. Accessories: Manufacturer's standard wall housing, and transition fittings as indicated, hanging brackets with rubber-in-shear vibration isolators.

2.6 MOTORS

A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.

B. Motor Sizes: Minimum sizes and electrical characteristics as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

C. Where 480 volt motor is scheduled, provide motor per section 15170 – Electrical motor, high efficiency, induction type.

D. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).

E. Service Factor: 1. 15 for polyphase motors and 1.35 for single-phase motors.

F. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B. Provide permanent-split capacitor classification motors for shaft-mounted fans and capacitor start classification for belted fans.

1. Bases: Adjustable.
2. Bearings: The following features are required:
   a. Ball or roller bearings with inner and outer shaft seals.
   b. Grease lubricated.
   c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
3. Enclosure Type: The following features are required-
   a. Open drip-proof motors where satisfactorily housed or remotely located during operation.
   b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
   c. Totally enclosed fan cooled where scheduled.
4. Overload protection.- Built-in, automatic reset, thermal overload protection.
5. Noise rating: Quiet.
6. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard II 2, Test Method B. Motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, Test Method B.
7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, roof curbs, equipment supports, and other conditions affecting performance of fans.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below, using the vibration control devices indicated.

2. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

B. Arrange installation of units to provide access space around air- handling units for service and maintenance.

3.3 CONNECTIONS

A. Duct installations and connections are specified in other Division 15 sections. Make final duct connections with flexible connections.

B. Electrical Connections- The following requirements apply:
1. Electrical power wiring is specified in Division 16.
2. Temperature control wiring and interlock wiring are specified in Division 15 Section "Electrical Control Systems."
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Inspection: Arrange and pay for a factory- authorized service representative to perform the following:
1. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
2. Prepare a written report on findings and recommended corrective actions.

3.5 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.6 COMMISSIONING

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
1. Remove shipping blocking and bracing.
2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.
7. Disable automatic temperature control operators.

B. Starting procedures for fans:
   1. Energize motor- verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
      a. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.

C. Shut unit down and reconnect automatic temperature control operators.

D. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for procedures for system testing, adjusting, and balancing.

3.7 DEMONSTRATION

A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following-
   1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
   2. Familiarization with contents of Operating and Maintenance Manuals specified in Series 0 Section "Project Closeout" and Division 15 Section "Basic Mechanical Requirements. "

B. Schedule training with at least 7 days advance notice.

END OF SECTION 15838

SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.3 SUBMITTALS

A. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.4 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. **TAB SUBCONTRACTOR SHALL BE HIRED, DIRECTED AND PAID BY THE GENERAL CONTRACTOR, INDEPENDENT OF THE MECHANICAL CONTRACTOR.**

F. Acceptable TAB subcontractors:
1. PHI
2. Air Technologies
3. Fluid Balance, Inc.

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 systems for installed balancing devices, such as manual volume dampers. Verify that locations of these balancing devices 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 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.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. 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.

L. Perform duct leak testing of all duct systems. Coordinate testing with Commissioning Agent and Engineer. Leakage shall be less than 6 CFM per SF of conditioned floor area served by the unit, at 25 Pa test pressure, or as required by latest code and ordinance.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance, smoke, and fire dampers are open.
5. Isolating and balancing valves are open.

6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
7. Windows and doors can be closed so indicated conditions for system operations can be met.

C. TAB Subcontractor shall visit the site not less than twice during the duct installation, prior to insulation, to verify balancing devices are being installed in proper locations and functional for balancing efforts. Submit a written report at each visit as to what was found, and any recommendations, and to verify corrections were or were not made from previous visits.

D. Coordinate with the Mechanical Contractor to participate in a complete duct leakage test for the supply and return duct.

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" or ASHRAE 111 or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

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.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 15 Section "HVAC Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, 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. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. 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.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Division 15 Section "Metal 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 sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

3. Measure static pressure across each component that makes up an air-handling unit.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. 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.
   Comply with requirements in Division 15 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 will occur. 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 within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

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. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

B. 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. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

3.10 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.

