BID SET – SPECIFICATIONS

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CITY OF WINTER SPRINGS

LIFT STATION 7W IMPROVEMENTS

July 2024

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SECTION 01 10 00
SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. The Work specified herein shall include construction for the replacement of lift station 7W located within the Western Wastewater Service Area within the City of Winter Springs.

B. Section Includes:

1. Contract description.
2. Work by Owner or other Work at the Site.
3. Owner-furnished products.
4. Contractor's use of Site and premises.
5. Future work.
6. Work sequence.
7. Owner occupancy.
8. Permits.
9. Specification conventions.

1.2 CONTRACT DESCRIPTION

A. Work of the Project includes:

1. Grading of site as designed
2. Removal and replacement of existing chain link fencing and gates
3. Installation of three (3) proposed sanitary manholes
4. Modification of two (2) existing sanitary manholes
5. Removal of existing VCP sanitary sewer pipe
6. Grout/Abandoning of existing PVC sanitary sewer pipe
7. Installation of 8-inch PVC sanitary sewer
8. Installation of 21-inch PVC sanitary sewer
9. Installation of 24-inch PVC sanitary sewer
10. Installation of 10-foot Diameter, 26-foot deep, concrete Triplex Lift Station
11. Installation of 16-inch DIP force main.
12. One (1) connection to existing 20-inch force main system
13. One (1) tap of existing 6- inch potable water system
14. One (1) tap of existing 8-inch reclaimed water system

15. Abandon existing ± 27’ depth wet-well and dry-well.
    a. Removal of existing pumps and valves within dry well.
16. Grout/abandoning of existing of 12” VCP sanitary sewer
17. Grout/abandoning of existing 18” RCP/CIPP sanitary sewer
18. Grout/abandoning of existing 24” RCP sanitary sewer
19. Grout/abandoning of existing 20-inch CI force main
20. Grout/abandoning of existing 10-inch by-pass force main
21. Install new concrete driveway, sidewalk, and slab.
22. Setting of 12’x16’x12’ pre-fabricated concrete electrical building
23. Removal of existing generator, day tank, control panels, variable frequency drive (VFD), and concrete curbing within existing generator building
24. Installation of new 125 kW diesel generator.
25. Installation of three (3) new VFDs, transformer, lighting panel, programmable logic controller (PLC), automatic transfer switch (ATS), circuit breaker, and other necessary and related appurtenances for the proposed new electrical building.

B. All materials, equipment, skills, tools, and labor which are reasonably and appropriately inferable and necessary for the proper completion of the Work and in compliance with the requirements stated or implied by these Specifications or Drawings shall be furnished and installed by CONTRACTOR without additional compensation, whether specifically indicated in the Contract Documents or not. This includes testing and placing into operation all equipment.

C. All fees and permits for the permanent construction that are required by controlling agencies or authorities, including fees for the review of Contract Documents prior to construction, will be procured by CONTRACTOR. Other licenses or permits for construction facilities of a temporary nature which are necessary for the prosecution of the work shall be secured and paid for by CONTRACTOR

D. Repair, replace, or otherwise settle with the OWNER, if damage to property or existing facilities occurs, including damage to pavements, utilities, lawns, structures, etc.

E. Construct the Project under a Unit Price Contract.

F. CONTRACTOR shall perform the Work complete, in place, and ready for continuous service, and shall include repairs, testing, permits, clean up, replacements, and restoration required as a result of damages caused during this construction.

1.3 WORK BY OWNER OR OTHERS

A. If work performed by the Owner or under Owner-awarded contracts interfere with each other due

to work being performed at the same time or at the same Site, Owner will determine the sequence of work under all contracts according to "Work Sequence" and "Contractor's Use of Site and Premises" Articles in this Section.

B. Coordinate Work with utilities of Owner and public or private agencies.

C. Work under this Contract includes:

1. Work as indicated on Drawings and defined herein.

D. Items noted NIC (Not in Contract), will be furnished and installed by Owner.

1.4 OWNER-FURNISHED PRODUCTS

A. Owner's Responsibilities: one (1) Generator and Automatic Transfer Switch (ATS), and three (3) submersible pumps,

1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples to Contractor.
2. Arrange and pay for delivery to Site.
3. Upon delivery, inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:

1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
2. Receive and unload products at Site; inspect for completeness or damage jointly with Owner.
3. Handle, store, install, and finish products.
4. Repair or replace items damaged after receipt.

1.5 CONTRACTOR'S USE OF SITE AND PREMISES

A. Limit use of Site and premises to allow:

1. Owner occupancy.
2. Work by Owner.
3. Work by Others as directed by the Owner.

B. Construction Operations: Limited to areas indicated on Drawings or as described herein.

1. Noisy and Disruptive Operations (such as use of jack hammers and other noisy equipment): Not allowed in close proximity to existing buildings during regular hours of operation. Coordinate and schedule such operations with Owner to minimize disruptions.

C. Time Restrictions for Performing Work:

1. Working Hours shall be in accordance with the General Conditions.
2. Some Work including, but not limited to, abandonments of existing piping systems, as well as connections, replacements, extensions thereto and thereof may necessitate work being done after or before normal work hours, said decision resting with the Engineer in coordination with the City of Winter Springs.
    a. Normally such extended hours will be required only to maintain service to existing customers or to minimize inconvenience to those customers or members of the public.
    b. This shall be considered incidental to the construction and therefore, no additional compensation shall be allowed.

D. Utility Outages and Shutdown:
1. Coordinate and schedule electrical and other utility outages with Owner.
2. Outages: Allowed only at previously agreed upon times.
3. At least one week before scheduled outage, submit Outage Request Plan to Owner itemizing the dates, times, and duration of each requested outage.

E. Sound Level Restrictions: Sound pressure level measured at boundary of Site shall not exceed 40 dBA.

1.6 WORK SEQUENCE

A. Construct Work in order to accommodate Owner's occupancy requirements during construction period. Coordinate construction schedule and operations with Owner.
B. Construction sequence shall be in accordance with 01 90 00 Sequence of Construction.
C. Sequencing of Construction Plan: Before start of construction, if required by the Engineer, submit three (3) hard copies and one (1) electronic copy of construction plan regarding phasing of all Work for acceptance by Owner. After acceptance of plan, construction sequencing shall comply with accepted plan unless deviations are accepted by Owner in writing.

1.7 OWNER OCCUPANCY

A. Owner will occupy Site for conduct of normal operations.
B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
C. Schedule the Work to accommodate Owner occupancy.

1.8 PERMITS

A. The Owner will obtain all permits required for work within State, County, and Railroad Rights-of-Way.
1. The Contractor shall verify the existence of the approved permit prior to commencing any

work.

B. Work within State of Florida Rights-of-Way:

1. All work related to State rights-of-way or property shall be in full compliance with all requirements of the permit and to the satisfaction of the State of Florida Department of Transportation.
2. Work within the rights-of-way of public thoroughfares, which are not under the jurisdiction of the State of Florida Department of Transportation, shall conform to the requirements of the agency having jurisdiction.
3. Installation shall include all the required work and necessary signs to provide the required traffic control, detours, and any other work to maintain traffic.
4. The Contractor shall notify the local Florida Department of Transportation Maintenance Engineer at least 48 hours prior to commencing work within the State rights-of-way and shall pay for any additional tests the State may require.
5. All work related to construction within the State rights-of-way shall be in full compliance with the terms of the permit and in accordance with the State of Florida Department of Transportation "Utility Accommodations Guide".
6. In the event of conflict between the requirements of Contract Documents and those of the State of Florida Department of Transportation, the more stringent requirements as determined by the Engineer, shall govern.
7. The costs of any, and all, items of work required by the State of Florida, payment for which is not specifically provided by bid items in the proposal, shall be included in the prices of bid items to which said items of work are related, incidental, or appurtenant. No additional compensation shall be allowed therefore.

C. Work within City of Winter Springs Rights-of-Way:

1. All work in City rights-of-way or property shall be in full compliance with all requirements of the permit, current service area agreement and to the satisfaction of the City of Winter Springs. Work within the rights-of-way of public thoroughfares which are not under the jurisdiction of City of Winter Springs shall conform to the requirements of the agency having jurisdiction. Installation shall include all the required work and necessary signs to provide the required traffic control, detours, and any other work to maintain traffic.
2. The Contractor shall notify the City of Winter Springs Public Works Department and City Engineer's Office at least 24 hours prior to commencing work within the City rights-of-way, and shall pay for any additional tests that the City may require.

3. In the event of conflict between the requirements of these Specifications and Details and those of the City, the more stringent requirements as determined by the Engineer, shall govern.
4. The costs of any, and all, items of work required by the City of Winter Springs, payment for which is not specifically provided by bid items in the Proposal, shall be included in the prices of bid items to which said items of work are related, incidental, or appurtenant. No additional compensation shall be allowed therefore.
5. The Contractor shall furnish copies of written approval or acceptance of the work by the City of Winter Springs to the Engineer along with the particular Periodic Estimate for Partial Payment on which payment for the work is requested. Final approval of the Project will not be issued until such approval has been furnished.

1.9 SPECIFICATION CONVENTIONS

A. These Specifications are written in imperative mood and streamlined form. This imperative language is directed to Contractor unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 20 00

PROJECT MEETINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preconstruction Meeting.
B. Progress Meetings.

1.2 REQUIREMENTS INCLUDED

A. OWNER shall schedule and administer preconstruction meeting, periodicprogress meetings, and specially called meetings throughout the progress of the work.

1. Prepare agenda for meetings.
2. Coordinate physical arrangements for meetings
3. Preside at meetings.
4. Prepare minutes of meetings.

B. Representatives of CONTRACTORs, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each individual represents.
C. CONTRACTOR shall attend meeting to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.3 PRECONSTRUCTION MEETING

A. OWNER OR AUTHORIZED REPRESENTATIVE will schedule a preconstruction meeting prior to beginning the work. This meeting shall be attended by ENGINEER, CONTRACTOR, and the OWNER. The purpose of the meeting shall be to review shop drawing procedures, construction methods, and to establish a construction schedule.
B. Location: A central site, convenient for all parties designated by the OWNER OR AUTHORIZED REPRESENTATIVE.
C. Attendance:

1. OWNER's Representative
2. ENGINEER’s Representative
3. CONTRACTOR's Superintendent.
4. Major Subcontractors
5. Major Suppliers.
6. Others as appropriate.

D. Suggested Agenda:

1. Distribution and discussion of:

a. List of major subcontractors and suppliers.

b. Projected construction schedules.

2. Critical work sequencing.
3. Major equipment deliveries and priorities including list of long lead time items and anticipated delivery dates.
4. Project Coordination and Communication.
5. Designation of responsible personnel.
6. Procedures and processing of:

   a. Field decisions.
   b. Proposal requests.
   c. Submittals.
   d. Change Orders.
   e. Applications for payment.

7. Adequacy of distribution of Contract Documents.
8. Procedures for maintaining record documents.
9. Use of Premises:

   a. Office, work, and storage areas.
   b. OWNER's requirements.

10. Construction facilities, controls, and construction aids.
11. Construction Sequencing to minimize facility down time.
12. Housekeeping procedures.
13. Check of required Bond and Insurance certifications.
14. Liquidated Damages.
15. Request for a weekly job meeting for all involved.
16. Equal Opportunity Requirements.
17. Laboratory testing of material requirements.
18. Inventory of material stored on-site provisions.

1.4 PROGRESS MEETINGS

A. Schedule regular periodic meetings. The progress meetings will be held every 30 days or less with the first meeting 30 days after the preconstruction meeting or 30 days or less after the date of Notice to Proceed.
B. Hold called meetings as required by progress of the work.
C. Location of the meetings: As designated by the OWNER.
D. Attendance:

   1. OWNER's Representative

2. ENGINEER’s Representative
3. CONTRACTOR's Superintendent.
4. Subcontractors as appropriate to agenda.
5. Suppliers as appropriate to agenda.
6. Others as appropriate.

E. Suggested Agenda

1. Review, approval of minutes of previous meeting.
2. Review of work progress since previous meeting
3. Field observations, problems, conflicts
4. Problems which impede construction schedule
5. Review of offsite fabrication, delivery schedules
6. Corrective measures and procedures to regain projected schedule
7. Revisions to construction schedule
8. Progress, schedule during succeeding work period
9. Coordination of schedules
10. Review submittal schedules, expedite as required
11. Maintenance of quality standards
12. Pending changes and substitutions
13. Review proposed changes for:
    a. Effect of construction schedule and on completion date
    b. Effect on other contracts of the Project
14. Other business
15. Construction Schedule
16. Critical/long lead items.

F. CONTRACTOR is to attend progress meetings and is to study previous meeting minutes and current agenda items, to be prepared to discuss pertinent topics such as deliveries of materials and equipment, progress of the work, etc.

G. CONTRACTOR is to provide a current submittal log at each progress meeting in accordance with Section 01 30 00 – Administrative Requirements.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 22 00

MEASUREMENT AND PAYMENT

PART 1 - - GENERAL

1.1 SUMMARY

A. General:

1. This Section includes the requirements for wastewater and associated road and Right-of-Way improvements measurement and payment for pay items required to complete the Work and as shown and specified in the Contract Documents.
2. Items listed in this Section correspond with the pay items on the Bid Form.
3. All pay items identified in this Section may not be represented on the Bid Form. The Contractor shall coordinate the pay items on the Bid Form with the corresponding paragraphs located herein.
4. The omission of reference to any item shall not alter the intent of the Bid Form or relieve the Contractor of the necessity of constructing a complete project under this Contract.
5. Payment shall be made for the items listed on the Bid Form on the basis of the Work actually performed and completed in strict accordance with the Contract Documents, such Work including but not limited to, the furnishing of all necessary labor, materials, equipment, tools, testing, transportation, delivery, disposal of waste and surplus material, restoration, and all other incidentals and appurtenances to complete the construction and installation of the Work as shown and specified.
6. No additional payment shall be made for clean-up work. The cost thereof shall be included in the price for related items as set forth in the Proposal.
7. The Contractor shall not be allowed additional payment or compensation for removing and replacing, relocating or otherwise protecting or adjusting existing culverts or other existing storm drainage facilities shown on the plans which may be affected by the construction. The cost thereof shall be included in the cost of bid items to which they are required or appurtenant.
8. The Contractor shall be responsible for any debris and foreign matter which is allowed to enter any system as a result of construction and shall be solely responsible for any damage resulting therefrom.
9. Except those items outlined in the Schedule of Prices Bid, the Contractor shall not be allowed additional payment or compensation for removing and replacing, shoring or bracing, relocating, or otherwise protecting or adjusting any and all utilities which may be affected by the construction. Specifically, the Contractor shall adjust all valve boxes, valve covers, manhole

frames, and manhole covers to required grades. All methods of adjusting utilities shall be subject to the approval of the Engineer. The cost of items described herein shall be included in the cost of bid items to which they are incidental or appurtenant.

10. Unless provided by specific bid items in the Schedule of Prices Bid, the following shall be considered incidental or appurtenant and no measurement or payment will be made:
    a. Erosion and sediment control.
    b. Clearing and grubbing.
    c. Excavation and backfill.
    d. Dewatering.
    e. Trench boxes.
    f. Installation and/or removal of sheeting and shoring.
    g. Seeding and sodding.

1.2 RELATED SECTIONS

A. General Conditions.

B. Agreement.

C. Section 01 30 00 - Administrative Requirements.

1.3 ESTIMATE OF QUANTITIES

A. The quantities set forth in the Bid Form are approximate and are given to establish a uniform basis for the comparison of bids. The Owner reserves the right to increase or decrease the quantity of any item or portion of the Work during the progress of construction in accordance with the terms of the Contract. The Bid Form shall serve as a basis of developing additive or deductive Change Orders.

1.4 MEASUREMENT OF QUANTITIES

A. Unless otherwise provided in the specifications for the particular items involved, all measurements shall be taken from "finished grades and elevations" for vertical measurements and from pipe end to pipe end horizontally for lineal measurements. The method or combination of methods or measurements shall be those which will reflect with reasonable accuracy the actual areas of the finished Work as determined by the Engineer.

B. The term "finished grade" as used herein shall mean the final elevation of the accepted Work as approved by the Engineer and when located in Florida Department of Transportation (F.D.O.T.) rights-of-way shall be the elevation required and approved by F.D.O.T. to conform to its Work as proposed or later modified. It shall be the Contractor’s responsibility to determine the finished grade at any point as required by the Engineer or F.D.O.T.

C. For those pay items which were not included in the Schedule of Prices Bid, it shall be mutually understood that all items for payment shall be made from the master list of pay items set forth below. Items that are not specifically listed hereafter shall utilize the basic numbering system set forth.
Pay Items that indicate multiple measurement methods shall be paid at the method included in the Schedule of Prices Bid.

1.5 SCHEDULE OF PIRCES BID

A. Mobilization/Demobilization:

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum basis for Mobilization/Demobilization in accordance with the Contract Documents.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Work on the Project, including, but not limited to, those operations necessary for the movement of personnel, equipment, supplies and incidentals to the project site, permits, etc.. Also included are temporary utilities/facilities, staging and storage areas, survey and layout, safety equipment and all other items not specifically identified under other bid items which are necessary for the construction, and compliance with administrative and regulatory requirements.
3. Payment of this item shall be in accordance with the following schedule:

Percent of Original Contract Amount Earned	**Allowable Percent of the lump sum Price to be Paid**
5	25
10	50
25	75
50	100*

* Partial payments for any project will be limited to ten (10) percent of the original contract amount listed above for that project. Any remaining amount will be paid upon completion of all work on the project.

B. Insurance, Performance and Payment Bond

1. Method of Measurement: Lump Sum (LS). The quantity to be paid shall be on a lump sum basis for Insurance, Performance and payment bond in accordance with the Contract Documents.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Work shall include

all costs for acquiring and maintaining all bonds specified in the Contract Documents, fees, bonds (excluding the Material and Workmanship Bond), and insurance

3. Payment of this item shall be in accordance with the following schedule:

Percent of Original Contract Amount Earned	Allowable Percent of the lump sum Price to be Paid
5	25
10	50
25	75
50	100*

C. Preconstruction Video

1. Method of Measurement: Lump Sum (LS). The quantity to be paid shall be on a lump sum basis for Preconstruction Video in accordance with the Contract Document.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents.

D. Construction Testing (Pressure, Density Testing, etc.)

1. Method of Measurement: Lump Sum (LS). The quantity to be paid shall be on a lump sum basis for Construction Testing in accordance with the Contract Document.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for Construction Testing (Pressure, Density Testing) as shown and specified.

E. Survey Layout and Record Drawings

1. Method of Measurement: Lump Sum (LS): The quantity to be paid shall be on a lump sum basis for the Survey Layout and Record Drawings in accordance with the Contract Documents.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs required to complete the Survey Layout and Record Drawings as shown and specified.

F. Demolition

1. Method of Measurement: Lump Sum (LS): The quantity to be paid under this unit cost shall be

on a lump sum basis for the following but not limited to cut, demolish, remove and dispose of existing control cabinets including the motor control panels and telemetry cabinets, removal and disposal of existing discharge piping, fittings, valves, and appurtenances, removal of existing control panels, removal of existing generator, removal of existing wet well access hatches and lids, and removal of three existing pumps– in accordance with the Contract Documents.

2. Payment for this bid item shall be made at the unit price set forth in the Bid Proposal and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all costs for removal and disposal of materials, and all incidentals and appurtenances required to complete the site work as shown and specified.

G. General Restoration - (Includes grading, seeding, debris removal and mulching all areas disturbed during construction, miscellaneous concrete)

1. Method of Measurement: Lump Sum (LS): The quantity to be paid shall be on a lump sum basis for General Restoration in accordance with the Contract Documents.

2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for General Restoration, including but not limiting to grading, seeding, mulching all areas disturbed during construction, general restoration of project, and all incidentals and appurtenances required to complete general restoration as shown and specified.

Percent of Original Contract Amount Earned	**Allowable Percent of the lump sum Price to be Paid**
5	25
10	50
25	75
50	100*

* Partial payments for any project will be limited to the percent of the original contract amount listed above for that project. Any remaining amount will be paid upon completion of all work on the project. The Contractor shall perform site restoration of each area of the project within two weeks of performing installation within that area. The project site shall not remain un-restored for longer than two weeks.

H. Clearing and grubbing, grading, general erosion Control

1. Method of Measurement: Lump Sum (LS). The quantity to be paid shall be on a lump sum basis

for Preconstruction Video in accordance with the Contract Document. Work Includes: Preparation and implementation of light clearing and grubbing, grading and sod – in accordance with the Contract Documents.

2. Payment shall include, but is not limited to, all costs for clearing and grubbing, disposal of materials, and all incidentals and appurtenances required to complete the site work as shown and specified. Additional measures may be necessary for supplement silt fence, including replacement and maintenance as needed based upon activities during construction. In the event temporary staging and storage areas are used, any required erosion and sediment control measures are to be included as well in this item.

I. Asphalt Removal/ Restoration:

1. Method of Measurement: Square Yard (SY): The quantity to be paid shall be the actual number of square yards of Asphalt Pavement in place in accordance with the Contract Documents.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for lime rock installation, grading, priming, asphalt installation, and all incidentals and appurtenances required to complete the Asphalt Pavement as shown and specified.

J. Silt Fence

1. Method of Measurement: Linear Feet (LF). The quantity to be paid shall be on a linear feet basis for the silt fence installed in accordance with the Contract Document.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents.

K. Existing Lift Station Abandonment:

1. Method of Measurement: Cubic Yard (CY): The quantity to be paid under this unit cost shall be the actual number of cubic yards of grout filled for full abandonment of lift station wet well, dry well, piping, valving, and appurtenances.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment partial removal of existing wet well and dry well and subsequent grout/gravel filling of wet well and dry well. Work also includes full removal of hatching, existing centrifugal pumps, interior suction piping, railing, mounting equipment, electrical, instrumentation, controls, bypass pumping, and all associated valves, piping, fittings, and appurtenances of the existing lift station system as shown and specified in the Contract Documents.