3.11 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.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. 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 contractor.
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 and pump 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.

3.12 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. 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 15950

SECTION 15955
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. Chlorine Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.
5. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
6. Items that do not require testing include: Piping between wetwells and wetwell isolation valves, Equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.

7. Test Pressure: As indicated on Piping Schedule.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Leave pipe full of water after repair of leaks.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

G. Defective Piping Sections: Replace, and retest as specified.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by Owner at start of each testing day. Inspector will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

Table 1*

A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

Example: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace, and retest as specified.

3.06 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).

b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 16055
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

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

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. Underwriters Laboratories, Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 15080, Process Piping Insulation, pipe as specified in Section 510S Pipe, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings.

F. Manufacturers and Products:

1. Raychem; BTV-CR.
2. Thermon; BSX.
3. Nelson; CL1-J1 or L1-J1.

2.03 CONNECTION SYSTEM

A. Rating: NEMA 250, Type 4 and Factory Mutual approved.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

C. Manufacturers and Products:

1. Power Connection Kit:
   a. Raychem; JBS-100.
   b. Thermon; PCA-1-SR or DP-L.
   c. Nelson; PLT-BC.
2. Splice Kit:
   a. Raychem; S-150.
   b. Thermon; PCS-1-SR.
   c. Nelson; PLT-BS.
3. Tee Kit:
   a. Raychem; T-100.
   b. Thermon; DS-S.
   c. Nelson; PLT-BY.
4. End Seal Kit:
   a. Raychem; E-150.
   b. Thermon; DE-S.
   c. Nelson; LT-ME.
5. Lighted End Seal Kit:
   a. Raychem; E-100-L.
   b. Thermon; DLS.
   c. Nelson; LT-L.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
   a. Raychem; AT-180.
   b. Thermon; AL-20P.

c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
   a. Raychem; GS54 or GT66.
   b. Thermon; PF-1.
   c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F.

B. Sensor: Fluid-filled with 3-foot capillary.

C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 to 140 degrees F).

B. Sensor: Fluid-filled probe.

C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 15080, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.
4. Install on services as follows:

    a. All chemical lines exposed outdoors.
    b. All water and non-potable lines less than or equal to 6 inches exposed outdoors.

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	**Heating Tape Length (min. feet)**
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer's instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 16220
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

F. ODP: Open drip-proof enclosure.

G. TEFC: Totally enclosed, fan-cooled enclosure.

H. TENV: Totally enclosed, nonventilated enclosure.

I. WPI: Open weather protected enclosure, Type I.

J. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
   a. Service factor.
   b. Locked rotor current.
   c. No load current.
   d. Safe stall time for motors 100 hp and larger.
   e. Multispeed load classification (for example, variable torque).
   f. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
   g. Guaranteed minimum full load efficiency and power factor.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.
11. Description, ratings, and wiring diagram of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.

B. Informational Submittals:

1. Factory test reports, certified.
2. Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Data.
3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01670, Manufacturers' Field Services and Training.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Reliance Electric.
2. MagneTek.
3. Siemens Energy and Automation, Inc., Motors and Drives Division.
4. Baldor.
5. U.S. Electrical Motors.
6. TECO-Westinghouse Motor Co.
7. Toshiba International Corp., Industrial Division.
8. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

E. Lifting lugs on motors weighing 100 pounds or more.

F. Operating Conditions:

1. Maximum ambient temperature not greater than 50 degrees C.
2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3

C. Suitable for full voltage starting.

D. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters and solid state reduced voltage starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.

b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound)**,** or as indicated in motor-driven equipment specification.

2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class F with Class B rise at nameplate horsepower and designated operating conditions, except EXP and DIP motors which must be Class B with Class B rise.