L. Pipe Abandonment - 18-Inch PVC Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 18-Inch PVC Sanitary Sewer Pipe filled and abandoned.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

M. Pipe Removal - 6-Inch VCP Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 6-Inch VCP Sanitary Sewer Pipe cut, plugged, and removed.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

N. Pipe Abandonment - 12-Inch VCP Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 12-Inch VCP Sanitary Sewer Pipe filled and abandoned.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

O. Pipe Abandonment - 24-Inch RCP Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 24-Inch RCP Sanitary Sewer Pipe filled and abandoned.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

P. Pipe Abandonment - 10-Inch By-pass Force Main:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 10-Inch By-pass force main filled and abandoned.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

Q. 10-inch Line Stop:

1. Method of Measurement: Each (EA): The quantity to be paid under this unit cost shall be on a unit price basis for labor and equipment cost for installation of proposed 10-inch line stop. Labor shall be included in the unit price in accordance with the contract documents.

2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all labor and equipment needed for handling and storage, materials, incidentals, and appurtenances required for complete installation of the manholes as shown and specified.

R. Existing Manhole Modification:

1. Method of Measurement: Each (EA): The quantity to be paid under this unit cost shall be on a unit price basis for labor and equipment cost for modifying the existing manhole structures. Labor shall be included in the unit price in accordance with the contract documents.
2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all labor and equipment needed for handling and storage, materials, incidentals, and appurtenances required for modifying the existing manholes as shown and specified.

S. Manhole Installation:

1. Method of Measurement: Each (EA): The quantity to be paid under this unit cost shall be on a unit price basis for labor and equipment cost for installation of proposed manhole structures. Labor shall be included in the unit price in accordance with the contract documents.
2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all labor and equipment needed for handling and storage, materials, incidentals, and appurtenances required for complete installation of the manholes as shown and specified.

T. Fencing Removal

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for removal of the existing chain link fencing.
2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances to remove existing fence and gate materials with associated concrete post bases, security wire, and all incidentals and appurtenances required for complete fence removal as shown and specified in the Contract Documents.

U. Fencing

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be

on a per linear foot basis for installation of the proposed additional chain link fencing.

2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances to furnish and install new fence and gate materials with associated concrete post bases, security wire, and all incidentals and appurtenances required for complete fence installation as shown and specified in the Contract Documents.

V. By-pass Operations:

1. Method of Measurement: Lump Sum (LS): The quantity to be paid under this unit cost shall be on a lump sum basis for labor and equipment cost for installation of proposed by-pass operations. Labor shall be included in the unit price in accordance with the contract documents.
2. Payment for this item shall be made at the unit price set forth in the Bid Proposal and Bid Form and shall constitute full compensation for Work shown and specified in the Contract Documents. Payment shall include, but is not limited to, all labor and equipment needed for handling and storage, materials, incidentals, and appurtenances, and fuel required for complete installation of the wet well, manholes as shown and specified.

W. Concrete (Driveway, Concrete Pads, New Sidewalk):

1. Method of Measurement: Square Yard (CY): The quantity to be paid shall be the actual number of square yards of concrete fill and rebar required for the lift station slab, driveway addition, driveway extension, sidewalk restoration, and any other concrete repair necessary to completely restore the site in accordance with the Contract Documents.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for grading, priming, concrete installation, and all incidentals and appurtenances required to complete the Asphalt Pavement as shown and specified.

X. 12-Inch DIP/HDPE Discharge Piping

1. Method of Measurement: Lump Sum (LS): The quantity to be paid under this unit cost shall be on a per lump sum basis for the 12-Inch DIP discharge piping.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment for this item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

Y. Potable and Reclaimed Water Service Connections

1. Method of Measurement: Each (EA). The quantity to be paid under this unit cost shall be on a per unit basis for connecting via a tapping saddle to the existing 6-Inch PVC Potable Water Main.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

Z. 20-Inch Plug Valve:

1. Method of Measurement: Each (EA). The quantity to be paid under this unit cost shall be on a per unit basis for the 20-Inch Plug Valves.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

AA. 16-Inch PVC Force Main – Open cut installation (includes fittings, restraints, adapters, etc.):

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 16-Inch PVC Force Main pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment for this item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

BB. 20-Inch PVC Force Main – Open cut installation (includes fittings, restraints, adapters, etc.):

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 20-Inch PVC Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment for this item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

CC. Connect to Existing 20-Inch Cast Iron Force Main:

1. Method of Measurement: Each (EA). The quantity to be paid under this unit cost shall be on a

per unit basis for connecting to the existing 20-Inch Cast Iron Force Main.

2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

DD. 1-Inch PVC Potable Water – Open cut installation:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 1-Inch PVC Potable Water Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

EE. 1-Inch PVC Reclaimed Water – Open cut installation :

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 1-Inch PVC Reclaimed Water Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

FF. 6-Inch PVC Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 6-Inch SDR 26 PVC Sanitary Sewer Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

GG. 8-Inch SDR 26 PVC Sanitary Sewer:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 8-Inch SDR 26 PVC Sanitary Sewer Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

HH. 12-Inch SDR 26 PVC Sanitary Sewer –:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 12-Inch SDR 26 PVC Sanitary Sewer Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

II. 21-Inch SDR 26 PVC Sanitary:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 21-Inch SDR 26 PVC Sanitary Sewer Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

JJ. 24-Inch SDR 26 PVC Sanitary Sewer – Open cut installation:

1. Method of Measurement: Linear Foot (LF): The quantity to be paid under this unit cost shall be on a per linear foot basis for the 24-Inch SDR 26 PVC Sanitary Sewer Pipe installed via open cut installation (including fittings, restraints, adapters, etc).
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, and materials for incidentals.

KK. 16-Inch Magnetic Flow Meter:

1. Method of Measurement: Each (EA). The quantity to be paid under this unit cost shall be on a per unit basis for the 16-Inch Magnetic Flow Meter.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Schedule and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but is not limited to, all costs for labor, equipment, materials for incidentals, and appurtenances.

LL. Electrical Instrumentation & Control:

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum for full installation of all electrical instrumentation and control devices.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment to install new wiring, PLCs, MCCs, control panels, telecommunications, and all other necessary furnishings related to

electrical instrumentation and controls as shown and specified in the Contract Documents.

MM. Prefabricated Concrete Electrical Building:

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum for full installation of prefabricated concrete electrical building.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment to install new prefabricated electrical building as shown and specified in the Contract Documents. This includes the lighting, HVAC system, control systems related to the electrical building, telecommunications, and all other necessary furnishings related to operations of the proposed electrical building, as well as any modifications necessary once arrived at the project location.

NN. Generator; Handling, Installation, and Start-up

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum for full handling, installation, and start-up of the proposed 125 kW permanent generator system, day tank and connection to existing con-vault.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment to install and startup proposed 125 kW permanent generator system and day tank including new wiring, piping, control systems, telecommunications, and all other necessary furnishings related to the 125 kW generator system as shown and specified in the Contract Documents.

OO. Wet Well Installation:

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum for full installation of lift station wet well, piping, valving, and appurtenances.
2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment to install new wet well, hatching, submersible centrifugal pumps with concrete pedestals, interior suction piping, railing, mounting equipment, wet well lining, electrical, instrumentation, controls, testing, bypass pumping, and all associated valves, piping, fittings, site restoration, and appurtenances as shown and specified in the Contract Documents.

JJ. Submersible Pumps Installation:

1. Method of Measurement: Lump Sum (LS). The quantity to be paid under this unit cost shall be on a lump sum for full installation of all pumps and associated piping, valving, and

appurtenances.

2. Payment for this bid item shall be made at the unit price set forth in the Bid Form and shall constitute full compensation for Work specified in the Contract Documents. Payment shall include, but not be limited to, furnishing all materials, labor, and equipment to install new wet well, hatching, submersible centrifugal pumps with concrete pedestals, interior suction piping,

PART 2 - PRODUCTS (NOT USED)
PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality assurance.

B. Product options.

C. Product substitution procedures.

1.2 QUALITY ASSURANCE

A. Contract is based on products and standards established in Contract Documents without consideration of proposed substitutions.

B. Products specified define standard of quality, type, function, dimension, appearance, and performance required.

C. Substitution Proposals: Permitted for specified products except where specified otherwise. Do not substitute products unless substitution has been accepted and approved in writing by Engineer.

1.3 PRODUCT OPTIONS

A. See Section 01 60 00 - Product Requirements.

1.4 PRODUCT SUBSTITUTION PROCEDURES

A. Engineer will consider requests for substitutions only within 30 days after date established in Notice to Proceed.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Document each request with complete data, substantiating compliance of proposed substitution with Contract Documents, including:

1. Manufacturer's name and address, product, trade name, model, or catalog number, performance and test data, and reference standards.

2. Itemized point-by-point comparison of proposed substitution with specified product, listing variations in quality, performance, and other pertinent characteristics.
3. Reference to Article and Paragraph numbers in Specification Section.
4. Cost data comparing proposed substitution with specified product and amount of net change to Contract Sum.
5. Changes required in other Work.
6. Availability of maintenance service and source of replacement parts as applicable.
7. Certified test data to show compliance with performance characteristics specified.
8. Samples when applicable or requested.
9. Other information as necessary to assist Architect/Engineer's evaluation.

D. A request constitutes a representation that Contractor:
1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
2. Will provide same warranty for substitution as for specified product.
3. Will coordinate installation and make changes to other Work that may be required for the Work to be completed with no additional cost to Owner.
4. Waives claims for additional costs or time extension that may subsequently become apparent.
5. Will coordinate installation of the accepted substitute, making such changes as may be required for the Work to be completed in all respects.
6. Will reimburse Owner and Engineer for review or redesign services associated with reapproval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals without separate written request or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:
1. Submit requests for substitutions to the Engineer in writing.
2. Submit three copies of Request for Substitution for consideration. Limit each request to one proposed substitution.
3. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
4. Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 - PRODUCTS - Not Used
PART 3 - EXECUTION - Not Used

END OF SECTION

SECTION 01 30 00

ADMINISTRATIVE REQUIREMENTS.

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project conditions.
B. Preconstruction meeting.
C. Progress meetings.
D. Pre-installation meetings.
E. Closeout meeting.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.
B. Verify that utility requirements and characteristics of operating equipment are compatible with existing utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.
C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

    1. Coordination Drawings: Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access, and where sequencing and coordination of installations are important.

D. Coordination Meetings: In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.
E. In finished areas, except as otherwise indicated, conceal pipes, ducts, and wiring within construction. Coordinate locations of fixtures and outlets with finish elements.
F. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion.
G. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Owner will schedule and preside over meeting after Notice of Award.
B. Attendance Required: Per General Conditions.
C. Minimum Agenda:

    1. Distribution of Contract Documents.
    2. Submission of list of Subcontractors, list of products, schedule of values, and Progress Schedule.

3. Designation of personnel representing parties in Contract.
4. Communication procedures.
5. Procedures and processing of requests for interpretations, field decisions, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
6. Scheduling.
7. Critical Work sequencing.
8. Status of required permits.

1.4 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work, at maximum, in monthly intervals.
B. Include first option in the following Paragraph when Contractor is responsible for progress meetings. When Architect/Engineer is responsible, edit second option accordingly.
C. Make arrangements for meetings, prepare agenda with copies for participants, and preside over meetings.
D. Attendance Required: Job superintendent, major Subcontractors and suppliers, Engineer, and Owner, and any additional personnel as appropriate to agenda topics for each meeting.
E. Minimum Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittal schedule and status of submittals.
6. Review of off-Site fabrication and delivery schedules.
7. Maintenance of Progress Schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on Progress Schedule and coordination.
13. Other business relating to Work.

F. Contractor: Record minutes and distribute copies to participants and those affected by decisions made within two (2) days after meeting.

1.5 PRE-INSTALLATION MEETINGS

A. When required in individual Specification Sections, convene pre-installation meetings at Project Site before starting Work of specific Section.
B. Require attendance of parties directly affecting, or affected by, Work of specific Section.

C. Notify Engineer, at minimum, five (5) days in advance of meeting date.
D. Prepare agenda and preside over meeting:

1. Review conditions of installation, preparation, and installation procedures.
2. Review coordination with related Work.

E. Record minutes and distribute copies to participants and those affected by decisions made within two (2) days after meeting.

1.6 CLOSEOUT MEETING

A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.
B. Attendance Required: Contractor, major Subcontractors, Engineer, Owner, and others appropriate to agenda.
C. Notify Engineer, at minimum, five (5) days in advance of meeting date.
D. Minimum Agenda:

1. Start-up of facilities and systems.
2. Operations and maintenance manuals.
3. Testing, adjusting, and balancing.
4. System demonstration and observation.
5. Operation and maintenance instructions for Owner's personnel.
6. Contractor's inspection of Work.
7. Contractor's preparation of an initial "punch list."
8. Procedure to request Engineer inspection to determine date of Substantial Completion.
9. Completion time for correcting deficiencies.
10. Inspections by authorities having jurisdiction.
11. Certificate of Occupancy, if required, and transfer of insurance responsibilities.
12. Final cleaning.
13. Preparation for final inspection.
14. Closeout Submittals:

    a. Project record documents.
    b. Operating and maintenance documents.
    c. Operating and maintenance materials.
    d. Affidavits.

15. Final Application for Payment.
16. Contractor's demobilization of Site.
17. Maintenance.

SECTION 01 31 50

PRECONSTRUCTION VIDEO

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide continuous color digital audio-video recording at each entire work area prior to construction to serve as a record of pre-construction conditions. Specific recordings shall be made of lift station 7W. Provide two copies of the audio-video recordings on a USB thumb drive. Supplement video recording with digital color photographs for areas that require details not ascertainable on the video recordings.

1.2 RELATED REQUIREMENTS

A. Section 01 33 00 – Submittal Procedures

1.3 QUALIFICATIONS:

A. Preconstruction audio-video recording shall be of professional quality that will clearly log an accurate visual description of existing conditions. Any portion of the recording that is not acceptable for the determination of the existing conditions shall be re-recorded at no additional cost to the OWNER. Completion progress by listed activity and sub-activity, to within five (5) working days prior to submittal.

PART 2 - PRODUCTS

2.1 GENERAL

A. Total audio-video recording system and the procedures employed in its use shall be such as to produce a finished product that will fulfill the technical requirements of the project. The video portion of the recording shall produce bright, sharp, clear pictures with accurate colors and shall be free from distortion, tearing, rolls or any other form of picture imperfection. The audio portion of the recording shall produce the commentary of the camera operator with proper volume, clarity, and be free from distortion. The recording system shall utilize EIA standard video and NTSC compatible color.

2.2 VIDEO RECORDING

A. Video recording shall record in color and a high resolution, 2100 pixels.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide OWNER a minimum of 48 hours' notice in advance of recording such that OWNER's representative can be present during recording. The recordings shall contain coverage of all surface features located within the construction's zone of influence. The construction's zone of influence shall be defined (1) as the area within the permanent and temporary easements or right-of-way, and areas adjacent to these areas which may be affected by routine construction operations, and (2) by the direction of the OWNER. The surface features within the construction's zone of influence shall include, but not be limited to, all roadways, pavements, curbs, driveways, ponds, sidewalks, culverts, headwalls, retaining walls, buildings, landscaping, trees, shrubbery, and

fences. Of particular concern shall be the existence or non-existence of any faults, fractures, or defects. Recording's coverage shall be limited to the construction site at any one time and shall include all surface conditions located within the zone of influence of construction supported by appropriate audio description.

B. Video recording shall be a simultaneously recorded audio recording. This audio recording, exclusively containing the commentary of the camcorder operator, shall assist in viewer orientation and in any needed identification, differentiation, clarification, or objective description of the feature being shown in the video portion of the recording. The audio recording also shall be free from any conversations between the camcorder operator and any other production technicians.
C. All USB thumb drives shall be permanently labeled and shall be properly identified by number and project title.
D. Each USB thumb drive shall have a log of the device's contents. The log shall describe the various segments of coverage contained on that thumb drive in terms of the names of streets or easements, coverage beginning and end, directions of coverage, and video unit counter numbers.

3.2 RECORDING SCHEDULE

A. The recording shall be performed prior to the placement of any construction materials or equipment on the proposed construction site.
B. CONTRACTOR shall coordinate the video recording with the construction schedule so that those portions of the construction that will be completed first will be recorded first. The recording company shall deliver the recordings to the OWNER upon their completion. Upon delivery of the thumb drives, transfer of Ownership of those drives shall be made to the OWNER.

3.3 VISIBILITY

A. All recordings shall be performed during times of good visibility. No recording shall be done during periods of significant precipitation, mist, fog, or any other conditions that would reduce visibility. The recording shall only be done when sufficient sunlight is present to properly illuminate the subject, and to produce bright, sharp video recordings of those subjects. No recording shall be performed when more than 10% of the area to be recorded contains debris or obstructions unless otherwise authorized by ENGINEER.

3.4 CONTINUITY OF COVERAGE

A. In order to increase the continuity of the coverage, the coverage shall consist of a single, continuous, unedited recording, which begins at one end of a particular construction area. However, where coverage is required in areas not accessible by conventional wheeled vehicles and smooth transport of the recording system is not possible, such coverage shall consist of an organized, interrelated sequence of recordings at various positions along that proposed construction area (e.g., wooded easement area).
B. The average rate of travel during a particular segment of coverage (e.g., coverage of one side of the street) shall be directly proportional to the number, size, and value of the surface features within that construction area's zone of influence.

3.5 CAMERA HEIGHT AND STABILITY

A. When conventional wheeled vehicles are used as conveyances for the recording system, the distance between the camera lens and the ground shall not be more than 10 feet. The camera shall be firmly mounted, such that transport of the camera during the recording process will not cause any unsteady picture.

3.6 CAMERA CONTROL

A. Camera pan, tilt, zoom-in, and zoom-out rates shall be sufficiently controlled such that recorded objects will be clearly viewed during playback. In addition, all other camera and recording system controls, such as lens, focus, aperture, video level, pedestal, chroma, white balance, and electrical focus, shall be properly controlled or adjusted to maximize recorded picture quality.

3.7 VIEWER ORIENTATION TECHNIQUES

A. Audio and video portions of the recording shall maintain viewer orientation. To this end, overall establishing views and visual displays of all visible house and building addresses shall be utilized. In easements where the proposed construction location will not be readily apparent in the recorder view, highly visible yellow flags shall be placed in such a fashion as to clearly indicate the proposed centerline of construction.

3.8 VIEWER ORIENTATION TECHNIQUES

A. CONTRACTOR shall televise and record, at a minimum, the following areas:

1. LIFT STATION 7W SITE EXISTING SITE
2. EXISTING GRAVITY SYSTEM TO BE ABANDAONED AS INDICATED IN THE CONSTRUCTION DRAWINGS

B. At no time shall CONTRACTOR be allowed to use any electrical circuits within private property building structure. All video recording shall be done during regular business hours, unless otherwise specified by the private property OWNER or ENGINEER. CONTRACTOR shall enter and leave private property in a professional and orderly, workmanlike manner.

END OF SECTION

E. Record minutes and distribute copies to participants and those affected by decisions made within two (2) days after meeting.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittals.
B. Bar chart schedules.
C. Review and evaluation.
D. Updating schedules.
E. Distribution.

1.2 SUBMITTALS

A. Submit preliminary progress schedule in accordance with the General Conditions.
B. If a bar chart schedule is to be used for simpler Projects, use the following two Subparagraphs.
C. Schedule Updates:

1. Overall percent complete, projected and actual.
2. Completion progress by listed activity and subactivity, to within five (5) working days prior to submittal.
3. Changes in Work scope and activities modified since submittal.
4. Delays in submittals or resubmittals, deliveries, or Work.
5. Adjusted or modified sequences of Work.
6. Other identifiable changes.
7. Revised projections of progress and completion.

1.1 BAR CHART SCHEDULES

A. Format: Bar chart Schedule, to include at least:

1. Identification and listing in chronological order of those activities reasonably required to complete the Work, including:

a. Subcontract Work.
b. Major equipment design, fabrication, factory testing, and delivery dates including required lead times.
c. Move-in and other preliminary activities.
d. Equipment and equipment system test and startup activities.
e. Project closeout and cleanup.
f. Work sequences, constraints, and milestones.

2. Listings identified by Specification Section number.

3. Identification of the following:

   a. Horizontal time frame by year, month, and week.

   b. Duration, early start, and completion for each activity and subactivity.

   c. Critical activities and Project float.

   d. Subschedules to further define critical portions of Work.

B. Sheet Size: 11 inches high x 17 inches wide.

1.2 REVIEW AND EVALUATION

A. Participate in joint review and evaluation of schedules with Engineer at each submittal.
B. Evaluate Project status to determine Work behind schedule and Work ahead of schedule.
C. After review, revise schedules incorporating results of review, and resubmit within five (5) days.

1.3 UPDATING SCHEDULES

A. Maintain schedules to record actual start and finish dates of completed activities.
B. Indicate progress of each activity to date of revision, with projected completion date of each activity. Update schedules to depict current status of Work.
C. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.
D. Upon approval of a Change Order, include the change in the next schedule submittal.
E. Indicate changes required to maintain Date of Substantial Completion.
F. Submit sorts as required to support recommended changes.
G. Prepare narrative report to define problem areas, anticipated delays, and impact on schedule. Report corrective action taken or proposed and its effect.

1.4 DISTRIBUTION

A. Following joint review, distribute copies of updated schedules to Contractor's Project site file, to Subcontractors, suppliers, Engineer, Owner, and other concerned parties.
B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Definitions.
B. Submittal procedures.
C. Construction progress schedules.
D. Proposed product list.
E. Product data.
F. Electronic CAD files of Project Drawings.
G. Shop Drawings.
H. Samples.
I. Other submittals.
J. Test reports.
K. Certificates.
L. Manufacturer's instructions.
M. Manufacturer's field reports.
N. Erection Drawings.
O. Construction photographs.
P. Contractor review.
Q. Engineer review.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.
B. Informational Submittals: Written and graphic information and physical Samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

A. Transmit each submittal with Engineer-accepted form.
B. In addition to the specified number of hard copies, one (1) electronic copy of each submittal shall be transmitted to the Engineer. The electronic copy shall be in Portable Document Format (.pdf) unless otherwise specified.
C. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
D. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number, and Specification Section number appropriate to submittal.
E. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.
F. Schedule submittals to expedite Project, and deliver to Engineer. Coordinate submission of related items.
G. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.
H. Allow space on submittals for Contractor and Engineer review stamps.
I. When revised for resubmission, identify changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
K. Submittals not requested will not be recognized nor processed.
L. Incomplete Submittals: Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Engineer.

1.4 CONSTRUCTION PROGRESS SCHEDULES

A. Comply with General Conditions and Section 01 32 16 - Construction Progress Schedule.

1.5 PROPOSED PRODUCT LIST

A. Within fifteen (15) days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.6 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.
B. Submit number of copies Contractor requires, plus three (3) copies Engineer will retain.
C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
D. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.7 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.
B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:

1. Use of files is solely at receiver's risk. Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.

4. Receiver shall not hold Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
5. Receiver shall understand that even though Engineer has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
6. Receiver shall not hold Engineer responsible for such viruses or their consequences, and shall hold Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

1.8 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a Professional Engineer licensed in the State of Florida responsible for designing components shown on Shop Drawings.

1. Include signed and sealed calculations to support design.
2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. Submit number of opaque reproductions Contractor requires, plus three (3) copies Engineer will retain.
E. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.9 SAMPLES

A. Samples: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.
B. Samples for Selection as Specified in Product Sections:

1. Submit to Engineer for aesthetic, color, and finish selection.
2. Submit Samples of finishes, textures, and patterns for Engineer selection.

C. Submit Samples to illustrate functional and aesthetic characteristics of products, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.
D. Include identification on each Sample, with full Project information.
E. Submit number of Samples specified in individual Specification Sections; Engineer will retain one (1) Sample.
F. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

G. Samples will not be used for testing purposes unless specifically stated in Specification Section.
H. After review, produce copies and distribute according to "Submittal Procedures" Article and for record documents described in Section 01 70 00 - Execution and Closeout Requirements.

1.10 OTHER SUBMITTALS

A. Closeout Submittals: Comply with Section 01 70 00 - Execution and Closeout Requirements.
B. Informational Submittal: Submit data for Engineer's knowledge as Contract administrator or for Owner.
C. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.11 TEST REPORTS

A. Informational Submittal: Test reports are typically submitted for Architect/Engineer's knowledge as Contract administrator or for Owner.
B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.12 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.
B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
C. Certificates may be recent or previous test results on material or product but must be acceptable to Engineer.

1.13 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Engineer's knowledge as Contract administrator or for Owner.
B. Submit printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, to Engineer in quantities specified for Product Data.
C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.14 MANUFACTURER'S FIELD REPORTS

A. Informational Submittal: Submit reports for Engineer's knowledge as Contract administrator or for Owner.
B. Submit report in duplicate within five (5) days of observation to Engineer for information.
C. Submit reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.15 ERECTION DRAWINGS

A. Informational Submittal: Submit Drawings for Engineer's knowledge as Contract administrator or for Owner.
B. Submit Drawings for information assessing conformance with information given and design concept expressed in Contract Documents.
C. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

1.16 CONSTRUCTION PHOTOGRAPHS

A. Provide photographs of Site and construction throughout progress of Work produced by an experienced photographer acceptable to Engineer.
B. Each month submit photographs with Application for Payment.
C. The quantity of photographs taken shall be sufficient to document progress of Work.
D. Digital Images: Deliver complete set of digital image electronic files on CD-ROM to Owner with Project record documents. Identify electronic media with date photographs were taken. Submit images that have same aspect ratio as sensor, uncropped.

1. Digital Images: Uncompressed TIFF format, produced by digital camera with minimum sensor size of 4.0 megapixels, and image resolution of not less than 1600 by 1200 pixels.
2. Date and Time: Include date and time in filename for each image.

1.17 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to Engineer.
B. Contractor shall be Responsible for:

1. Determination and verification of materials including manufacturer's catalog numbers.
2. Determination and verification of field measurements and field construction criteria.
3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
4. Determination of accuracy and completeness of dimensions and quantities.
5. Confirmation and coordination of dimensions and field conditions at Site.
6. Construction means, techniques, sequences, and procedures.
7. Safety precautions.
8. Coordination and performance of Work of all trades.

C. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.
D. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Engineer.

1.18 ENGINEER REVIEW

A. Do not make "mass submittals" to Engineer. "Mass submittals" are defined as six or more submittals or items in one day or 20 or more submittals or items in one week. If "mass submittals" are received, Engineer's review time will be extended as necessary to perform proper review. Engineer will review "mass submittals" based on priority determined by Engineer after consultation with Owner and Contractor.
B. Informational submittals and other similar data are for Engineer's information, do not require Engineer's responsive action, and will not be reviewed or returned with comment.
C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.
D. Submittal approval does not authorize changes to Contract requirements unless accompanied by Change Order.

E. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality control.
B. Tolerances.
C. References.
D. Labeling.
E. Testing and inspection services.
F. Manufacturers' field services.

1.2 QUALITY CONTROL

A. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Work of specified quality.
B. Comply with specified standards as the minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
C. Perform Work using persons qualified to produce required and specified quality.
D. Products, materials, and equipment may be subject to inspection by Engineer and Owner at place of manufacture or fabrication. Such inspections shall not relieve Contractor of complying with requirements of Contract Documents.
E. Supervise performance of Work in such manner and by such means to ensure that Work, whether completed or in progress, will not be subjected to harmful, dangerous, damaging, or otherwise deleterious exposure during construction period.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
B. Comply with manufacturers' recommended tolerances and tolerance requirements in reference standards. When such tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard except when more rigid requirements are specified or are required by applicable codes.
B. Conform to reference standard by date of issue current as of date of Contract Documents except where specific date is established by code.
C. Obtain copies of standards and maintain on Site when required by product Specification Sections.
D. When requirements of indicated reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
E. Neither contractual relationships, duties, or responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference in reference documents.

1.5 LABELING

A. Attach label from agency approved by authorities having jurisdiction for products, assemblies, and systems required to be labeled by applicable code.
B. Label Information: Include manufacturer's or fabricator's identification, approved agency identification, and the following information, as applicable, on each label:

    1. Model number.
    2. Serial number.
    3. Performance characteristics.

C. Manufacturer's Nameplates, Trademarks, Logos, and Other Identifying Marks on Products: Not allowed on surfaces exposed to view in public areas, interior or exterior.

1.6 TESTING AND INSPECTION SERVICES

A. Owner will employ and pay for specified services of an independent firm to perform testing and inspection for the first successful test.
B. Contractor shall be responsible for all costs associated with retesting of any Work that fails initial tests.
C. Independent firm will perform tests, inspections, and other services specified in individual Specification Sections and as required by Engineer.
D. Testing, inspections, and source quality control may occur on or off Project Site. Perform off-Site testing as required by Engineer or Owner.
E. Reports shall be submitted by independent firm to Engineer, Contractor, and authorities having jurisdiction, in duplicate, indicating observations and results of tests and compliance or noncompliance with Contract Documents.

    1. Submit final report indicating correction of Work previously reported as noncompliant.

F. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.

    1. Notify Engineer and independent firm 48 hours before expected time for operations requiring services.
    2. Make arrangements with independent firm and pay for additional Samples and tests required for Contractor's use.

G. Employment of testing agency or laboratory shall not relieve Contractor of obligation to perform Work according to requirements of Contract Documents.
H. Retesting or re-inspection required because of nonconformance with specified or indicated requirements shall be performed by same independent firm on instructions from Engineer.
I. The Contractor shall be responsible for all costs associated with failed tests, retesting, or re-inspection.
J. Agency Responsibilities:

    1. Test Samples of mixes submitted by Contractor.
    2. Provide qualified personnel at Site. Cooperate with Engineer and Contractor in performance of services.

3. Perform indicated sampling and testing of products according to specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or products.
6. Perform additional tests required by Engineer.
7. Attend preconstruction meetings and progress meetings.

K. Agency Reports: After each test, promptly submit two (2) copies of report to Engineer, Contractor, and authorities having jurisdiction. When requested by Engineer, provide interpretation of test results. Include the following:

a. Date issued.
b. Project title and number.
c. Name of inspector.
d. Date and time of sampling or inspection.
e. Identification of product and Specification Section.
f. Location in Project.
g. Type of inspection or test.
h. Date of test.
i. Results of tests.
j. Conformance with Contract Documents.

L. Limits on Testing Authority:

1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

1.7 MANUFACTURER'S FIELD SERVICES

A. When specified in individual Specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, quality of workmanship, startup of equipment, testing, adjusting, and balancing of equipment, and commissioning as applicable, and to initiate instructions when necessary.
B. Submit qualifications of observer to Engineer thirty (30) days in advance of required observations. Observer is subject to approval of Engineer.
C. Report observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturer's written instructions.
D. Refer to Section 01 33 00 - Submittal Procedures, "Manufacturer's Field Reports" Article.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities:

1. Temporary electricity.
2. Temporary lighting for construction purposes.
3. Temporary heating.
4. Temporary cooling.
5. Temporary ventilation.
6. Temporary water service.
7. Temporary sanitary facilities.

B. Construction Facilities:

1. Vehicular access.
2. Parking.
3. Progress cleaning and waste removal.
4. Project identification.
5. Traffic regulation.
6. Fire-prevention facilities.

C. Temporary Controls:

1. Barriers.
2. Enclosures and fencing.
3. Security.
4. Water control.
5. Dust control.
6. Erosion and sediment control.
7. Noise control.
8. Pest and rodent control.
9. Pollution control.

D. Removal of utilities, facilities, and controls.

1.2 REFERENCES

A. ASTM International:

1. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
3. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.3 TEMPORARY ELECTRICITY

A. Retain first Paragraph below when Contractor is required to pay for power costs or second Paragraph when Owner is required to pay for power costs.
B. Provide and pay for power service required from utility source as needed for construction operation.
C. Provide temporary electric feeder from existing building electrical service, if applicable, at location as directed by Owner. Do not disrupt Owner's use of service.
D. Power Service Characteristics: as required for construction operations.
E. Provide power outlets with branch wiring and distribution boxes located as required for construction operations. Provide suitable, flexible power cords as required for portable construction tools and equipment.
F. Provide main service disconnect and overcurrent protection at location meeting all applicable codes and regulations.
G. Permanent convenience receptacles may be used during construction.

1.4 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain lighting necessary for safe and functional construction operations.
B. Provide and maintain one (1) watt/sq ft lighting to exterior staging and storage areas after dark for security purposes.
C. Provide and maintain 0.25 watt/sq ft HID lighting to interior work areas after dark for security purposes.
D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, lamps, and the like, for specified lighting levels.
E. Maintain lighting and provide routine repairs.
F. Permanent building lighting may be used upon written permission from the Owner during construction, if applicable.

1.5 TEMPORARY HEATING

A. Provide and pay for heating devices and heat as needed to maintain specified conditions for construction operations.
B. Contractor shall be responsible for all operation and maintenance costs associated with temporary heating.
C. Maintain minimum ambient temperature as required in individual Sections of the Contract Documents.

1.6 TEMPORARY COOLING

A. Provide and pay for cooling devices and cooling as needed to maintain specified conditions for construction operations.
B. Contractor shall be responsible for all operation and maintenance costs associated with temporary cooling.

C. Maintain maximum ambient temperature as required in individual Sections of the Contract Documents.

1.7 TEMPORARY VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.8 TEMPORARY WATER SERVICE

A. Provide suitable quality water service as needed to maintain specified conditions for construction operations.
B. Contractor shall be responsible for coordination, cost of temporary connection(s), and cost of temporary water.
C. Extend branch piping with outlets located so that water is available by hoses with threaded connections.

1.9 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide facilities at time of Project mobilization.

1.10 VEHICULAR ACCESS

A. Construct temporary all-weather access roads from public thoroughfares to serve construction area, of width and load-bearing capacity to accommodate unimpeded traffic for construction purposes.
B. All temporary vehicular access crossing public rights-of-way, property, or easements shall be coordinated with the authority having jurisdiction and comply with all applicable regulations.
C. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
D. Extend and relocate vehicular access as Work progress requires and provide detours as necessary for unimpeded traffic flow.
E. Locate as indicated on Drawings or approved by Engineer.
F. Provide unimpeded access for emergency vehicles. Maintain twenty (20) foot-wide driveways with turning space between and around combustible materials.
G. Provide and maintain access to fire hydrants and control valves free of obstructions.
H. Provide means of removing mud from vehicle wheels before entering streets.
I. Use designated existing on-Site roads for construction traffic upon written approval from the Owner.

1.11 PARKING

A. Provide temporary parking areas to accommodate construction personnel.
B. Locate as indicated on Drawings or approved by Engineer.
C. Off-Site Parking:

    1. If Site space is not adequate, provide additional off-Site parking.
    2. The Contractor shall provide to the Engineer written permission or executed permit from property owner prior to utilizing off-Site parking that is not on City property.

D. Use of designated areas of existing on-Site streets and driveways used for construction traffic is not permitted. Tracked vehicles are not allowed on paved areas.
E. Use of designated areas of existing parking facilities used by construction personnel is permitted upon written approval from the Owner.

F. Do not allow heavy vehicles or construction equipment in parking areas.
G. Do not allow vehicle parking on existing pavement.
H. Designate two (2) parking space for Engineer.
I. Permanent Pavements and Parking Facilities:

1. Bases for permanent roads and parking areas may be used for construction traffic.
2. Avoid traffic loading beyond paving design capacity. Tracked vehicles are not allowed.
3. Use of permanent parking structures is not permitted.

J. Maintenance:

1. Maintain traffic and parking areas in sound condition, free of excavated material, construction equipment, products, mud, snow, ice, and the like.
2. Maintain existing and permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original condition.

K. Removal, Repair:

1. Remove temporary materials and construction before Substantial Completion.
2. Remove underground Work and compacted materials to depth of two (2) feet; fill and grade Site as indicated.
3. Repair existing facilities damaged by use, to original condition.

L. Mud from Site vehicles:

1. Provide means of removing mud from vehicle wheels before entering streets.

1.12 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris, and rubbish. Maintain Site in clean and orderly condition.
B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, before enclosing spaces.
C. Broom and vacuum clean interior areas before starting surface finishing, and continue cleaning to eliminate dust.
D. Collect and remove waste materials, debris, and rubbish from Site and dispose of off-Site as required to maintain a safe, neat, and orderly Site.
E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.13 PROJECT IDENTIFICATION

A. Project Identification Sign:

1. Project Identification Sign shall comply with Owner standards.
2. Main signage boards shall be ¾-inch pressure treated plywood mounted on a two-inch (2”) x four-inch (4”) pressure treated wood frame painted on all sides.

3. Sign portability:

    a. Each sign shall consist of two of the above described plywood sheets and frames hinged together at the top to form a two-sided sign that folds together for transportation from location to location, transportation provided by the Contractor.

    b. When installed at the site, the hinged connection will allow the bottom portion to move outward forming a triangle with the ground, allowing the sign to stand on its own.

    c. The sign faces shall be positioned so that oncoming traffic from both directions can read one side.

        1) Lettering shall be black intermediate grade vinyl or approved equal.

        2) Border Line shall be black, a minimum of one half inch (1/2") wide, and inset one inch (1") from the board edge.

B. Project Informational Signs:

1. Painted informational signs of same colors and lettering as Project identification sign or standard products; size lettering for legibility at 100-foot distance.
2. Provide sign at each field office and storage shed, and provide directional signs to direct traffic into and within Site. Relocate as Work progress requires.
3. Provide directional traffic signs to and within Site as required by the agency having jurisdiction.
4. No other signs are allowed without Owner's permission except those required by law.

C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

D. Show content, layout, lettering, color, foundation, structure, sizes, and grades of members.

E. Sign Materials:

1. Structure and Framing: New wood or metal, structurally adequate.
2. Sign Surfaces: Exterior grade plywood with medium-density overlay, minimum of 3/4 inches thick, standard large sizes to minimize joints.
3. Rough Hardware: Galvanized.
4. Paint and Primers: Exterior quality, two (2) coats; sign background of color as selected.
5. Lettering: Exterior quality paint or precut vinyl self-adhesive products, colors as selected.

F. Installation:

1. Install Project identification sign within fifteen (15) days after date established by Notice to Proceed.
2. Erect at location of high public visibility adjacent to main entrance to Site.
3. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind

loadings.

4. Install sign surface plumb and level, with butt joints. Anchor securely.
5. Paint exposed surfaces of sign, supports, and framing.

G. Maintenance: Maintain clean signs and supports; repair deterioration and damage.
H. Removal: Remove signs, framing, supports, and foundations at completion of Project and restore area.

1.14 TRAFFIC REGULATION

A. Signs, Signals, and Devices:

1. Post-Mounted and Wall-Mounted Traffic Control and Informational Signs: As approved by authorities having jurisdiction.
2. Traffic Control Signals: As approved by local jurisdictions.
3. Traffic Cones, Drums, Flares, and Lights: As approved by authorities having jurisdiction.
4. Flag Person Equipment: As required by authorities having jurisdiction.

B. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
C. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
D. Haul Routes:

1. Consult with authorities having jurisdiction and establish public thoroughfares to be used for haul routes and Site access.
2. Confine construction traffic to designated haul routes.
3. Provide traffic control at critical areas of haul routes to regulate traffic and to minimize interference with public traffic.

E. Traffic Signs and Signals:

1. Provide signs at approaches to Site and on Site, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
2. Provide, operate, and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control and areas affected by Contractor's operations.
3. Relocate signs and signals as Work progresses, to maintain effective traffic control.

F. Removal:

1. Remove equipment and devices when no longer required.
2. Repair damage caused by installation.
3. Remove post settings completely.

1.15 FIRE-PREVENTION FACILITIES

A. Prohibit smoking within buildings under construction and demolition. Designate area on Site where smoking is permitted. Provide approved ashtrays in designated smoking areas.
B. Establish fire watch for cutting, welding, and other hazardous operations capable of starting fires. Maintain fire watch before, during, and after hazardous operations until threat of fire does not exist.
C. Portable Fire Extinguishers: NFPA 10; 10-pound capacity, 4A-60B: C UL rating.

1. Provide minimum of one (1) fire extinguisher in every construction trailer and storage shed.

D. Provide fire extinguishers for construction equipment as required by applicable federal, state, and local codes.

1.16 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of Site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
B. Provide barricades and covered walkways required by authorities having jurisdiction for public rights-of-way and for public access to existing building.
C. Tree and Plant Protection: Preserve and protect existing trees and plants designated to remain.

1. Protect areas within drip lines from traffic, parking, storage, dumping, chemically injurious materials and liquids, ponding, and continuous running water.
2. Provide 6-foot-high barriers around drip line, with access for maintenance.
3. Replace trees and plants damaged by construction operations.

D. Protect non-owned vehicular traffic, stored materials, Site, and structures from damage.

1.17 ENCLOSURES AND FENCING

A. Construction and type of fencing may require description by Drawing detail.
B. Construction: Commercial-grade chain-link fence unless otherwise shown or specified.
C. Provide 6-foot-high fence around construction Site and storage area(s); equip with vehicular and pedestrian gates with locks.
D. Exterior Enclosures:

1. Provide temporary weathertight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating, cooling, and maintenance of required ambient temperatures identified in individual Specification Sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.18 SECURITY

A. Security Program:

1. Protect Work on existing premises and Owner's operations from theft, vandalism, and unauthorized entry.

2. Initiate program in coordination with Owner's existing security system at Project mobilization.
3. Maintain program throughout construction period until directed by Engineer.

B. Entry Control:

1. Restrict entrance of persons and vehicles to Project Site and existing facilities.
2. Allow entrance only to authorized persons with proper identification.
3. Maintain log of workers and visitors and make available to Owner on request.
4. Coordinate access of Owner's personnel to Site in coordination with Owner's security forces.

C. Personnel Identification:

1. Provide identification badge for each person authorized to enter premises.
2. Badge to Include: Personal photograph, name, expiration date, and employer.
3. Maintain list of accredited persons and submit copy to Owner on request.
4. Require return of badges at expiration of employment on the Work.

1.19 WATER CONTROL

A. Grade Site to drain. Maintain excavations free of water. Provide, operate, and maintain necessary pumping equipment.
B. Protect Site from puddles or running water. Provide water barriers as required to protect Site from soil erosion.

1.20 DUST CONTROL

A. Execute Work by methods that minimize raising dust from construction operations.
B. Provide positive means to prevent airborne dust from dispersing into atmosphere.

1.21 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills from borrow and waste disposal areas. Prevent erosion and sedimentation.
B. Minimize surface area of bare soil exposed at one time.
C. Provide temporary measures including berms, dikes, drains, and other devices to prevent water flow.
D. Construct fill and waste areas by selective placement to avoid erosive surface silts and clays.
E. Periodically inspect earthwork to detect evidence of erosion and sedimentation. Promptly apply corrective measures.

1.22 NOISE CONTROL

A. Provide methods, means, and facilities to minimize noise produced by construction operations.

1.23 PEST AND RODENT CONTROL

A. Provide methods, means, and facilities to prevent pests and insects from damaging the Work.
B. Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

1.24 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere

from discharge of noxious, toxic substances and pollutants produced by construction operations.

B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.25 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, and materials before Substantial Completion inspection.
B. Remove underground installations to minimum depth of two (2) feet.
C. Clean and repair damage caused by installation or use of temporary Work.
D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS - NOT USED
PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products.
B. Product delivery requirements.
C. Product storage and handling requirements.
D. Product options.
E. Equipment electrical characteristics and components.

1.2 PRODUCTS

A. At minimum, comply with specified requirements and reference standards.
B. Specified products define standard of quality, type, function, dimension, appearance, and performance required.
C. Furnish products of qualified manufacturers that are suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise. Confirm that manufacturer's production capacity can provide sufficient product, on time, to meet Project requirements.
D. Do not use materials and equipment removed from existing premises except as specifically permitted by Contract Documents.
E. Furnish interchangeable components from same manufacturer for components being replaced.