D. Motors With Form-Wound Coils: Locked coil bracing system in accordance with NEMA C50.41.

2.09 ENCLOSURES

A. Enclosures to conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Submersible: In accordance with Article Special Motors.

D. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Above 400 hp: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.
4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer’s standard lubrication 100 hp and smaller.
   c. Oil lubricated 125 hp and larger.
   d. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.
   c. Oil lubricated 250 hp and larger.
   d. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.

2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

E. Inverter Duty Rated Motors, Bearing Isolation: Motors larger than 50 hp shall have electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Field painting in accordance with Section 09900, Painting and Coating.

B. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Resistance Temperature Detector:
   a. 100-ohm platinum, three-wire, precision resistors with calibrated resistance-temperature characteristics.
   b. Six (two each phase) positioned to detect highest winding temperature and located between coil sides in stator slots.
   c. Compatible with monitoring instrumentation provided with motor controller and with adjustable speed control equipment.
   d. Leads brought to separate motor terminal box.

C. Bearing Temperature Protection:

1. On each bearing of horizontal motors.
2. On the thrust bearing of each vertical motors.

3. Bearing Temperature Detector:
    a. 100-ohm precision resistors with calibrated resistance-temperature characteristics.
    b. Compatible with monitoring instrumentation provided with motor controller and with adjustable speed control equipment.
    c. Leads brought to separate motor terminal box common to Winding Thermal Protection motor terminal box.

D. Provide integrated vibration sensor and transmitter with 4 to 20 mA output signal.

1. Features:
    a. Mounting: Single ¼-28 threaded stud for side mount in location to be measured.
    b. Enclosure: Hermetically sealed sensor housing with integral 6-foot armored cable for connection in Contractor supplied junction box.
    c. Signal Interface: 2-wire, loop powered.
    d. Programming: Sensor shall be fully programmable via USB adaptor. Provide a single programming kit that includes software and associated accessories for complete access to all transmitter features.
    e. Output Acceleration: User Configurable either Velocity or displacement in rms or peak vibration.
    f. Unit: User Configurable either English or SI units.
    g. Filters: User selectable three low-pass filters and two high-pass filters.
    h. Quantity: 1
    i. Range and Setpoint: Motor manufacturer's recommendation.
    j. Mounting Location: Motor manufacturer's recommendation.
    k. Manufacturer/Model: IMI Sensors, 64xxxx Series.

E. Space Heaters:

1. Provide winding space heaters with leads wired out to motor terminal box for motors from 1 to 40 hp and a separate terminal box for motors larger than 40 hp.
2. Provide extra hole or hub on motor terminal box as required.
3. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.

F. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

G. Anchor Bolts: Provide meeting manufacturer's recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.
7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
    a. At 40 Degrees C Ambient: 1.15.
    b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

C. Severe-duty Explosion-proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-duty, Dust-ignition-proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in motor-driven equipment specification.

F. Inverter Duty Motor:

1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated per NEMA MG1, Part 31 with rating listed on nameplate accordingly.
2. Suitable for operation over entire speed range indicated.

3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
4. When installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in Division 1 location.
5. Shaft Grounding Device: Motors larger than 20 hp shall be provided with shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to grounded motor frame per manufacturer's recommendations.
   a. Manufacturers:
      1) Grounding Brush: Sohre Turbomachinery, Inc.
      2) Grounding Ring: EST-Aegis.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
   a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
   b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
   c. On motors of 100 hp and smaller, furnish certified copy of motor efficiency test report on an identical motor.
4. Provide certified test reports for polyphase motors100 hp and larger.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.
3. Efficiency and power factor by Test Method F, IEEE 112, Forms F-1, F-2, and F-3.
4. Temperature Test: IEEE 112, Form A-2.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative at Site in accordance with Section 01670, Manufacturers' Field Services and Training, for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 100 hp.

B. Manufacturer's Certificate of Proper Installation.

END OF SECTION