1.3 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products according to manufacturer's instructions.
B. Promptly inspect shipments to ensure products comply with requirements, quantities are correct, and products are undamaged.
C. Provide equipment and personnel to handle products; use methods to prevent soiling, disfigurement, or damage.

1.4 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products according to manufacturer's instructions.
B. Store products with seals and labels intact and legible.
C. Store sensitive products in weathertight, climate-controlled enclosures in an environment suitable to product.
D. For exterior storage of fabricated products, place products on sloped supports aboveground.
E. Provide off-Site storage and protection when Site does not permit on-Site storage or protection.
F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
H. Provide equipment and personnel to store products; use methods to prevent soiling, disfigurement, or damage.
I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.5 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Products complying with

specified reference standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and complying with Specifications; no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with Provision for Substitutions: Submit Request for Substitution for any manufacturer not named, according to Section 01 25 00 - Substitution Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.

B. Cord and Plug: Furnish minimum 6-foot long cord and plug including grounding connector for connection to electric wiring system. Cord of longer length may be specified in individual Specification Sections.

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Field engineering.
B. Closeout procedures.
C. Starting of systems.
D. Demonstration and instructions.
E. Project record documents.
F. Operation and maintenance data.
G. Manual for materials and finishes.
H. Manual for equipment and systems.
I. Spare parts and maintenance products.
J. Product warranties and product bonds.
K. Examination.
L. Preparation.
M. Execution.
N. Cutting and patching.
O. Protecting installed construction.
P. Final cleaning.

1.2 FIELD ENGINEERING

A. Employ land surveyor registered in State of Florida and acceptable to Engineer.
B. Locate and protect survey control and reference points. Promptly notify Engineer of discrepancies discovered.
C. Control datum for survey is indicated on Drawings.
D. Prior to beginning Work, verify and establish floor elevations of existing facilities to ensure that new Work will meet existing elevations in smooth and level alignment except where specifically detailed or indicated otherwise.
E. Verify setbacks and easements; confirm Drawing dimensions and elevations.
F. Provide field engineering services. Establish elevations, lines, and levels using recognized engineering survey practices.
G. Submit copy of Site drawing and certificate signed by land surveyor certifying elevations and locations of the Work are in conformance with Contract Documents.
H. Maintain complete and accurate log of control and survey Work as Work progresses.
I. Protect survey control points prior to starting Site Work; preserve permanent reference points during construction.
J. Promptly report to Engineer loss or destruction of reference point or relocation required because of changes in grades or other reasons.
K. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.
L. Final Survey: Prior to Substantial Completion, prepare final survey illustrating locations, dimensions, angles, and elevations of all Work and the relationship to permanent benchmarks and property lines.

1. All elevations shall be referenced to N.A.V.D 88.
2. All drawings shall have their boundaries tied into the City of Winter Springs GPS horizontal

control network with a minimum of two corners at each end of one boundary line identified by state plane coordinates.

3. Include certification, signed by surveyor, that the survey meets State of Florida applicable standards of practice for As-Built/Record Surveys.

1.3 CLOSEOUT PROCEDURES

A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:

1. Submit maintenance manuals, Project record documents, digital images of construction photographs, and other similar final record data in compliance with this Section.
2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
4. Obtain and submit releases enabling Owner's full, unrestricted use of Project and access to services and utilities. Include certificate of occupancy, operating certificates, and similar releases from authorities having jurisdiction and utility companies.
5. Deliver tools, spare parts, extra stocks of material, and similar physical items to Owner.
6. Make final change-over of locks and transmit keys directly to Owner. Advise Owner's personnel of change-over in security provisions.
7. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.
8. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Contractor considers Work to be substantially complete, submit to Engineer:

   a. Written certificate that Work, or designated portion, is substantially complete.

   b. List of items to be completed or corrected (initial punch list).

2. Within seven (7) days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.
3. Should Engineer determine that Work is not substantially complete:

a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Engineer.
c. Engineer will reinspect Work.
d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer's inspection.

4. When Engineer finds that Work is substantially complete, Engineer will:

a. Prepare Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Contractor considers Work to be complete, submit written certification that:

a. Contract Documents have been reviewed.
b. Work has been examined for compliance with Contract Documents.
c. Work has been completed according to Contract Documents.
d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

a. Final punch list indicating all items have been completed or corrected.
b. Final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
c. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
d. Accounting statement for final changes to Contract Sum.
e. Contractor's affidavit of payment of debts and claims.
f. Contractor affidavit of release of liens.

g. Consent of surety to final payment.

3. Perform final cleaning for Contractor-soiled areas according to this Section.

D. Final Completion Inspection:

1. Within seven (7) days after receipt of request for final inspection, Engineer will make inspection to determine whether Work or designated portion is complete.

2. Should Engineer consider Work to be incomplete or defective:

a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.

b. Contractor shall remedy stated deficiencies and send second written request to Engineer that Work is complete.

c. Engineer will reinspect Work.

d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer's inspection.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.
B. Notify Engineer a minimum of seven (7) days prior to startup of each item.
C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.
E. Verify that wiring and support components for equipment are complete and tested.
F. Execute startup under supervision of manufacturer's representative or Contractors' personnel according to manufacturer's instructions.
G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.
H. Submit a written report according to Section 01 33 00 - Submittal Procedures that equipment or system has been properly installed and is functioning correctly.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two (2) weeks prior to date of Substantial Completion.
B. Demonstrate Project equipment and instruct in classroom environment at a location determined by the Owner and instructed by authorized manufacturer's representative who is knowledgeable about the Project.
C. Video Recordings: If required by the Engineer, provide high-quality color video recordings of demonstration and instructional sessions. Engage commercial videographer to record sessions. Include classroom instructions, demonstrations, board diagrams, and other visual aids. Include menu navigation.
D. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
E. Use operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
F. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and

shutdown of each item of equipment at scheduled time, at equipment location.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
H. Required instruction time for each item of equipment and system is specified in individual Specification Sections.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain on Site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, product data, and Samples.
6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.
C. Store record documents separate from documents used for construction.
D. Record information concurrent with construction progress, not less than weekly.
E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates used.
3. Changes made by Addenda and modifications.

F. As-Built Drawings:

1. As-Built Drawings shall be prepared, signed, and sealed by a Professional Mapper and Surveyor (PMS), licensed to practice in the State of Florida. If the project was designed by an Engineer hired by the Developer, the As-Builts shall also be sealed by the Professional Engineer registered in the State of Florida and submitted on CD or DVD using state plane coordinates.
2. The following information is required on all As-Built Drawings. The Contractor shall note that additional information may be required by the Engineer when deemed necessary.

    a. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and Change Orders.
    b. Unless otherwise specified, the original construction plans, with as-built information shown, will be accepted for those projects contracted by the City.
    c. The drawings shall be revised (redrawn) to scale to indicate final as-built data (true to scale) and in accordance to all construction changes. Only changing a station and off-set note or

just adding notes is not acceptable for horizontal changes. In making changes to the drawings, utility lines or other features to be changed shall be erased before new lines are drawn, notations to be changed shall be reworded as required.

d. Items that were not installed as shown shall be so indicated by placing a "revision cloud" around the as-built information and a note shall be placed on the sheet near the lower right-hand corner in bold marking indicating that the information contained within the cloud is as-built. The as-built date shall also be shown.

e. Items that were constructed exactly per plan shall be shown by placing an asterisk adjacent to the as-built information indicating that it was built per plans with no changes.

f. Water, Sewer, and Reclaim As-Built Drawings:

1) Pipe location and depth.

2) Pipes shall be referenced to power poles (identify power pole number) or other permanent structures such as inlets, sidewalks, edge of pavement, or right-of-way lines. Where no permanent above grade structure exists, pipes shall be referenced to rights-of-way lines and edge of pavement every one-hundred (100) feet.

3) Fittings shall be referenced on the drawings. At least two (2) above ground, visible reference distances shall be shown for each fitting. Insets may be used to decrease drawing scale and increase detail. Where water mains are adjusted vertically, fittings and their elevations must be shown on As-Builts. Provide a cross-section detail showing the fittings and measurements.

4) Where service lines are installed, the services shall be shown in their relative position. Services shall be clearly identified as to single or double services. Where services vary more than two feet (2') from the property corner, the distance from the service to the property corner shall be shown. Show the size and type of service pipe. This may be noted in a legend.

5) Reference all valves two inches (2") in diameter and larger. Valves shall be referenced on Valve Tie Sheets. Valves shall be shown in their relative positions to one another and shall clearly indicate which lines they control. Sheet numbers of Valve Tie Sheets shall be shown on the As-Built Drawings for easy referencing.

6) Reference all existing valves within fifty feet of the Site.

7) Under general notes, the name of the manufacturer and model number shall be shown for all valves referenced.

8) All As-Built Drawings shall be prepared by using the Owner's Standard Legend and Abbreviations.

9) The size and type of water mains shall be indicated between all valves and tees.

10) The following items shall be located by Global Positioning System (GPS) equipment: valve boxes, meter boxes, fire hydrants, fittings, casings, and points of connection to the existing system. Depending on the type of project there may be other features that require GPS location.

3. Procedure for Submitting As-Built Drawings:

a. Original Submittal: Three (3) copies of all required As-Built materials, including Valve Tie Sheets, shall be submitted to the Engineer. No originals or certified copies shall be submitted in the Original Submittal. Submittals must be furnished with a cover sheet or letter of transmittal. As-Builts submitted without cover sheets will not be accepted. In lieu of paper submittals, As-Builts can be submitted electronically until the final submittal.

b. As-Built Review: The Original Submittal shall be reviewed for content and compliance to the specified requirements. If the As-Builts are found to be incomplete, one set will be returned with comments marked in red. The Contractor shall correct the As-Builts as indicated.

c. Resubmittal: After corrections, additions, or deletions are complete, the As-Builts shall be resubmitted. Three (3) sets of those items that were returned for corrections along with the red lined set shall be resubmitted. Resubmittal without the red lined set will be refused. No resubmittals will be accepted without a cover sheet. No originals or certified copies shall be submitted with the Resubmittal.

d. Final Submittal: After all As-Builts have been reviewed and comply with all specified requirements, the Engineer shall notify the Contractor to submit final As-Builts. Final As-Builts shall include a cover letter, two copies of the As-Builts signed, sealed, and dated by a professional mapper and surveyor, and one electronic file with one reproducible original. The Final Submittal shall also include As-Built Drawings in AutoCAD .dwg format. The Contractor shall verify the version of AutoCAD utilized by the Owner to prevent file compatibility issues.

1.7 OPERATION AND MAINTENANCE DATA

A. Select one or both forms of submittal in following Paragraphs.
B. Submit in PDF composite electronic indexed file.
C. Submit data bound in 8-1/2-inch (8.5”) x 11-inch (11”) text pages, three D side ring binders with durable plastic covers.
D. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of Project, and subject matter of the binder when multiple binders are required.

E. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
F. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
G. Contents: Prepare table of contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:

1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Include the following:

    a. Significant design criteria.
    b. List of equipment.
    c. Parts list for each component.
    d. Operating instructions.
    e. Maintenance instructions for equipment and systems.
    f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
    g. Safety precautions to be taken when operating and maintaining or working near equipment.

3. Part 3: Project documents and certificates, including the following:

    a. Shop Drawings and product data.
    b. Air and water balance reports.
    c. Certificates.
    d. Photo copies of warranties.

1.8 MANUAL FOR MATERIALS AND FINISHES

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one (1) copy with comments.
B. For equipment, or component parts of equipment, put into service during construction and operated by Owner, submit documents within ten (10) days after acceptance.
C. Submit one copy of completed volumes before Substantial Completion. Draft copy to be reviewed and returned after Substantial Completion, with Engineer comments. Revise content of document sets as required prior to final submission.
D. Submit three (3) sets of revised final volumes within ten (10) days after final inspection.
E. Submit in PDF composite electronic indexed file of final manual within ten (10) days after final inspection.
F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for re-ordering custom-manufactured products.
G. Instructions for Care and Maintenance: Include manufacturer’s recommendations for cleaning

agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.

I. Additional Requirements: As specified in individual product Specification Sections.

J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.9 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit two (2) copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one (1) copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten (10) days after acceptance.

C. Submit one copy of completed volumes before Substantial Completion. Draft copy will be reviewed and returned after Substantial Completion, with Engineer comments. Revise content of document sets as required prior to final submission.

D. Submit three (3) sets of revised final volumes within ten (10) days after final inspection.

E. Submit in PDF a composite electronic indexed file of final manual within ten (10) days after final inspection.

F. Each Item of Equipment and Each System: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

H. Include color-coded wiring diagrams as installed.

I. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.

J. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

K. Include servicing and lubrication schedule and list of lubricants required.

L. Include manufacturer's printed operation and maintenance instructions.

M. Include sequence of operation by controls manufacturer.

N. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

O. Include control diagrams by controls manufacturer as installed.

P. Include Contractor's coordination drawings with color-coded piping diagrams as installed.

Q. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

R. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

S. Include test and balancing reports as specified in Section 01 40 00 - Quality Requirements.

T. Additional Requirements: As specified in individual product Specification Sections.

U. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

1.10 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.
B. Deliver to Project Site and place in location as directed by Owner; obtain receipt prior to final payment.

1.11 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten (10) days after completion of applicable item of Work.
B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.
C. Verify documents are in proper form, contain full information, and are notarized.
D. Co-execute submittals when required.
E. Include table of contents and assemble in three D side ring binder with durable plastic cover.
F. Submit prior to final Application for Payment.
G. Time of Submittals:

1. For equipment, or component parts of equipment, put into service during construction with Owner's permission, submit documents within ten (10) days after acceptance.
2. Make other submittals within ten (10) days after date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten (10) days after acceptance, listing date of acceptance as beginning of warranty or bond period.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
C. Examine and verify specific conditions described in individual Specification Sections.
D. Verify that utility services are available with correct characteristics and in correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance according to manufacturer's instructions.
B. Seal cracks or openings of substrate prior to applying next material or substance.
C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

3.3 EXECUTION

A. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until

completion of construction.

B. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.

D. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
2. Physically separate products in place, provide electrical insulation, or provide protective coatings to prevent galvanic action or corrosion between dissimilar metals.
3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual-effect choices to Engineer for final decision.

E. Allow for expansion of materials and movement of structures.

F. Climatic Conditions and Project Status: Install each unit of Work under conditions to ensure best possible results in coordination with entire Project.

1. Isolate each unit of Work from incompatible Work as necessary to prevent deterioration.
2. Coordinate enclosure of Work with required inspections and tests to minimize necessity of uncovering Work for those purposes.

G. Mounting Heights: Where not indicated, mount individual units of Work at industry recognized standard mounting heights for particular application indicated.

1. Refer questionable mounting heights choices to Engineer for final decision.
2. Elements Identified as Accessible to Handicapped: Comply with applicable codes and regulations.

H. Adjust operating products and equipment to ensure smooth and unhindered operation.

I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

3.4 CUTTING AND PATCHING

A. Employ skilled and experienced installers to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements affecting:

1. Structural integrity of element.
2. Integrity of weather-exposed or moisture-resistant elements.
3. Efficiency, maintenance, or safety of element.
4. Visual qualities of sight-exposed elements.
5. Work of Owner or separate contractor.

C. Execute cutting, fitting, and patching including excavation and fill to complete Work and to:

1. Fit the several parts together, to integrate with other Work.
2. Uncover Work to install or correct ill-timed Work.
3. Remove and replace defective and nonconforming Work.
4. Remove samples of installed Work for testing.
5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.
E. Cut masonry and concrete materials using masonry saw or core drill.
F. Restore Work with new products according to requirements of Contract Documents.
G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
I. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
J. Identify hazardous substances or conditions exposed during the Work to Engineer for decision or remedy.

3.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual Specification Sections.
B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
C. Prohibit traffic from landscaped areas.

3.6 FINAL CLEANING

A. Execute final cleaning prior to final Project assessment.

1. Employ experienced personnel or professional cleaning firm.

B. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces.
C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.
D. Replace filters of operating equipment.
E. Clean debris from drainage systems.
F. Clean Site; sweep paved areas, rake clean landscaped surfaces.
G. Remove waste and surplus materials, rubbish, and construction facilities from Site.

END OF SECTION

SECTION 01 90 00

SEQUENCE OF CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Owner is required to maintain proper operation of Lift Station 7W at all times during the execution of the Contract. The Contractor shall follow a sequence of construction consistent with that requirement. Down time during connection to the existing force main is anticipated, but must be kept to a minimum so operations and service to the customers is not interrupted.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 OVERALL SEQUENCE OF CONSTRUCTION

A. Erosion control measures must be established prior to commencement of construction. The pre-construction video must also be completed before starting construction.

B. The Contractor is required to maintain proper operation of Lift Station 7W at all times during the execution of the Contract.

C. Contractor shall submit a Sequence of Construction if their plan and identify any deviations from the following sequence. Suggested Sequence of Construction:

1. Procure and excavate for Proposed wet well.
2. Installation of Proposed Manhole (P02)
    a. Place proposed manhole (P02) in ground with E invert in and NW invert out plugged.
3. Installation of Proposed Manhole (P03)
    a. Place proposed manhole (P03) in ground with W invert out plugged.
4. Modify existing manhole (03).
    a. Manhole will be modified to have existing SW invert out plugged and have new S invert out connected.
    b. Flow-through plug will be utilized to keep manhole in service during modification.
5. Connect/Install proposed 21-inch PVC sanitary sewer from modified existing manhole (03) to proposed manhole (P03).
    a. Have by-pass system on standby to divert flows from P03 to the existing sanitary receiving structure once flows are active in P03.
6. Installation of proposed 10-foot diameter wet well lift station.
    a. Install 10-foot diameter wet well.

b. Connect and plug invert in from proposed manhole (P02) to the wet well structure.

7. Installation of Proposed Doghouse Inside Drop Manhole (01)

   a. Doghouse manhole will be placed, but not cut until new downstream 12-inch PVC sanitary sewer is installed.

8. Installation of Proposed 12-inch PVC Sanitary Sewer from proposed manhole (P01) to (P02).

   a. Install/Connect proposed 12-inch PVC sanitary sewer.
   b. Have by-pass system on standby to driver flows from P02 to the existing wet-well structure.
   c. Cut existing 6-inch VCP sanitary sewer and divert upstream flows via flow through plug to new 12-inch PVC sanitary sewer.
   d. Remove remaining pipe to NW invert in existing manhole (02).

9. Installation of proposed 8-inch PVC from existing manhole (01) to proposed manhole (P01).

   a. Connect flow through wye/tee from existing SE and SW inverts into existing manhole (02).
   b. Modify manhole to be fitted to have slope inverted for NW invert out.
   c. Connect/Install 8-inch PVC from existing manhole (01) to proposed manhole (P01).
   d. Adjust flow through plug to divert flow into new 8-inch PVC NW invert out.
   e. Plug, grout, and abandon existing NE invert to existing sanitary receiving structure.
   f. Remove flow through plugs from existing manhole (02) and proposed manhole (P01).

10. Installation and testing of Proposed 16-inch force main, valves and flow meter.
11. Connection of proposed 16-inch DIP force main assembly to existing 20-inch Cast Iron force main.

    a. Close valving/line stop necessary to isolate existing 20-inch Cast Iron force main.
    b. Cut existing force main at connection point and remove necessary section of force main to make connection.
    c. Grout and cap upstream portion of existing 20-inch Cast Iron force main.

12. Installation of Proposed 21-inch PVC sanitary sewer from Proposed Manhole (P03) to Proposed Manhole (P02)

    a. Relocate by-pass system to diver flow from proposed manhole (P03) to the existing wet-well structure.
    b. Existing 10-inch by-pass force main and modified to be used as a temporary by-pass

connection.

c. Cut and remove intersecting sections of existing 10-inch by-pass force main and existing 18-inch RCP sanitary sewer.

d. Grout plugged/capped portions of piping.

e. Connect/Install proposed 21-inch PVC sanitary sewer from proposed manhole (P03) to proposed manhole (P02).

f. Remove by-pass from proposed manhole (P03) to existing wet well.

13. Connect by-pass system from the existing wet well structure to the existing 10-inch by-pass force main previously cut.
14. Shut-off pumps in existing dry-well.
15. Conduct lift station start-up.

    a. If start up test passes, remove by-pass system from wet-well.

    b. Vacuum existing 10-inch by-pass force main. Then grout and Plug/Cap, and backfill trench.

3.2 ELECTRICAL IMPROVEMENTS SEQUENCE OF CONSTRUCTION

A. Contractor shall provide backup power and controls to maintain proper operation of Lift Station 7W at all times during the execution of the Contract. Provide temporary generator, starter, control panel, etc. as required.

B. Proposed Electrical Sequence of Construction:

1. Install new electrical building, all electrical equipment.
2. Coordinate with Duke Energy & Owner to temporarily shut off power to the lift station. Provide conduit and wire from existing transformer to new electrical building and service. Temporarily power both existing and new service.
3. Energize new service. Test all equipment.
4. Coordinate with Owner and transfer two pumps to new electrical service.
5. Note – One Pump must always be energized either on temporary or permanent service.
6. Once all electrical equipment is transferred to new service, prepare removal of existing service.
7. Coordinate with Duke Energy & Owner to temporarily shut off power to the lift station. Remove conduit and wire associated with existing service.
8. Provide temporary generator adjacent to new electrical building with plug matching new generator receptacle.
9. Remove existing electrical equipment, generator, generator batteries, day tank, VFDs, and appurtenances from existing generator building.

10. Install new generator, day tank, etc.
11. Energize and Test automatic transfer switch and generator systems.
12. Remove all temporary equipment. Any temporary starters or control panels to be given to the Owner.

END OF SECTION

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SECTION 02 20 50

SITE GRADING

PART 1 - 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. Provide work under this section as shown or specified and in accordance with the Contract Documents.
B. Section Includes:

1. Preparing sites for the installation of structures, and horizontal directional drill pits.

1.3 REGULATORY REQUIREMENTS

A. Comply with Winter Springs, Florida Code of Ordinances Chapter 9 Land Development Standards.

PART 2 - PART 2 - PRODUCTS (NOT USED)

PART 3 - PART 3 - EXECUTION

3.1 GENERAL

A. Uniformly grade areas within the designated limits, including adjacent transition areas. Smooth finished surfaces to within specified tolerances with uniform levels or slopes between points where elevations are given or between such points and existing grade.
B. The degree of finished required for general site grading will be ordinarily obtainable with either motor grader or landscaping scraper operations. Grade areas around structures to meet required elevations and contours. Smooth and hand rake as required for a uniform surface, free of lumber, rocks, clods, rocks or other undesirable material.
C. Return any grade modified locations that may have been required during construction to preconstruction grade unless otherwise indicated.

3.2 SURFACE AREAS

A. Shape areas to receive surfacing material to line, with finished surface +0.0 to -0.10 feet of required sub-grade elevations. Slope areas to prevent any ponding. Compact to not less than 95% of standard density per AASHTO T-180.
B. Provide openings and temporary drainage facilities to prevent ponding of water on sub-grade before surfacing material is placed.

3.3 PROTECTION OF SURFACES

A. Comply with erosion control handbook requirements for prevention of erosion. Promptly repair, reestablish and install protective measures on settled, eroded, rutted or otherwise damaged areas to restore specified tolerances.

END OF SECTION

SECTION 02 32 00

TRENCHING, BEDDING, AND BACKFILLING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Trenching for piping and electrical work.
B. Excavation for manholes, junction boxes, meter vaults, and appurtenances.
C. Sheeting, shoring and bracing.
D. Bedding, backfilling, and compaction.

1.2 RELATED SECTIONS

A. Section 022050 -Site Grading

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO) latest edition:
B. AASHTO M145 - Classification of Soils
C. AASHTO T180 - Moisture-Density Soil Sampling and Testing
D. American Society for Testing and Materials (ASTM) latest edition:
E. ASTM D1557 - Moisture-Density Soil Sampling and Testing
F. ASTM D2487 - Classification of Soils

1.4 DEFINITIONS

A. Bedding = Area from bottom of trench to centerline of pipe
B. Backfill = material above the top of pipe to the topsoil, paving sub-grade, or foundation level.
C. Influence Area = the area within lines sloped downward at 45 degrees from the outer edges of paving, foundations, and utility lines.

1.5 QUALITY ASSURANCE

A. Field density testing frequencies:

1. One test for each 200 lineal feet or fraction thereof per lift of general backfilling in the pipeline trench.
2. One test for each 100 square feet or fraction thereof of backfill around and under structures.
3. One test per lift per each change in type of fill.

B. Density testing is required around sanitary manholes. Tests shall be staggered around the manhole within three feet of the structure’s outside diameter.

1.6 PRECONSTRUCTION REQUIREMENTS

A. Precondition surveys and vibration monitoring are required for those areas where residential structures are within 100 feet of the proposed construction.

PART 2 - PRODUCTS

2.1 GENERAL

A. It is intended that previously excavated materials conforming to the following requirements be utilized wherever possible.

2.2 MATERIALS

A. Suitable materials: AASHTO M145 classification A-1, A-3, A-2-4; ASTM D2487 classification GW, GP, SW, SP, SP-SM; unless otherwise disapproved within the Soil and Subsurface investigation reports. No more than 12% of acceptable materials shall pass the number 200 sieve.
B. Unsuitable materials: All materials other than those listed above.
C. Controlled low strength material ("flowable fill") shall meet the requirements of FDOT specification sections 121-1, 121-2, 121-3, 121-4, 121-5, and 121-6, except the range of acceptable 28-day compressive strength (as defined in 121-3) shall be revised to 75-100 psi.

2.3 SHEETING, SHORING, AND BRACING

A. The structural strength and safety of all sheeting, shoring, and bracing shall be the sole responsibility of the Contractor. Repair any damage resulting from failure to provide adequate supports.
B. Provide timber work, shoring, bracing, sheeting, and sheet piling where necessary to retain banks of excavations, prevent cave-in of adjacent ground, prevent displacement of utilities and structures, and to protect public safety.
C. Contractor is solely responsible for the design, installation, and operation of dewatering systems and their safety and conformity with local codes and regulations.

PART 3 - EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide suitable temporary drainage channels for any water that may flow along or across the work.
B. Provide barriers, warning lights, and other protective devices at all excavations.
C. Sidewalks, roads, streets, and pavements shall not be blocked or obstructed by excavated materials, except as authorized by the Engineer, in which case adequate temporary provisions must be made for satisfactory temporary passage of pedestrians and vehicles. Minimize inconvenience to public travel or to tenants occupying adjoining properties.
D. Where necessary to place excavated material adjacent to buildings, erect barriers to keep earth at least 4 feet from such buildings. Earth deposited on lawns shall be promptly and carefully removed to preserve the turf. All trees, shrubs, etc., shall be protected. Boring and jacking shall be used, if necessary, except where ENGINEER permission is granted to remove trees and shrubs.
E. If open excavations cross existing rigid surfacing, the surfacing shall be removed for a width one foot beyond the anticipated edge of the excavation. The pavement break shall be sawed to insure a straight joint. Surface replacement shall match existing surfacing except as otherwise indicated on the Drawings. Where open excavation is allowed along or across public roadways, excavation, backfill, and surface replacement shall conform to the requirements of all permits applicable thereto. In no case shall surface replacement edges bear on less than 12 inches of undisturbed soil.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.
B. Locate and identify existing utilities that are to remain and protect from damage.
C. Notify utility companies to remove or relocate utilities that are in conflict with proposed improvements.
D. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
E. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed, it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

3.3 SHEETING, SHORING, AND BRACING

A. Furnish, install, and maintain, without additional compensation, sheeting, bracing, and shoring support required to keep excavations within the easement provided, to support the sides of the excavation, and to prevent any movement which may damage adjacent pavements or structures, damage or delay the work, or endanger life and health. Voids outside the supports shall be immediately filled and compacted.
B. Sheeting, where required, shall be driven below the bottom of excavation so the lowest set of swales and struts are above the bottom of the excavation to allow necessary working room.
C. The Engineer may direct in writing that supports in trenches be cut off at any specified elevation, in which case Contractor shall be paid for the supports left in place.
D. Contractor may leave in place, to be embedded in the backfill of the excavation, any or all supports for the purpose of preventing injury to persons or property, whether public or private. However, no supports which are within 4' of the ground or pavement surface may be left in place without written permission of the Engineer. No extra payment will be made for supports left in place at the Contractor's option.
E. All supports not left in place shall be removed in such manner as to avoid endangering the piping, structures, utilities, or property, whether public or private. All voids left by the withdrawal of sheeting shall be immediately filled and compacted.
F. The right of the Engineer to order supports left in place shall not be construed as creating an obligation on his part to issue such orders. Failure by the Engineer to exercise this right shall not relieve the Contractor from total liability for damages to persons or property resulting from the failure of the Contractor to leave in place sufficient supports to prevent any caving or moving of the ground adjacent to the excavation.

3.4 TRENCHING

A. All excavations shall be made by open cut unless otherwise indicated. Sides of trenches shall be kept as nearly vertical as possible from the trench bottom to a level of one foot above the top of the pipe.
B. Excavation of trenches shall not advance more than 50 feet ahead of completed pipe installation except as approved by the ENGINEER.
C. Excavate trenches to depth indicated or required for indicated flow lines and invert elevations.
D. Where rock is encountered, carry excavation 6 inches below scheduled elevation and backfill with a 6-inch layer of crushed stone or gravel prior to installation of pipe.
E. For pipes or conduit 5 inches or less, excavate to indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
F. For pipes or conduit 6 inches or larger, and other work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6 inches below bottom of work to be supported.
G. Except as otherwise indicated, excavate for pressure piping so top of piping is minimum 3 feet below finished grade.
H. Unsuitable excavated materials shall be removed from the site and disposed, unless otherwise indicated on the Drawings.
I. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
J. Trench bottoms shall be kept dry, compacted, and stable to a depth two feet below the bottom of the trench.
K. Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 9 to 12-inch clearance on each side of pipe or conduit.
L. If more than one pipe is to be installed in a trench, the pipes shall be spaced a minimum of one (1) foot apart for pipes 4 inches and larger.

M. If portions of the bottom of trenches consist of material unstable to such a degree that, in the opinion of the Engineer, it cannot adequately support the pipe or structure, the bottom shall be over excavated and stabilized with approved coarse granular stabilization material. Depth of stabilization shall be as directed by the Engineer. The initial 10 tons of stabilization shall be incidental to the Contract. Compensation will be allowed only for such additional quantities as the Engineer shall direct in writing to be placed.
N. Do not backfill trenches until tests and inspections have been made.

3.5 TRENCH BACKFILLING

A. Following placement of pipe and inspection of joints, install tamped bedding material. Place bedding fill materials in layers of 6-inch loose depth.
B. All bedding and backfill material shall be suitable soils or flowable fill. Backfill material within 1 foot of pipe and appurtenances shall not contain rock or stone larger than 2-inch diameter. If a sufficient quantity of suitable material is not available from the trench or other excavations within the site, provide additional suitable material or flowable fill.
C. After completion of bedding and preliminary approval of piping and testing, the pipe shall be covered to a point one foot above the top of the pipe for the full trench width, placed in layers of 6-inch loose depth.
D. Place backfill over pipe. Where trench is within the influence area of roadways, structures, foundations, or slabs, place backfill in layers of 6-inch loose depth. In all other areas, place backfill in layers of 8-inch loose depth.
E. Take necessary precautions not to cause settlement or damage to adjacent slabs, walls, structures, or foundations. Place backfill and fill materials evenly adjacent to structures, without wedging against structures or displacement of piping or conduit.

3.6 MINOR STRUCTURAL EXCAVATION AND BACKFILLING

A. Minor structures are defined as manholes, junction boxes, inlets, valve vaults, and meter vaults. Do not excavate for any structure until that structure is scheduled for construction. Excavate only to the depth and dimensions necessary for the construction.
B. The bottom of all excavations shall be undisturbed earth unless otherwise indicated, and shall be approved by the Engineer before any subsequent work is started.
C. Excavations carried below depths indicated on the Drawings without the previous approval of the Engineer shall be filled with 2500-psi concrete or flowable fill to the correct level at the expense of the Contractor.
D. Maintain excavations in good order. If the bearing capacity of the foundation soils is reduced because the excavation is allowed to remain open prior to commencing work, the weathered soil shall be removed and replaced with 2500 psi concrete or flowable fill at the expense of the Contractor.
E. Do not backfill until new concrete has properly cured, coatings have been approved, and any required tests have been accepted.
F. Exercise care during backfilling operations to avoid any puncture, break or other damage to waterproofing systems, if any. Backfill adjacent to waterproofing in the presence of the Engineer.
G. Where backfilling is required on both sides of structures, backfill and compact simultaneously on opposite sides in even layers. Other backfilling sequences shall be as specifically noted.

3.7 COMPACTION

A. Unless otherwise indicated, the type of equipment and number of passes required to obtain the specified degree of compaction shall be determined at the site, subject to the approval of the Engineer.
B. Provide mechanical compaction for cohesive material and vibratory compaction for granular materials, unless otherwise approved by the Engineer. Vibratory compaction is not allowed within

100 feet of existing structures. In these areas, compaction shall be accomplished by static means only. If compaction difficulties arise, the Engineer shall be consulted to review and possibly modify compaction procedures.

C. Noncohesive soils shall be compacted with vibrating roller or equivalent; cohesive soils shall be compacted with sheeps-foot roller, pneumatic tamping, or approved equivalent, unless otherwise indicated.

D. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.8 TESTING AND CLEANUP

A. Provide for testing and cleanup as soon as practicable, so these operations do not lag far behind pipe installation. Perform preliminary cleanup and grading operations immediately after backfilling.

B. All surplus excavated material shall be disposed of by the Contractor.

3.9 FIELD QUALITY CONTROL

A. Minimum Density Requirement (ASTM D1557 or AASHTO T180)

1. Fill under and within the influence area of roadways, structures, slabs, foundations = 98%
2. Pond and road embankment fill = 95%
3. Landscape areas = 85%
4. All other areas = 90%

END OF SECTION

SECTION 02 41 19
DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation.
2. Salvage requirements.
3. Demolition.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Demolition Schedule: Indicate overall schedule and interruptions required for utility and building services.
C. Shop Drawings:

1. Indicate demolition and removal sequence.
2. Indicate location of items designated for reuse and Owner’s retention.
3. Indicate location and construction of temporary work.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Accurately record actual locations of capped utilities, concealed utilities discovered during demolition, and subsurface obstructions.

1.4 QUALITY ASSURANCE

A. Conform to applicable codes and regulations for demolition work, dust control, and products requiring electrical disconnection and re-connection.
B. Conform to applicable codes and regulations for procedures when hazardous or contaminated materials are discovered.
C. Obtain required permits from authorities having jurisdiction.
D. Perform Work in accordance with federal, state, and local regulations.

1.5 SEQUENCING

A. Section 01 10 00 - Summary: Requirements for sequencing.
B. Owner may conduct salvage operations before demolition begins to remove materials Owner chooses to retain.

1.6 SCHEDULING

A. Section 01 30 00 - Administrative Requirements: Requirements for scheduling.
B. Schedule Work to coincide with new construction.
C. Cooperate with Owner in scheduling noisy operations and waste removal that may impact Owners operation in adjoining spaces, or disturb the neighboring public.
D. Coordinate utility and building service interruptions with Owner.

1. Do not disable or disrupt building fire or life safety systems without five (5) days prior written notice to Owner.
2. Schedule tie-ins to existing systems to minimize disruption.

1.7 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent facilities.
B. Cease operations immediately if structure appears to be in danger and notify Engineer. Do not resume operations until directed.

PART 2 - PRODUCTS (NOT USED)
PART 3 - EXECUTION

3.1 PREPARATION

A. Notify affected utility companies before starting work and comply with applicable requirements.
B. Mark location and termination of utilities.
C. Edit the following for specific Project conditions. Reference Section 015000 for temporary partition construction.
D. Erect, and maintain temporary barriers and security devices, including warning signs and lights, and similar measures, for protection of the public, Owner, and existing improvements indicated to remain.
E. Retain the following only for demolition of post-tensioned elements.
F. Layout cuts in post tensioned concrete elements to avoid cutting concrete within 12 inches of any stressing tendon. Notify Engineer five (5) days in advance of cutting post-tensioned concrete.
G. Erect and maintain weatherproof closures for exterior openings.
H. Provide and maintain temporary measures to prevent spread of dust, odors, and noise.
I. Prevent movement of existing structures, utilities, or other facilities pertaining or adjacent to demolition activities; provide temporary bracing and shoring required.
J. Do not close or obstruct building egress path.

3.2 SALVAGE REQUIREMENTS

A. Coordinate with Owner to identify components and equipment required to be removed and delivered to Owner.
B. Tag components and equipment Owner designates for salvage.
C. Protect designated salvage items from demolition operations until items can be removed.
D. Carefully remove components and equipment indicated to be salvaged.
E. Disassemble as required to permit removal.
F. Package small and loose parts to avoid loss.
G. Mark equipment and packaged parts to permit identification and consolidation of components of each salvaged item.
H. Prepare assembly instructions consistent with disassembled parts. Package assembly instructions in protective envelope and securely attach to each disassembled salvaged item.
I. Deliver salvaged items to Owner. Obtain signed receipt from Owner.

3.3 DEMOLITION

A. Conduct demolition and/or removal operations, and the removal of equipment and debris to ensure minimum interference with roadways, walkways, and parking areas both onsite and offsite, and to

ensure minimum interference with occupied or used facilities.

B. Coordinate demolition activities to minimize impacts with Owner's operations.
C. Maintain protected egress from, and access to, adjacent existing buildings and parking areas at all times.
D. Do not close or obstruct roadways, driveways, parking areas, or sidewalks without prior written approval from the Engineer.
E. Cease operations immediately when any structure or facility appears to be in danger and notify Engineer.
F. Partial demolition of existing concrete structures and slabs shall include saw cutting in neat, orderly lines.
G. Disconnect and remove designated utilities within demolition areas.
H. Cap and identify abandoned utilities at termination points when utility is not completely removed. Annotate Record Drawings indicating location and type of service for capped utilities remaining after demolition.
I. Edit the following for specific Project conditions.
J. Demolish in orderly and careful manner. Protect existing improvements and facilities.
K. Carefully remove components indicated to be reused.

1. Disassemble components as required to permit removal.
2. Package small and loose parts to avoid loss.
3. Mark components and packaged parts to permit reinstallation.
4. Store components, protected from construction operations, until reinstalled.

L. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.
M. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.
N. Remove temporary Work.

END OF SECTION

SECTION 03 32 05

PRECAST CONCRETE BUILDINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes specifications for modular Precast Concrete Buildings
B. Related Work Specified Elsewhere.

1. SECTION 02200 – Earthwork
2. SECTION 03200 – Concrete Reinforcement
3. DIVISION 16

1.2 REFERENCES

A. American Concrete Institute (ACI), “Building Code Requirements for Reinforced Concrete, ACI 318-08 and ACID-318R-08”.
B. American National Standard Institute (ANSI):

1. A156 – Specifications for Door and Frame Preparation.
2. A156.4 – Standards for Door Controls – Closer.
3. A156.13 – Standards for Mortise Locks and Latches.

C. American Society of Engineers (ASCE), “Minimum Design Loads for Buildings and Other Structures, ASCE 7-95.
D. American Society of Testing and Materials (ASTM): D1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
E. Federal Specifications (Fed. Spec.): TT-S-00227: Sealing Compound; Elastomeric Type, Multi Component.
F. 2024 Florida Building Code

1.3 SUBMITTALS

A. Submit as required per DIVISIONS 2, 3, and 16 for materials to be incorporated in the work.
B. Submit manufacturer’s product data and certification that the proposed modular precast concrete building, steel doors and exhaust fan/ air-conditioning and other components conform to the specified requirements.
C. Submit manufacture’s standard design data and calculations for components of modular precast concrete building, together with detailed layout drawings showing all reinforcement and concrete cover, and indicating all block-outs and penetrations, that bear the seal and signature of a Registered Professional Engineer licensed to practice by the State of Florida.
D. Submit manufacturer’s standard design for form liners for selection of manufacturer’s standard textures.
E. Submit manufacturer’s product data sheets, for the steel insulated doors and hardware, exhaust fan, louvers, air-conditioner, interior finishes, floor coating, paint products and any other required building component.
F. Submit detail fabrication and erection shop drawings for placement of components and manufactured material.
G. Product/Code Certification: Provide written verification that the precast building and associated

exterior components provided and installed as a system or assembly in this Project meet or exceed requirements of 2024 Florida Building Code and ASCE 7-95 for wind resistance of components and classing. Products shall be designed and tested to be impact resistant in accordance with SBCCI STD 12-99. Provide design data and verification documentation signed and sealed by a professional engineer registered in the State of Florida including, but not limited to, the following:

1. Manufacturer's written certification indicating the type, grade, and size unit provided meets requirements.
2. Manufacturer's test data and engineering data developed indicating that requirements have been met.
3. Independent testing laboratory reports and certifications verifying that products meet requirements.
4. Calculations and definition of the code required loading for each unit in the Project.
5. Installation requirements describing types of fasteners and spacing.
6. Submit certification prior to or in conjunction with other submittals required herein. Other submittals received prior to receipt of this certification will be rejected.

1.4 QUALITY ASSURANCE:

A. Modular precast concrete building shall be designed and manufactured by a manufacturer having not less than three (3) years experience in the design and manufacture of similar facilities. Building design and drawings shall be prepared under the direct supervision of a Registered Professional Engineer.

Acceptable Manufacturers:

1. Leesburg Concrete Company, Inc., Leesburg, Florida
   Ph: 352-787-4177, Fx 352-787-7935.
2. Pre-Approved equal.

B. The manufacturer shall warrant its work against leakage for a period one year following installation. Leakage shall constitute proof of noncompliance with this specification, and shall be repaired at the Contractor's expense.

C. Precast Concrete Building envelope shall be resistant to 308 caliber (steel jacketed) rifle bullets, fired from a distance of 50-ft.

1.5 DESIGN CRITERIA

A. The modular precast concrete building(s) shall be constructed of reinforced concrete, and shall be designed to meet the following requirements using the most restrictive:

1. ASCE 7-95, or latest edition.
2. Building Code Requirements for Reinforced Concrete, ACI 318-08 and ACID-318R-08
3. 2024 Florida Building Code

B. The building(s) shall be designed for the following minimum loadings, unless the above reference codes are more restrictive:

1. Roof Live Load – 60 psf.
2. Roof Dead Load – 50 psf (minimum).
3. Floor Live Load – 100 psf.
4. Floor Dead Load – 63 psf (minimum).
5. Wind Speed – 150 mph / Category IV / Importance Factor – 1.15.
6. Earthquake – Zone 1.

C. The building(s) shall be designed to provide a factor of safety of at least 1.50 against overturning when subjected to the specified design wind loading. Provide additional concrete structure dead weight or soil anchors as required to ensure building's stability against overturning and sliding.
D. The building(s) shall be designed in accordance with AI 318. The floor and roof slabs shall be designed for 12-foot clear span without the use of interior supporting members. The interior finished ceiling height shall be not less than 12'-0". Concrete floor to concrete ceiling.
E. The building(s) shall be constructed of precast concrete panel sections which are plant assembled using structural steel connections. Joints shall be caulked with a material selected by the building manufacturer to maintain a permanent seal under severe weather and handling conditions.
F. Roof joints in modular buildings shall be sealed with EPDM membrane roofing strips of a thickness and width selected by the building manufacturer for the application proposed. Strips shall be cemented to the concrete with a compound designed for that purpose, and shall be sloped for drainage.
G. Exterior walls shall receive a skip trowel stucco finish and chamfered strip type extension at base, edges, seams and roof line to prevent unnecessary spalling. Exterior roof finish shall be smooth.
H. Interior of building(s) shall have an R-factor of 14 on the walls and 21 on the ceiling. Wall covering shall be 5/8" Type "X" drywall with "knockdown" finish. Painted white or color by owner. Interior on storage shall be light broom finish. Painted light gray or color by owner
I. The building(s) shall be assembled, sealed, waterproofed, and tested for watertightness at the building manufacturer's plant. All joints shall be caulked and concrete interior surfaced smoothed to remove projections.
J. Interior and exterior surfaces shall be painted as specified herein.
K. Coordinate the location of all openings for mechanical and electrical equipment.
L. Prefabricated building manufacturer shall provide wall-mounted air conditioning units manufacturer by Mitsubishi. Building manufacturer shall design the AC unit to provide sufficient building cooling based on the envelope dimensions and electrical loads shown in the building schedule below. Calculations shall be provided and signed and sealed by a Professional Engineer in the State of Destination.

1.6 BUILDING SCHEDULE

Location	Interior Dimensions	Access	AC Units
Electrical Building	As Shown in the Contract Drawings	1 PAIR 3’-0” x 8’-0” x 1-3/4” Steel Doors RHRA FL #4553-R11	Qty (1) two-ton split indoor unit system with one (1) outdoor wall-hung condenser as specified in the Contract Drawings.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation and field application of paints and other coatings.

1.2 DEFINITIONS

A. Refer to ASTM D16 for definitions of terms used in this Section.

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
2. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. American Water Works Association:

1. AWWA/ANSI C104/A21.4 – Cement Mortar Lining for Ductile Iron Pipe and Fittings.

C. Green Seal:

1. GS-03 - Anti-Corrosive Paints.
2. GS-11 - Paints and Coatings.

D. Master Painters Institute:

1. MPI - Approved Products List.
2. MPI - Architectural Painting Manual.

E. South Coast Air Quality Management District:

1. SCAQMD Rule 1113 - Architectural Coatings.

1.4 SEQUENCING

A. Section 01 10 00 - Summary: Requirements for sequencing.
B. Do not apply finish coats until paintable sealant is applied.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data:

1. Submit manufacturer data on all painting and coating products specified herein.

2. Include MPI - Approved Products Lists with proposed products highlighted.

C. Samples:

1. Submit two (2) copies of the manufacturer’s complete color charts for each coating.
2. Painted Samples:

a. Submit two (2) painted samples, illustrating selected colors and textures for each selected color and system with specified coats cascaded.

D. Manufacturer's Certificate:

1. Certify that products meet or exceed specified requirements.
2. Certify that coating and lining products are appropriate for the intended service.

E. Applicator’s Certificate:

1. The applicator shall supply a "Certificate of Application" attesting that the specified lining systems are supplied and applied as specified.

F. Manufacturer Instructions: Submit special surface preparation procedures and substrate conditions requiring special attention for each coating system.
G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
H. Qualifications Statements:

1. Coordinate following Subparagraphs with requirements specified in QUALIFICATIONS Article.
2. Submit qualifications for manufacturer and applicator.
3. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Operation and Maintenance Data: Submit information on cleaning, touchup, and repair of painted, coated, and lined surfaces.

1. Furnish product number for recommend repair compounds for each coating and lining system supplied.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
B. Extra Stock Materials:

1. Furnish 1 gal. of each color and type of coating provided for Project.
2. Label each container with manufacturer's label, color, type, texture, and Site location.
3. Store where directed by Engineer.

1.8 QUALITY ASSURANCE

A. MPI Standards:

1. Comply with indicated MPI standards.
2. Products: Listed in MPI - Approved Products List.

B. Surface Burning Characteristics:

1. Fire-Retardant Finishes: Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years of documented experience.
B. Applicator: Company specializing in performing Work of this Section with minimum five (5) years of documented experience and approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Container Labeling: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
C. Inspection:

1. Accept materials on Site in manufacturer's sealed and labeled containers.
2. Inspect for damage and to verify acceptability.

D. Store materials in ventilated area and otherwise according to manufacturer instructions.
E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
B. Storage Conditions:

1. Minimum Ambient Temperature: 45 degrees F.
2. Maximum Ambient Temperature: 90 degrees F

C. Application Conditions:

1. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by coating manufacturer.

2. Do not apply exterior coatings during rain or snow, when relative humidity is outside humidity ranges, or when moisture content of surfaces exceeds those required by paint manufacturer.
3. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors and 50 degrees F for exteriors, unless otherwise indicated by manufacturer instructions.

1.12 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
B. Furnish five-year manufacturer's warranty for paint and coatings.

PART 2 - PRODUCTS

2.1 PAINTS AND COATING SYSTEMS

A. Cement Mortar Pipe Lining:

1. Cement mortar pipe lining shall conform to AWWA/ANSI C104/A21.4.
2. All potable water main pipe lining materials shall conform to NSF 61 and NSF 372 requirements.

B. Amine Cured Novalac Cured Epoxy:

1. Description: Two component amine cured novalac epoxy for interior sewer pipe lining.
2. Minimum Solids Content: 87%.
3. Minimum Ceramic Quartz Content: 20%.
4. Minimum Dry Film Thickness: 40 mils.
5. Permeability:

a. The ceramic epoxy shall have a permeability rating of zero permeance when a film of at least 40 mils is tested according to ASTM D1653-79.
b. A permeability rating of 0.0 perms shall be achieved when measured using method A of ASTM E66-96 with a test duration of 42 days.

6. Manufacturers:

a. Fast Fabricators, SP-2000W
b. Induron, Protecto 401,
c. Environmental MD, Permox-CTF.

C. Bituminous Coating:

1. Description: Bituminous coating for concrete and pipe in mildly corrosive environments.
2. Number of Coats: Two (2).
3. Dry Film Thickness per Coat: Twelve (12) mils.

4. Application Method: Brush or Spray.
5. Each coat shall be applied at a rate of one (1) gallon per one hundred (100) square feet.
6. Manufacturers:
    a. Koppers, Bitumastic No. 300,
    b. Tnemec, 46H-413,
    c. or approve equal.

D. Polyamide Anti-Corrosive Coating – Moderately Corrosive Environment:

1. Description: Polyamide anti-corrosive coating for exposed metal and piping in moderately corrosive environments as shown and specified.
2. Polyamide, anti-corrosive epoxy primer:
    a. Number of Coats: One (1).
    b. Minimum Thickness per Coat: Three (3) mils.
3. Polyurethane Enamel:
    a. Number of Coats: Two (2).
    b. Minimum Thickness per Coat: Three (3) mils.
4. Manufacturers:
    a. Tnemec:
        1) Epoxy Primer: Series 66HS Hi-Build Epoxoline.
        2) Finish Coat: Series 72 Endura-Shield.
    b. Sherwin Williams
        1) Epoxy Primer: Macropoxy 646FC Polyamide Epoxy.
        2) Finish Coat: Macropoxy 646FC Polyamide Epoxy.

E. Polyamide Anti-Corrosive Coating – Highly Corrosive Environment:

1. Description: Polyamide anti-corrosive coating for exposed metal and piping in highly corrosive environments as shown and specified.
2. Polyamide, anti-corrosive epoxy primer:
    a. Number of Coats: One (1).
    b. Minimum Thickness per Coat: Three (3) mils.
3. Polyamide Epoxy-Coal Tar:

a. Number of Coats: Two (2).

b. Minimum Thickness per Coat: Eight (8) mils.

4. Manufacturers:

a. Tnemec:

1) Epoxy Primer: Series N69F Hi-Build Epoxoline.

2) Finish Coat: Series 435 Perma-Shield.

b. Sherwin Williams

1) Epoxy Primer: Cor-Cote SC Epoxy High Build Amine Cured Epoxy.

2) Finish Coat: Cor-Cote SC Epoxy High Build Amine Cured Epoxy.

F. Coal Tar Epoxy:

1. Description: Polyamide, epoxy-coal tar for application in moderately corrosive environments as shown or specified.
2. Exposure: Moderate.
3. Minimum Solids Content: 100-percent by volume.
4. Number of Coats: Two (2).
5. Minimum Dry Film Thickness Per Coat: Eight (8) mils.
6. Coating Systems:

a. Tnemec:

1) Epoxy Primer: Series N69F Hi-Build Epoxoline.

2) Finish Coat: Series 446 Perma-Shield.

b. Sherwin Williams:

1) Epoxy Primer: Cor-Cote SC Epoxy High Build Amine Cured Epoxy.

2) Finish Coat: Cor-Cote SC Epoxy High Build Amine Cured Epoxy.

G. Epoxy Coating for Concrete Coating for Highly Corrosive Environments:

1. Description: Multi-component aggregate-filled epoxy for application in highly corrosive environments as shown or specified.
2. Exposure: Severe.
3. Substrate Repair Material:

a. Number of Coats: One (1).

b. Minimum Thickness: 125 mil.

c. Application Method: Trowel.

4. Aggregate-Filled Epoxy Sealer:

a. Number of Coats: One (1).

b. Minimum Thickness: 125 mil.

c. Application Method: Spray or Trowel.

5. Minimum Solids Content: 100-percent by volume.

6. Manufacturers:

a. Sauereisen, SewerGard No. 210,

b. Tnemec, Series 434 Perma-Shield H2S,

c. Sherwin Williams, SherFlex Polyurethane Elastomer.

H. Coating for Aluminum in Contact with Dissimilar Materials:

1. Coat all surfaces of aluminum in contact with dissimilar materials such as concrete, mansonry, and steel with the following:

a. Two component polyamidoamine or polyamine epoxy.

b. Minimum Solids: 100-percent by volume.

c. Number of Coats: Two (2).

d. Minimum Thickness: 8 mil DFT per coat.

e. Manufacturers:

1) Tnemec, Series 165 Epoxoline 100,

2) Sherwin Williams, Dura-Plate UHS,

3) or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.
B. Verify that surfaces are ready to receive Work as recommended by product manufacturer.
C. Examine surfaces scheduled to be finished prior to commencement of Work and report conditions capable of affecting proper application to Engineer.
D. Test shop-applied primer for compatibility with subsequent cover materials.
E. Moisture Content:

1. Measure moisture content of surfaces using electronic moisture meter.

2. Do not apply finishes unless moisture content of surfaces are below following maximums:

a. Masonry, Concrete, and Concrete Unit Masonry: 15 percent.

b. Concrete Floors: 8 percent.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Surface preparation, curing times, number of coats, and the application methods shall be as contained in the lining and/or coating material manufacturer's published literature.

C. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

D. Defects:

1. Correct defects and clean surfaces capable of affecting Work of this Section.
2. Remove or repair existing coatings exhibiting surface defects.

E. Impervious Surfaces:

1. Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach.
2. Rinse with clean water and allow surface to dry.

F. Aluminum Surfaces Scheduled for Paint Finish:

1. Remove surface contamination by steam or high-pressure water.
2. Remove oxidation with acid etch and solvent washing.
3. Apply etching primer immediately following cleaning.

G. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish:

1. Remove foreign particles to permit adhesion of finishing materials.
2. Apply compatible sealer or primer.

H. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.

I. Concrete Floors:

1. Remove contamination, acid etch, and rinse floors with clear water.
2. Verify that required acid-alkali balance is achieved.
3. Allow to dry.

J. Copper Surfaces Scheduled for Paint Finish:

1. Remove contamination by steam, high-pressure water, or solvent washing.
2. Apply vinyl-etch primer immediately following cleaning.

K. Gypsum Board Surfaces:

1. Fill minor defects with filler compound.
2. Spot-prime defects after repair.

L. Galvanized Surfaces:

1. Remove surface contamination and oils, and wash with solvent.
2. Apply coat of etching primer.

M. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish:

1. Concrete Manhole and Wet Well:
2. Sandblast according to Specification SSPC-SP-7 ("Brush Off Blast Cleaning") with 60-80 mesh sand and air pressure of 50-60 psi to remove all cement glaze and residue of form release agents and provide a uniform surface profile of approximately one (1) mil.
3. Vacuum clean or air blast surface prior to coating. Apply coating to a dry surface (less than [15%] moisture-free as measured by a moisture meter) only.

N. Metal, Non-Submerged:

1. Clean all metal surfaces according to Specification SSPC- SP6 ("Commercial Blast Cleaning").

O. Shop-Primed Steel Surfaces:

1. Sand and scrape to remove loose primer and rust.
2. Feather edges to make touch-up patches inconspicuous.
3. Clean surfaces with solvent.
4. Prime bare steel surfaces.

P. Metal Doors Scheduled for Painting: Prime metal door at top and bottom edge surfaces.

Q. Existing Work:

1. Extend existing paint and coatings installations using materials and methods compatible with existing installations and as specified.

3.3 APPLICATION

A. Ductile Iron Pipe:

1. Ductile iron pipe interior and exterior coatings shall be checked for thickness using a magnetic film thickness gauge.
2. Thickness testing shall be done using the method outlined in SSPC-PA-2 film thickness testing.
3. The lining material shall not be applied above the thickness per coat as recommended in the manufacturer's printed literature.
4. Each pipe joint and fitting shall be marked with the date of the application of the lining system and with its numerical sequence of application on that date.

B. Concrete Manhole and Wet Well:

1. Apply liner and coatings to uniform thickness and in strict accordance with manufacturer's instructions and these requirements.
2. After pre-cast sections have been assembled seal all joints with a minimum six (6) inch overlap at each joint.

C. Metal, Non-Submerged:

1. Paint all exposed steel that is not stainless steel, exposed pipe work (except PVC), fittings, motors, and all mechanical equipment.
2. Touch up all shop-primed metal work as required in the field with epoxy primers and final coatings.

D. Comply with MPI - Architectural Painting Manual.
E. Do not apply finishes to surfaces that are not dry.
F. Apply each coat to uniform appearance.
G. Apply each coat of paint slightly darker than preceding coat, unless specified otherwise.
H. Sand metal surfaces lightly between coats to achieve required finish.
I. Cleaning:

1. Vacuum surfaces to remove loose particles.
2. Use tack cloth to remove dust and particles just prior to applying next coat.

J. Finishing Mechanical and Electrical Equipment:

1. Paint shop-primed equipment.
2. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components, and paint separately.
3. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars, and supports, except where these items are shop finished.
4. Paint interior surfaces of air ducts visible through grilles and louvers with one coat of flat black paint to visible surfaces.
5. Paint dampers exposed behind louvers and grilles to match face panels.
6. Paint exposed conduit and electrical equipment installed in finished areas.
7. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
8. Color-Coding:

    a. Color-code equipment, piping, conduit, and exposed duct work according to indicated requirements.
    b. Color band and identify with flow arrows, names, and numbering as shown and specified.

9. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings that were removed prior to finishing.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Inspecting and Testing: Comply with MPI - Architectural Painting Manual.

3.5 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
B. Collect waste material that may constitute fire hazards, place in closed metal containers, and remove daily from Site.

3.6 ATTACHMENTS

A. Schedule: Finishes shall be as shown on the Drawings.

END OF SECTION

Section 13300

PROCESS INSTRUMENTATION AND CONTROL SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Work includes engineering, furnishing, installing, programming, testing, documenting and placing in operation a Programmable Logic Controller (PLC) within a SCADA/RTU Panel at Lift Station 7 West.

B. It is the ultimate responsibility of the CONTRACTOR to furnish a complete and fully operable system that reliably performs the specified functions. However, it is the intent of these Contract Documents that a single entity (henceforth referred to as the SYSTEM SUPPLIER) be retained by the CONTRACTOR to have overall responsibility for designing, furnishing, interfacing, adjusting, testing, documenting, and starting-up the equipment described in the Contract Documents.

C. The work defined in this Specification Section shall be performed by the following listed below and henceforth referred to as the SYSTEM SUPPLIER.

1. Revere Controls

2. Inframark A&I

3. iQuest

D. The CONTRACTOR shall be responsible for:

1. Equipment storage and protection until installed following the storage and handling instructions recommended by the SYSTEM SUPPLIER. Anti-static and winterization requirements shall be per the SYSTEM SUPPLIER's instructions and the SYSTEM SUPPLIER shall periodically verify that these instructions are followed.

2. Including within the electrical subcontractor's scope the provision, installation and termination of field and power wiring to the SCADA/RTU Panel. Termination shall be made in accordance with final accepted interconnection diagrams developed by the SYSTEM SUPPLIER. The electrical subcontractor shall mark on the interconnect diagram the field wire numbers used for each termination point. The SYSTEM SUPPLIER shall finalize the

interconnect diagrams by including these field wire numbers in the final as built version.

E. All engineering development required by the SYSTEM SUPPLIER will be in accordance with the Conditions of this Contract.

F. Equipment found to be defective prior to system acceptance shall be replaced and installed at no additional cost to the OWNER.

G. In the bid price, the SYSTEM SUPPLIER shall provide for obtaining the services of authorized field personnel from the manufacturers of components or systems provided under this section but not manufactured by the SYSTEM SUPPLIER. Should these personnel be required during installation, start-up and checkout of the new PLC, such services shall be provided at no additional cost to the OWNER.

1.02 RELATED WORK

A. All conduits, power and field wiring and cables are provided and installed under Division 16.

1.03 SUBMITTALS

A. Furnish, as prescribed under the General Requirements, all required submittals covering the items included under this section and its associated sections of the work.

B. Submit complete, neat, orderly, and indexed submittal packages. Handwritten diagrams are not acceptable, and all documentation submittals shall be made using CADD generated utilities.

C. Partial submittals or submittals that do not contain sufficient information for complete review or are unclear will not be reviewed and will be returned by the ENGINEER as not approved.

D. Provide all shop drawing submittals in PDF format.

E. Provide a single control panel shop drawing submittal containing the following:

1. Loop diagrams, consisting of complete wiring and/or plumbing diagrams for each control loop showing all terminal numbers, the location of the dc power supply, the location of any booster relays or common dropping resistors, surge arrestors, etc. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus divide each

loop diagram into four areas for identification of element locations: PLC I/O point(s), panel face, back-of-panel, and field, respectively.

2. System interconnect diagram that shows all connections required between component parts of the items covered in this section and between the various other systems specified in this Contract. Number all electrical terminal blocks and field wiring. Identify each line at each termination point with the same number. Do not use this number again for any other purpose in the complete control scheme.

3. Bill of Materials: A list of all components, including all 3rd party software. Group components by type and include component model number and part number, component description, quantity supplied, and reference to component catalog information.

4. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements. Clearly mark all options and features proposed for this project.

5. Installation Details. Equipment installation drawings showing external dimensions, enclosure material and spacing, mounting connections, and installation requirements.

6. A list of, and descriptive literature for, spares, expendables, and test equipment.

F. Test Procedures: Submit the procedures proposed to be followed during all system testing. Procedures shall include test descriptions, forms, and check lists to be used to control and document the required tests.

G. Test Reports: Upon completion of each required test, document the test by submitting a copy of the signed off test procedures to the ENGINEER.

1.04 FINAL DOCUMENTATION

A. After the demonstration tests have been completed and as a part of the final acceptance requirements, submit the system record drawings. Record drawings shall include, corrected for any changes that may have been made up through Substantial Completion:

1. instrument loop wiring diagrams

2. panel wiring diagrams

3. panel elevations

4. interconnection diagrams showing terminal numbers at each wiring termination

B. Record drawings shall be developed or converted to the latest version of AutoCAD. Provide two copies of all AutoCAD files on USB Drives.

C. Operating and Maintenance (O&M) Manuals: Provide the specified number of complete sets of three-ring bound O&M manuals in accordance with Division 1. Include descriptive material, drawings, and figures bound in appropriate places. Include:

1. Cross references to 3rd party O&M manuals.

2. Additional operating and maintenance instructions in sufficient detail to facilitate the operation, removal, installation, adjustment, calibration and maintenance of each component provided.

3. All the submittal data for each component from the approved shop drawing submittals with corrections made on approved as noted items.

4. A USB containing the shop drawing data in PDF format in the binder sleeve.

D. Provide the following additional final documentation:

1. licenses in the OWNER's name for all software supplied including software used for programming.

2. final copies of all programming files on USB Drive

1.05 QUALITY CONTROL

A. The SYSTEM SUPPLIER shall be subcontracted by and paid by the CONTRACTOR.

B. The SYSTEM SUPPLIER shall meet all of the requirements of these specifications, and, unless specifically stated otherwise, no prior acceptance of any subsystem, equipment, or materials has been made.

C. All equipment furnished by the SYSTEM SUPPLIER shall be of the latest and most recent design and shall have overall accuracy as guaranteed by the manufacturer.

D. Materials and equipment used shall be U.L. approved wherever such approved equipment and materials are available.

E. Component equipment shall be as supplied by one of the manufacturers named or approved equal. The design of the system is based on the first-named manufacturer's equipment if there is a difference.

F. To facilitate the OWNER's operation and maintenance, products shall be of the same major MANUFACTURER, with panel mounted devices of the same type and model as far as possible.

G. In order to insure the interchangeability of parts and the maintenance of quality, strict compliance with the above requirements shall be maintained.

H. The SYSTEM SUPPLIER shall designate a single point of contact for interface with the ENGINEER on this project. The ENGINEER reserves the sole right to approve or reject this point of contact.

I. The SYSTEM SUPPLIER shall provide experienced personnel on-site to coordinate and/or perform installation, termination, and adjustment; on-site testing; OWNER training; and startup assistance for the system.

1.06 STANDARDS

A. The design, testing, assembly, and methods of installation of the wiring materials, electrical equipment and accessories proposed under this Contract shall conform to the National Electrical Code and to applicable state and local requirements. UL listing and labeling shall be adhered to under this Contract.

B. Instrument Society of America (ISA) and National Electrical Manufacturers Association (NEMA) standards shall be used where applicable in the design of the system.

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

D. Any additional work needed resulting from any deviation from codes or local requirements shall be at no additional cost to the OWNER.

1.07 WARRANTY AND GUARANTEES

A. In accordance with Division 1, the SYSTEM SUPPLIER shall furnish to the OWNER a written two year guarantee commencing with substantial completion, that all equipment and parts thereof, material and/or workmanship are of top quality and free from defects.

B. The SYSTEM SUPPLIER shall guarantee all equipment whether or not of his own manufacture.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Equipment to be installed in a hazardous area shall meet Class, Group, and Division classification as shown on the Contract Electrical Drawings, or comply with the local or National Electrical Code, whichever is the most stringent requirement.

B. All components supplied shall be of the MANUFACTURER's latest design and shall produce or be activated by signals, which are established standards for the water and wastewater industries.

C. Electronic equipment shall utilize printed circuitry suitably coated to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for their purpose, to assure optimum long-term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

D. All equipment shall be designed to operate on a 60-Hertz alternating current power source at a normal 120 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

E. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single MANUFACTURER, insofar as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion through the installation of plug-in circuit cards or additional cabinets.

F. The equipment furnished shall be designed to operate satisfactorily between 0 degrees C and 40 degrees C at up to 95 percent Relative Humidity (non-condensing).

G. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 volts-amperes (VA), unless specifically noted otherwise.

H. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

2.02 FIELD INSTRUMENTS

A. Provide the field instruments shown on the Contract Drawings and as further defined herein.

B. Electro-magnetic Flow Metering System. The magnetic flow metering system shall comprise a flow through spool piece with sensing electrodes (Flow Element, FE) and an electronics unit (Flow Indicating Transmitter, FIT). The spool piece shall contain a coil energized by D.C. pulses from the electronics unit. The voltage induced in the process fluid shall be sensed by the electrodes and converted, by the electronics unit, into a derived flow signal.

1. System Performance:

   a. Systems shall be wet calibrated at the factory using NIST traceable equipment.

   b. Overall system accuracy shall be plus or minus 0.2 percent of rate between 1 and 30 feet per second.

   c. It shall be possible to verify system calibration in the field. Methods which require removal of the spool piece or a second flow measurement (i.e. another meter or known volume) will not be acceptable.

2. Materials:

   a. Tube – 304 Stainless Steel

   b. Liner – Teflon or Ebonite

   c. Electrodes – 316 Stainless Steel or Hastelloy

3. Ratings:

   a. Vault located spool piece – Rated for continual submergence to 10 feet. This shall include potting of the able between the spool piece and electronics unit.

   b. Other spool pieces –NEMA 4X.

   c. Electronics Unit – NEMA 4X

4. Electrical:

   a. Power Requirement - 120 VAC plus or minimum 10 percent, 60 Hertz.

   b. Maximum Power Consumption – 20 Watts.

5. Functional:

   a. Programmable low flow cut-out

   b. Empty pipe detection

   c. Electronic unit display: minimum of 2 x 16-character, backlit LCD.

6. Options:

   a. Provide HART compatible instrument communications.

   b. Provide grounding rings as required to establish potential matching.

   c. Provide ultrasonic cleaning where necessary for coating sensitive systems.

   d. Provide special tools and software necessary to effect field calibration.

   e. Provide certificate of factory calibration.

7. Manufacturer, Model series:

   a. Siemens SiTran Mag5100 flow tube and FM Mag 6000 transmitter with Siemens Verificator.

   b. ABB WaterMaster

C. Ultrasonic Level Element and Transmitter. The system shall consist of a sensor (Level Element, LE) that uses a non-contact measurement technique to measure the liquid level in a vessel, tank or basin that produces an analog signal proportional to level.

1. System Performance:

   a. Overall system accuracy shall be plus or minus 0.08 inches.

b. The unit shall contain programmable functions that allow false echoes from passing equipment are damped out.

c. The system shall be field calibratable

2. Power Requirement – Loop powered

3. Materials – PVDF cone

4. Options:

a. Provide manufacturer provided stainless steel mounting hardware.

b. Provide manufacturer supplied stainless steel sunshield.

5. Manufacturer, Model series:

a. Siemens HydroRanger, with XPS-15

b. Approved equal.

D. Level Switch, Float. The level switch shall be a direct acting, weighted float suspended on its own cable. As the liquid level rises the float tilts and actuates a hermetically sealed mercury switch inside the float. The cable shall be terminated within a junction box located outside the tank or basin. For multiple float applications, all cables shall terminate in a single junction box.

1. Materials:

a. Float wetted part – Polypropylene

b. Cable – PVC jacketed

c. Junction box – 316 SS

2. Ratings:

a. Junction box – NEMA 4X

3. Electrical:

a. Dry contact rated to 4.5 Amps at 120 VAC

b. Normally open or normally closed as required for the application

4. Options

a. Provide stainless steel supports/mounting accessories as required.

5. Manufacturer, model:

a. Anchor Scientific, Roto-float type S

b. No equal.

E. ~~Limit Switch. The limit switch shall detect the closed position of a hatch, door, etc. by means of an actuator. The actuator shall energize the switch while the door is closed.~~

~~1. General:~~

~~a. Actuator orientation: As required for application~~

~~b. Actuator mechanism: Adjustable lever roller.~~

~~c. Switch shall not be mounted on the moving portion of the door or hatch.~~

~~2. Materials:~~

~~a. Normal applications: Phosphate coated zinc with Epoxy coating.~~

~~b. Corrosive locations: All 316 Stainless Steel including actuating lever.~~

~~3. Ratings:~~

~~a. NEMA 4X for normal applications.~~

~~b. NEMA 6 where potential submergence exists.~~

~~c. Use explosion proof switches with factory installed cable for all Class I rated locations.~~

~~4. Electrical:~~

~~a. Normally open and normally closed dry contacts~~

~~b. Dry contact rated to 10 Amps at 120 VAC~~

~~5. Options~~

~~a. Provide stainless steel supports/mounting and strike plates as required.~~

~~6. Manufacturer, model:~~

~~a. Honeywell, model HDLS or LSX as applicable~~

~~b. Approved equal.~~

Radar Level Element and Transmitter. The system shall consist of a sensor (Level Element, LE) that uses a non-contact measurement technique to measure the liquid level in a vessel, tank, or basin that produces an analog signal proportional to level.

1. System Performance:

a. Overall system accuracy shall be plus or minus 0.08 inches.

b. The unit shall contain programmable functions that allow false echoes from passing equipment are damped out.

c. The system shall be field calibratable.

2. Power Requirement:

a. Loop Powered.

3. Materials:

a. Stainless Steel.

4. Communications:

a. 4-20mA Output.

b. HART.

5. Options:

a. Provide manufacturer provided stainless steel mounting hardware.

b. Provide manufacturer supplied stainless steel sunshield.

6. Manufacturer, Model Series:

a. Siemens LR560.

b. Approved equal.

2.03 PROGRAMMABLE LOGIC CONTROLLER

A. Monitoring and control of the site shall be accomplished within the PLC. All control strategies specified in Part 3 of this Specification Section shall be implemented within the new PLC.

B. The PLC shall be implemented using the Schneider M340 family of controllers and I/O. The use of other manufacturer's products will not be acceptable.

C. The PCP shall be NEMA 4X 316 stainless steel enclosure with a continuous piano hinge and a lockable 3-point latch.

D. The PCP shall be PLC based and be in strict compliance with the control panel requirements defined herein.

E. The PLC shall be implemented using the Schneider M340 series modules housed in a DIN-rail mounted chassis:

1. Power Supply Module. Each PLC rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source. Any power transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. Provide Schneider P/N BMXCPS3020

2. Central Processor Unit (CPU). The CPU module shall include a math coprocessor and a minimum of 8 MBytes of SRAM memory shall be installed. However, the actual amount of memory supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide Schneider M340 P/N BMXP342020 as necessary to perform the required functions. The PLC shall be programmed using Schneider's Unity platform.

3. Ethernet Module. Interfaces the CPU rack with an Ethernet network, either 10 Base-T/100 Base-TX or 100 Base-FX. Provide Schneider P/N BMXNGD0100.

4. Process I/O modules. Provide process I/O modules sufficient to accommodate the required I/O as shown on the Contract Drawings plus a minimum of 15% fully wired spares of each signal type. All I/O modules shall be provided with screw type terminal blocks with barriers between adjacent terminals for connection of field wiring. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminal blocks shall be key coded to prevent connection to other I/O modules. The following modules shall be used:

5. Discrete inputs: Schneider model BMXDDI3202K.

6. Analog inputs: Schneider model BMXAMI0810.

7. Discrete outputs: Schneider model BMXDRA0805.

8. Analog outputs: Schneider model BMXAMO0410.

9. Ethernet Backplanes. Used to interface I/O modules to the CPU. The following models are acceptable:

10. 4 Slot Ethernet Backplane: Schneider model BMEXBP0400

11. 12 Slot Ethernet Backplane: Schneider model BMEXBP1200

12. Memory Card. The Memory card shall be a 4GB SD memory card which will be used for program backup. Provide Schneider P/N BMXRMS004GPF

2.04 OPERATOR INTERFACE TERMINALS

A. An operator interface terminal shall be provided, where shown and/or specified. The OIT shall be a front panel mounted OIT with a 19" wide display (1366x768). Provide application software and programming as needed to allow local operator monitoring and control of the associated PLC. Provide a Harmony GTU, no equal.

2.05 CONTROL PANEL DEVICES

A. Uninterruptible Power Supply. A UPS shall be provided to power all components within the control panel. The UPS shall meet the following minimum requirements.

1. Voltage. 120VAC

2. VA Rating. 1500 VA

3. Wattage. 1350 W

4. Receptacles. 6 5-15R

5. Outputs. 2 Relay Outputs

6. Manufacturer, model

a. Eaton, 9SX1500

b. No Equal.

2.06 SPARES

A. Provide the following spare parts to cover all three stations:

1. One spare CPU module

2. One spare of each type of Power Supply Module.

3. One spare Interface Module of each type provided.

4. Two spare I/O modules of each type provided.

5. Five percent (rounded up) spare relays of each type provided.

6. One spare network switch.

2.07 COMMUNICATION

A. The CONTRACTOR shall provide an AT&T ASE fiber circuit. The circuit shall terminate on a telephone board in the electrical building per drawings.

B. The CONTRACTOR shall establish the AT&T ASE circuit account and maintain the contract until substantial completion. Upon substantial completion, the contractor shall turn over the service and account responsibility to the county.

C. All powered communication devices and appliances shall be provided online UPS power for bumpless power connectivity in case of a power outage.

PART 3 - EXECUTION

3.01 GENERAL

A. Prerequisite Activities and Lead Times: Do not start the following key project activities until the listed prerequisite activities have been completed and lead times have been satisfied:

1. Hardware Purchasing, Fabrication, and Assembly: Associated design related submittals completed (no exceptions, or approved as noted).

2. Shipment: Completion and approval of all design related submittals.

3. Startup: Operational Checkout Tests.

4. OWNER Training: Owner Training Plan completed and O&M manuals delivered.

5. Demonstration Tests: Operational Check-out Tests, Startup, OWNER Training, and Demonstration Test Procedures must be complete. Give 4 weeks' notice prior to the planned test start date.

B. Substantial Completion: Substantial Completion for the project is as defined in the General Conditions. However, the following requirements must be fulfilled before consideration will be given for Substantial Completion of the system:

1. All system submittals have been completed.

2. The system has successfully completed the Demonstration Tests.

3. The required OWNER training has been completed.

4. All spares, expendables, and test equipment have been received by OWNER.

C. Final Acceptance: system final acceptance is defined as the date when the ENGINEER issues a written notice of final acceptance. For this Section, the following must have been completed before consideration will be given to the issuance of notice of final acceptance:

1. All punch-list items have been checked off.

2. Revisions to the system O&M Manuals have been made (that may have resulted from the Demonstration Tests).

3.02 PRODUCT HANDLING

A. Adequately pack manufactured material to prevent damage during shipping, handling, storage and erection. Pack all material shipped to the project site in a container properly marked for identification. Use blocks and padding to prevent movement.

B. Ship materials that must be handled with the aid of mechanical tools in wood-framed crates.

C. Ship all materials to the project site with at least one layer of plastic wrapping or other approved means to make it weatherproof. Anti-stat protection shall be provided for all sensitive equipment.

D. Inspect the material prior to removing it from the carrier. Do not unwrap equipment until it is ready to be installed. If any damage is observed, immediately notify the carrier so that a claim can be made. If no such notice is given, the material shall be assumed to be in undamaged condition, and any subsequent damage that is discovered shall be repaired and replaced at no additional expense to the OWNER.

E. Store and protect equipment until installation following the storage and handling instructions recommended by the equipment manufacturers. Place special emphasis on proper anti-static protection of sensitive equipment.

F. ESD Protection: Provide for the proper handling, storage, and environmental conditions required for the system components deemed static sensitive by the equipment manufacturer. Utilize anti-stat wrist straps and matting during installation of these items to prevent component degradation.

G. Protection During Construction: Throughout this Contract, provide protection for materials and equipment against loss or damage and from the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions. Provide covers for panels and other elements that may be exposed to dusty construction environments. Specific storage requirements shall be in accordance with the SYSTEM SUPPLIER's recommendations.

H. Corrosion Protection: Protect all consoles, panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules. Prior to shipment, include capsules in the shipping containers, and equipment as recommended by the capsule manufacturer. During the construction period, periodically replace the capsules in accordance with the capsule manufacturer's recommendations. Replace all capsules just prior to Final Acceptance.

I. The CONTRACTOR shall be responsible for any damage charges resulting from the handling of the materials.

3.03 INSTALLATION

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch-up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. Clean and polish the exterior of all panels and enclosures upon the completion of the demonstration tests.

B. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance. Coordinate I&C work with the OWNER and work of other trades to avoid conflicts, errors, delays, and unnecessary interference.

C. Start up the new PLC and confirm its proper operation. While the station operation must be temporarily taken out of backup control to achieve this,

return it to that condition following any checkout work until the start up is fully and satisfactorily completed.

D. Once the new PLC is in full control of the station, verify the operation of the Backup Control Panel set forth in the Contract Drawings.

3.04 TRAINING

A. The cost of training programs to be conducted with OWNER's personnel shall be included in the Contract price.

B. All training schedules shall be coordinated with, and at the convenience of the OWNER. Shift training may be required to correspond to the OWNER's working schedule.

C. Provide a minimum of one day training for up to three of the OWNER's personnel in the maintenance of the hardware which shall include:

1. Training in standard hardware maintenance for the equipment provided.

2. Specific training for the actual hardware configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up.

3. Test, adjustment, and calibration procedures.

4. Troubleshooting and diagnosis.

5. Component removal and replacement.

6. Periodic maintenance.

D. Provide a minimum of one day training for up to six of the OWNER's personnel in the use of the operator graphic screens.

3.05 TESTING - GENERAL

A. All elements of the system, both hardware and software, shall be tested to demonstrate that the total system satisfies all of the requirements of the Contract Documents

B. As a minimum, the testing shall include shop tests, operational check-out tests, and Demonstration Tests.

C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system producing the correct result (effect), the specific test requirements will have been satisfied.

D. All tests shall be conducted in accordance with, and documented on, prior approved procedures, forms, and checklists. Each specific test to be performed shall be described and a space provided after it for signoff by the appropriate party after its satisfactory completion. Copies of these signoff test procedures, forms, and checklists will constitute the required test documentation.

E. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. Define these simulation techniques in the test procedures.

F. The SYSTEM SUPPLIER shall coordinate all of their testing with the CONTRACTOR, the ENGINEER, all affected suppliers, and the OWNER.

G. The ENGINEER reserves the right to test or retest any and all specified functions whether or not explicitly stated in the approved test procedures. The ENGINEER's decision shall be final regarding the acceptability and completeness of all testing.

3.06 FACTORY ACCEPTANCE TEST

A. Prior to shipment, perform a factory demonstration test on the fully assembled and functioning system as further defined below. Actual software furnished by others shall be loaded on the simulated development environment virtual machines. It is anticipated that this test will be of at least three full working days duration.

B. The testing shall include VFD and MCC equipment furnished under Division 16.

C. Successfully perform a full dry run of the test prior to certifying to the ENGINEER that the system is ready for OWNER and/or ENGINEER witness of a formal test. Travel and living costs for the two (2) ENGINEERS and two (2) OWNER personnel to witness the test shall be the responsibility of the SYSTEM SUPPLIER.

D. The intent of this test is to demonstrate to the ENGINEER’s satisfaction that the system is fully operational and debugged prior to shipment and installation. It is recognized that loop tuning, final drive parameter settings, etc. can only be performed in the field. However, subsequent to shipment it should only be necessary to confirm correct wiring and installation and proper control loop operation. The factory demonstration test shall therefore be structured to confirm the functional operation of the complete system.

E. Before starting the test, prepare a system inspection log. In the log, record the serial numbers of all major components and document that all portions

of the system have been inspected by quality assurance personnel. Include the log in the required test report.

F. Start-up the system from a fully powered down condition demonstrating that the various system elements can be brought online without adverse consequences. Throughout subsequent testing use system CISCO, VLAN, VMWare, PLC, and PICS diagnostics to demonstrate system status under the various fault scenarios.

G. Demonstrate normal operations including the following:

1. Functioning of all control strategies using the operator process graphics.

2. Correct operation of protective interlock relay logic within the Local Control Panels, Backup Relay Panels, and MCCs.

H. Demonstrate the ability, from an Operator Workstation, to review, modify, and adjust the following:

1. PLC programs

2. VFD drive parameters

3. Reduced Voltage Starter parameters.

4. Electronic Overload Relay parameters.

5. Network management including the redundant ring.

6. Remote management and configuration of the Ethernet switches

I. Demonstrate the required UPS back-up duration. This may be performed concurrently with other portions of the test.

J. Demonstrate the system can detect hardware failures and failover to standby systems, and that other system functions remain unaffected:

1. Failure of a power supply, server, network switch, network cable, and PLC.

2. Failure of a HMI, drive, starter, motor overload, power monitor, and network card.

3. Loss of communications with a server, workstation, HMI, switch, VFD, and WAP.

4. Failure of a field instrument, blown fuses, and relay failure.

K. Provide for up to two hours per day of OWNER/ENGINEER directed additional tests.

L. The SYSTEM SUPPLIER shall provide any and all travel and lodging for the entirety of the factory acceptance testing. The OWNER shall not incur any cost as it relates to the factory acceptance testing.

3.07 OPERATIONAL READINESS TEST (ORT)

A. Prior to startup and demonstration testing, certify that the system (inspected, tested and documented) is ready for operation. These inspections and tests shall include Loop/Component inspections and tests. The SYSTEM SUPPLIER shall fully debug problems in the system as a whole. Final approval of control software will not be based on written descriptions of software functions alone, but on actual performance in the field.

B. Check the entire system for proper installation, calibration and adjustment on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittals and the Specifications.

C. The Loop/Component Inspections and Tests shall be implemented using approved forms and checklists. These shall be developed by the SYSTEM SUPPLIER and submitted for approval.

D. Loop Status Report: Each control loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check-off items with spaces for sign-off by the SYSTEM SUPPLIER:

1. Project Name

2. Control Loop Number or description

3. Tag Number or description for each component of the control loop

4. Check-offs/sign-offs for each component for proper installation, termination, and calibration/adjustment

5. Check-offs/sign-offs for the control loop for proper panel interface terminations, I/O interface terminations, I/O signal operation relative to the computer network, and total loop operation ready

6. Space for comments

E. Component Calibration Sheet: Each field instrument element and each PLC I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for signoff by the SYSTEM SUPPLIER:

1. Project Name

2. Component Identification or I/O Module Number

3. Manufacturer, Model Number/Serial Number of field element

4. Summary of Functional Requirements (scale, range, computing equation, control action, etc.)

5. Calibrations of span, setpoints, and preset adjustable parameters

6. Space for comments

F. Maintain the Loop Status Reports and Component Calibration Sheets at the jobsite and make them available to the ENGINEER at any time.

G. Witnessing: These inspections and tests do not require witnessing. However, the ENGINEER will review the Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Check-out Tests. Correct any deficiencies found.

3.08 FIELD ACCEPTANCE TEST (FAT)

A. Once the system has passed the ORT, the SYSTEM SUPPLIER shall perform a witnessed Field Acceptance Test (FAT) on the complete system. The FAT shall demonstrate that the system is operating and in compliance with the Contract requirements. Each specified function shall be demonstrated on a paragraph-by-paragraph, and site-by-site basis.

B. Prior to the FAT, the entire installed system shall be certified in writing by the CONTRACTOR that it is ready for operation.

C. The system shall operate for a continuous 100 hours without failure before this test will be considered successful.

D. The FAT shall cover the entire system, including control functions, alarms, and status monitoring. Test procedures used for shop tests may be adopted for these tests if modified as required.

3.09 30-DAY SITE ACCEPTANCE TEST (SAT)

A. After completion of the Field Acceptance Test, the entire system shall operate for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.

B. Provide complete O&M Manuals for the system at the jobsite at least two weeks prior to the SAT.

C. During this test, plant operating and SYSTEM SUPPLIER personnel shall be present as required. The SYSTEM SUPPLIER is expected to provide personnel for this test who have an intimate knowledge of the hardware and software of the system.

D. While this test is proceeding, the OWNER shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.

E. Any malfunction during the tests shall be analyzed and corrections made by the SYSTEM SUPPLIER. The ENGINEER and/or OWNER will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

F. Any malfunction, during this 30 consecutive day test period, which cannot be corrected within 24 hours of occurrence by the SYSTEM SUPPLIER's personnel, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.

G. Upon completion of repairs, by the SYSTEM SUPPLIER, the test shall be repeated as specified herein.

H. In the event of rejection of any part or function, the SYSTEM SUPPLIER shall perform repairs or replacement within 90 days.

I. All data base errors must be corrected prior to the start of each test period. The 30-day test will not be considered successful until all databases are correct.

J. The total availability of the system shall be greater than 99.5 percent during this test period.

1. Availability is given by “(Total Time-Down Time) / Total Time".

2. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided, shall not contribute to the availability test times above.

K. Upon successful completion of the 30-day Site Acceptance Test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

3.10 CONTROL STRATEGIES

A. General. Provide control strategies that meet the following general conditions:

1. Utilize the OWNER's standard Type 6 program as the base programming for this project.

2. Wherever in the descriptions the control strategy refers to the operator, it is intended to mean via the operator graphic screens on the OIT or at the SCADA master site.

3. All control strategies shall run within the PLC. Data manipulation (calculated analog values, elapsed time functions, event determination) shall be performed by the PLC for the associated equipment it is monitoring. Any resulting values from these manipulations shall be reported as individual registers. The intent is to avoid utilizing the HMI software for this purpose.

4. The control functions described herein are not intended to be complete comprehensive programming logic descriptions. They describe only the general intended control operation required. Provide complete program logic to completely fulfill the functional requirements indicated.

5. Provide all programming necessary to support the functional requirements of the operator graphic screens.

6. Provide complete debugging services to address issues identified by the OWNER or ENGINEER during and after startup until final acceptance.

B. Overall Station Operation. Provide the following operator adjustable settings associated with overall station pumping operations:

1. A software WET WELL 1/BOTH/WET WELL 2 select switch. While the switch is set to WET WELL 1 or WET WELL 2, use that wet well's level transducer as the process variable for control. If the selected wet well level transducer fails, turn off the PLC FAIL output to initiate back up control operations. If BOTH is selected proceed as follows:

   a. Calculate the average reading of the two level transducers and use it as the process variable for control.

   b. If either transducer fails, issue an advisory alarm and switch to the other.

   c. If the difference between the readings of the level transducers differs by a preset amount, issue an advisory alarm.

2. A software IN SERVICE/OUT OF SERVICE select switch for each wet well. If a wet well is placed out of service, automatically set the

above select switch to the wet well still in service. If both wet wells are placed out of service, disable the control strategy. Establish a LEAD/LAG sequence for the wet wells that can be manually overridden by the operator. Automatically rotate the sequence when all pumps stop or after 24 hours.

3. LSL. Lower operating limit for wet well level.

4. LS. Target operating point for wet well level.

5. LSH. Upper operating limit for wet well level.

C. Overall Pumping Control Strategy. Establish a LEAD/LAG/LAG-LAG sequence for the pumps in each wet well that can be manually overridden by the operator. Omit from the schedule those pumps not in AUTO (including those not yet installed). Automatically rotate the sequence when all pumps in a wet well stop or after 24 hours. Issue calls for pumps as follows:

1. Provide a PID control loop that adjusts pump speed to maintain the process value at LS.

2. Call for another pump if the speed signal is at 100% and the process value rises to LSH. When starting the pump, ramp down operating pump speed until the new pump's speed matches then resume PID control. Call for pumps using the LEAD pump in the LEAD wet well first, followed by the LEAD pump in the LAG wet well and so on.

3. Stop the longest running pump if the speed signal is at an operator adjustable low value and the process value falls to LSL.

4. Automatically call for the next pump in sequence if a pump fails to start or fails while running.

5. Prevent a pump starting within a preset time of it being turned off.

D. Individual Pump Control. Provide the operator with a software HAND/OFF/AUTO select switch and SPEED potentiometer (restricted to the range 55%-100%) and proceed as follows:

1. While the select switch is in HAND run the pump at the speed set by the software potentiometer.

2. While the select switch is in OFF stop the pump and prevent it from running.

3. While the select switch is in AUTO, control the pump based on the overall pumping strategy above.

4. Set a software fail and operator alarm for any pump which:

   a. Fails to run within a preset time of being called to start.

   b. Fails to stop within a preset time of being called to stop.

   c. Fails while running.

5. Provide an operator controllable reset switch for the above software faults.

6. Within the PLC accumulate the elapsed run time and number of starts for the pump. Make these figures available to the operator through the graphic screens and provide the operator the ability to individually reset them to zero.

E. Station Mixer Control. Provide a control strategy within the new PLC to operate the two mixers when its respective wetwell is in service. Refer to Division 11 specs for additional requirements.

F. Slide Gate Controls. Provide a control strategy within the new PLC to operate the three slide gates when its respective wetwell is in service. Refer to Division 11 specs for additional requirements.

3.11 MONITORING FUNCTIONS

A. Station Flow Monitoring. Provide the following functions:

1. Monitor for and record minimum and maximum daily 5-minute average values for station flow. Record the date and time of occurrence for each.

2. Accumulate running daily total flow. At midnight, transfer the total to yesterday's total then restart accumulating from zero.

B. Station Discharge Pressure Monitoring. Monitor for and record minimum and maximum daily value of station pressure signal. Record the date and time of occurrence for each.

C. Station Potable Water Monitoring. Monitor for and record minimum and maximum daily value of water pressure signal. Record the date and time of occurrence for each.

D. Analog Signal Monitoring. For all analog signals monitored by the system excluding VFD speed signals, provide operator adjustable high and low level values and issue an alarm if the analog value goes outside this range.

E. Discrete Signal Monitoring. In addition to any alarms specifically described within the previously defined Control Strategies, issue an alarm for any fail status or for any un-commanded change of state.

3.12 OPERATOR GRAPHICS

A. Ensure that all command functions require a two-step process.

B. The graphic screens shall support all the operator interface functions associated with the PLC control strategies.

3.13 PROGRAMMING DEVICES AND SOFTWARE

A. Programming Device. The SYSTEM SUPPLIER shall provide a new Siemens PG M6 to the OWNER in the OWNER'S name with all the latest projects stored on the machine. The PG shall be provided with the latest version of TIA Portal Step 7 and WinCC Advanced. The owner shall be provided with a 1-year SUS on the PG and shall be transferred to the OWNER'S name after turnover.

B. Simocode ES. The SYSTEM SUPPLIER shall provide a licensed copy of Simocode ES V15.1 in TIA Portal in the OWNER'S name. A programming cable shall be provided to the OWNER by the SYSTEM SUPPLIER. This license is to be included in the SUS provided in subsection A of 3.12.

C. PLCSIM Advanced. The SYSTEM SUPPLIER shall provide a licensed copy of the latest version of Siemens TIA Portal PLCSIM Advanced in the OWNER'S name. This license is to be included in the SUS provided in subsection A of 3.12.

End of Section

SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and install complete and make operational, electrical and process instrumentation systems as shown on the Drawings and as specified herein.

B. The work shall include furnishing, installing, and testing the equipment and materials specified in other Sections of the Division 16 Specifications and shown on the Drawings.

C. The work shall include furnishing and installing the following:

1. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.
2. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these specifications, including process instrumentation primary elements, transmitters, local indicators, and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these specifications.
3. A complete raceway system for the Data Highway Cables and specialty cable systems. Install the Data Highway Cables and other specialty cable systems in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the computer system supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways.
4. Power wiring for all heating, ventilating, and air conditioning (HVAC) equipment furnished under other Divisions of these Specifications, including power wiring for 120V unit heater motors, thermostats, fan motors, dampers and other HVAC inline unit wiring shown on the Drawings.
5. Furnish and install precast manholes and precast handholes.
6. Furnish and install manhole and handhole frames and covers.
7. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost.

D. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site in which work under this Division is to be performed and carefully inspect the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

E. The CONTRACTOR shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the

ENGINEER for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, manholes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished. All layouts shall be drawn to scale on 24 x 36 sheets. Refer to the SUBMITTALS paragraph within this specification for additional requirements.

F. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

G. A single manufacturer shall provide switchgear, motor control centers, transformers, disconnect switches, panel boards, etc. This manufacturer shall also provide the power system study as specified herein.

H. CONTRACTOR shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved in writing by the ENGINEER. Any temporary added shall be removed at final completion.

I. Complete coordination with other CONTRACTORs. CONTRACTOR shall coordinate with all other CONTRACTORs equipment submittals and obtain all relevant submittals.

J. Mount transmitters, process instruments, operator stations, etc. furnished under other Divisions of these specifications.

K. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading, and seeding is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

L. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in Division 16. All work shall be done in accordance with Divisions 2 and 3 of these specifications.

1.2 RELATED WORK

A. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in Division 2.

B. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, light pole bases and reinforcing steel, is specified in Division 3.

1.3 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01300, Submittal Procedures, for equipment, materials and other items furnished under Division 16.

B. Shop drawings shall be submitted for the following equipment:

1. Section 16110 – Raceways, Boxes and Cabinets
2. Section 16108 – Miscellaneous Equipment
3. Section 16120 – Wires and Cables
4. Section 16150 – Motors
5. Section 16160 – Panelboards
6. Section 16195 – Electrical Identification
7. Section 16370 – Variable Frequency Drives
8. Section 16440 – Group Mounted Switchboards
9. Section 16450 – Grounding System
10. Section 16500 – Lighting System
11. Section 16670 – Lightning Protection System
12. Section 16709 – Surge Protection Devices (SPD)

C. Submittals shall be required for the following items:

1. Qualifications of Electrical Contractor Superintendent
2. Concealed and buried conduit layouts
3. Preliminary Short Circuit Study
4. Final Power System Study
5. Test reports
6. Manufacturer's service reports

D. The manufacturers name and product designation or catalog numbers shall be submitted for the following material utilized:

1. Testing Equipment
2. Ground System Resistance Test Equipment

E. Check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.

F. The ENGINEER's check shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the CONTRACTOR from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.

G. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

H. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered, or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM", "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED".

I. In addition to manufacturer's equipment shop drawings, submit electrical installation working drawings containing the following:

1. Concealed and buried conduit layouts, shown on floor plans drawn at not less than 1/4-in = 1-ft-0-in scale. The layouts shall include locations of process equipment, motor control

centers, transformers, panelboards, control panels and equipment, motors, switches, motor starters, large junction or pull boxes, instruments and any other electrical devices connected to concealed or buried conduits.

2. Plans shall be drawn on high quality paper, size 36-in by 24-in and shall be presented in a neat, professional manner.
3. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are approved.

J. Operation and Maintenance Data

1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01720. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc., to instruct operating and maintenance personnel unfamiliar with such equipment.
2. Manuals shall include the following as a minimum:

    a. A comprehensive index.
    b. A complete "As-Built" set of approved shop drawings.
    c. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.
    d. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.
    e. System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Section.
    f. Detailed service, maintenance and operation instructions for each item supplied.
    g. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
    h. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
    i. Complete parts list with stock numbers, including spare parts.

1.4 REFERENCE STANDARDS

A. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. National Fire Protection Association (NFPA)
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. Insulated Cable ENGINEERs Association (ICEA)
7. Instrument Society of America (ISA)
8. Underwriters Laboratories (UL)
9. Factory Mutual (FM)
10. International Electrical Testing Association (NETA)
11. Institute of Electrical and Electronic ENGINEERs (IEEE)

B. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., and

shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 PRIORITY OF THE CONTRACT DOCUMENTS

A. If, during the performance of the work, the CONTRACTOR finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the ENGINEER and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization, or association, or between Laws and Regulations, the higher performance requirement shall be binding on the CONTRACTOR, unless otherwise directed by the ENGINEER.

E. In accordance with the intent of the Contract Documents, the CONTRACTOR accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the CONTRACTOR's responsibility to comply with all Laws and Regulations at all times.

1.6 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, non-process indoor locations.
2. NEMA 12 for "DUST" locations.
3. NEMA 4X 316 stainless steelfor outdoor locations, rooms below grade (including basements and buried vaults), "DAMP", "WET", “PROCESS” and "CORROSIVE" locations.
4. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

1.7 HAZARDOUS AREAS

A. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502, 503, 504 and 510.

B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

1.8 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.9 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 16 and repair or replace all defective work and equipment. Refer to the individual equipment sections for additional specific testing requirements. Employ the services of an independent recognized power systems testing company, other than the manufacturer of the switchgear or motor control centers, to perform the tests specified herein.

B. Field testing and commissioning shall be performed in accordance with the latest revisions of NETA Standard ATS "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" unless otherwise modified by these Sections.

C. A typed test report for each component tested shall be submitted to the ENGINEER for the project record files. The firm doing the testing shall include, in the report, their opinion whether or not the equipment being tested complies with the specification. Any discrepancies shall be noted in the concluding summary of the report. Test report forms shall be in compliance with NETA standards. A minimum of three complete copies shall be provided. Reports shall be signed by the person in responsible charge of the field testing, an officer of the firm performing the tests and an officer of the Electrical CONTRACTOR.

D. Make adjustments to the systems and instruct the OWNER's personnel in the proper operation of the systems.

E. In addition to the specific testing requirements listed in the individual sections, the following minimum tests and settings shall be performed.

1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.
2. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the ENGINEER of the same, including MCC cubicle location and driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.
3. Check power and control power fuse ratings. Replace fuses if they are found to be of the

incorrect size.

4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.
5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
6. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.
7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.
8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.
9. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 clockwise rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.
10. Verify correct wire termination positions across tie circuits, transfer switches, or other devices that normally have two sources of three-phase power present by performing a hot phase test. That is, in addition to verifying clockwise rotation, a voltage reading across both incoming circuits should measure 0 volts when phase “A” of one side is compared to phase “A” of the other side.
11. Check all wire and cable terminations. Verify to the ENGINEER connections meet the equipments torque requirements.
12. Field set all transformer taps as required to obtain the proper secondary voltage.
13. Infra-red hot spot inspection shall be made of all electrical equipment including but not limited to switchgear, motor control centers, transformers, switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the OWNER and again 3 months before expiration of the 1-year warranty period.

F. Make the following minimum tests and checks prior to energizing electrical equipment. Submit test reports upon final completion.

1. Test and calibrate protective relays and circuit breakers.
2. Mechanical inspection of air interrupter switches and circuit breakers to assure proper operation.

G. Testing shall be scheduled and coordinated in writing with the ENGINEER at least 2 weeks in advance. The testing firm shall provide all material, labor, equipment and technical supervision to perform the tests and inspection. Provide certified calibration sheets including dates for all equipment to be used for testing with notice of scheduled testing. Calibration sheets shall also indicate that the units have been calibrated within six months of the testing date. The CONTRACTOR shall have qualified personnel present during the testing.]

1.10 POWER SYSTEM STUDY

A. General:

1. The major electrical equipment manufacturer (i.e. switchgear and motor control centers) shall provide a computerized Power System Study for the electrical power distribution

and motor control equipment. The study shall verify adequacy of all of the existing equipment as well as new additions being implemented under these Specifications.

2. The study shall also include the utility company's protective devices, the emergency generators, the main switchgear, all feeders from the main switchgear, all substations and distribution and all associated MCC's. Graphic indication of coordination shall be furnished in the form of a clearly labeled and identified composite drawing showing time-current curves of system protective devices. Time-current curves of each device shall also be furnished.
3. The CONTRACTOR/Manufacturer shall be responsible for obtaining and verifying with the Power Company in writing all information needed to conduct this study. Provide this correspondence and information including contacts and phone numbers with the study submittal.
4. The CONTRACTOR shall set all protective devices and relays based on this coordination study to provide coordinated, selective protection for all equipment supplied or affected by the installation under this Contract.
5. The CONTRACTOR/Manufacturer shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length, motor data, switchgear data, existing protective relay settings, existing generator data, and any other information relevant to the study.
6. A summary of the short circuit analysis shall be provided to the CONTRACTOR at the time shop drawings for all of the new equipment is submitted for approval. This preliminary short circuit submittal shall be required in order to approve the equipment submittal.
7. The CONTRACTOR shall provide and install equipment specific arc flash warning labels per the arc flash study performed herein.

B. Scope:

1. The power system study consists of four major parts. The first part is the preliminary short circuit study. The preliminary short circuit study shall verify new and existing equipment affected on this project are being applied with design ratings. Shop drawings for new equipment will not be reviewed until the preliminary short circuit study is approved by the ENGINEER.
2. The second and third parts of the power system study include the final short circuit and protective device coordination study. New equipment will not be energized until this study is approved by the ENGINEER and devices are set in the field in accordance with the study.
3. The fourth and final part of the power system study is the arc flash study. The arc flash study labels will be added after the equipment is energized and all changes, upgrades or modifications have been made, to ensure field labeling will be accurate.
4. The short circuit study shall be in accordance with ANSI Standard C37.010 and C37.13, shall be performed to check the adequacy, and to verify the correct application of circuit protective devices and other system components specified. The study shall address the case when the system is being powered from the normal source as well as from the on-site generating facilities. Minimum as well as maximum possible fault conditions shall be adequately covered in the study.
5. Fault contribution of all motors shall be considered. The CONTRACTOR shall be responsible for obtaining all required data of equipment. All back-up calculations shall become part of the final report. The Calculations shall be in sufficient detail to allow easy

review.

C. Contents:

1. The study shall include representation of the power company's systems, the base quantities selected, impedance source-data, calculation methods and tabulations, one-line and impedance diagrams, conclusions and recommendations. Short circuit momentary duties, shall be calculated on the basis of an assumed bolted three-phase short circuit at each bus, low voltage switchboard bus, switchboards, motor control centers, distribution panelboards, pertinent branch circuit panelboards, and other significant locations through the systems. The short-circuit tabulations shall include significant X to R ratios, asymmetry factors, KVA, and symmetrical fault current.
2. A protective device time current coordination study shall be included with coordination plots of key and/or limiting devices, tabulated data, rating, and/or settings selected. The study shall present an engineering balance between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity and speed.
3. Separate plots shall be provided for each mode of "normal" and "stand-by" operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.
4. Existing protective device settings shall be reviewed to ensure selectivity under the new conditions. Recommended changes shall be indicated in the report. The Contractor shall be made aware of required changes immediately.
5. Transformer damage curves in accordance with ANSI C57.109.
6. Feeder cable damage curves.
7. Required settings for breakers and relays shall be maximized to provide the most effective protection possible whether the system is fed from the normal or emergency source.
8. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the emergency source.
9. An executive summary outlining the distribution system, the information received from the utility company, assumptions made to complete the study, statement of the adequacy of the distribution equipment to safely clear or close on any fault, and identification of any problem areas with recommendations for resolving the problem.
10. Generator short circuit decrement curves and thermal limit curves shall be included.
11. Tabulation of arc flash information.

D. Motor Current-Time Characteristic Curves:

1. A complete independent set of current-time characteristic curves for all medium voltage motor drives indicating coordination between the protective relays and the thermal characteristics of the motor shall be provided.
2. The Contractor shall obtain from the motor supplier, the necessary information to perform the study. Certified curves for "safe time versus current at 100 percent voltage" and "accelerating time versus current at 100 percent voltage" shall become part of the final report.

E. Motor Starting Study:

1. A motor starting study for all large electric drives (100 horsepower and above) to

determine voltage dip or power inrush limitations at selected locations due to starting of motors shall be provided. This applies to both the normal and the emergency mode.

F. General Information for Time-Current Curves Presentations:

1. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company's relay or system characteristics, significant motor starting characteristics, complete parameters for power, and substation transformers, and complete operating bands for low-voltage circuit breaker trip devices.
2. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required.
3. The short-time region shall indicate the medium voltage relay instantaneous elements, the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing to tolerance bands, and significant symmetrical and asymmetrical fault currents.
4. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.
5. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.
6. Protective relays shall be separated, where feasible, by a 0.3 second time margin when the maximum three-phase fault flows, to assure proper selectivity.

G. Generator(s) Protective Devices:

1. The study shall address all of the new and existing protective devices provided for generator protection.
2. Protective relays requiring settings shall include, but not necessarily limited to:

    a. Differential
    b. Overcurrent with voltage restraint
    c. Ground
    d. Undervoltage
    e. Reverse power
    f. Unbalanced loading and open phase
    g. Loss of excitation

3. Contractor shall obtain all necessary new generator information to perform this study.

H. Arc Flash Study:

1. The study shall utilize the fault current values calculated in the short circuit study and the clearing time of the upstream protective device in the coordination study to calculate the incident energy at each fault location.
2. Study shall be in accordance with IEEE Standard 1584 and NFPA 70E.
3. Study shall calculate the incident energy and flash protection boundary at all significant locations in the electrical distribution system (switchgear, switchboards, motor control centers, panelboards) where work could be performed on energized parts. Include any

208 volt or 240 volt equipment that is fed from transformers greater than 125 kVA.

4. Incident energy calculations shall include maximum and minimum fault contribution scenarios, since protective device clearing times can vary greatly depending upon the fault current.
5. Tabulations shall be provided showing each fault location, the arcing fault magnitude, protective device clearing time, duration of the arc, arc flash boundary, working distance, incident energy and hazard risk category.

I. Arc Flash Mitigation and Reduction Modes

1. Where devices are furnished with alternative trip settings intended to mitigate arc flash hazards, the study engineer shall coordinate these alternative pickup settings and provide representation of their tripping characteristics via TCC's. The alternative pickup settings shall be coordinate with the associated load and shall be set to provide the fastest device response time while avoiding nuisance trips during normal plant operation.

J. The power system study shall be bound in a standard 8-1/2" x 11" size report. The completed short circuit and coordination study shall be submitted to and approved by the ENGINEER before any of the equipment is shipped. All protective devices shall be adjusted, tested, and calibrated in the field, prior to energizing the equipment, per the settings listed in the study. This work shall be performed by the manufacturer as described in this section and prior to final acceptance by the OWNER.

K. All protective devices, existing and new shall be calibrated and tested as recommended by and under the supervision of the distribution gear manufacturer's representative as specified in this section. Coordination study engineer shall review and certify that all 'As-Left' settings have been implemented to their recommendations and include certified documentation (signed & sealed letter sufficient) into the final report.

L. The coordination study shall be stamped and signed by a professional ENGINEER registered in the state in which the equipment is to be installed.

M. Arc Flash Warning Labels:

1. Provide a machine printed 3.5-inch x 5-inch thermal transfer type label of high adhesion polyester for each location identified in the arc flash study.
2. Labels shall include the following machine printed information (hand lettering is not acceptable): equipment name, flash hazard boundary, incident energy, boundaries for shock hazard, limited approach, restricted approach and prohibited approach, PPE (personal protective equipment) category and date.
3. One label shall be required at each piece of equipment rated 50 volts or greater.

1.11 INTERPRETATION OF DRAWINGS

A. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Install each 3-phase circuit in a separate conduit unless otherwise shown on the Drawings.

C. Unless otherwise approved by the ENGINEER, conduit shown exposed shall be installed

exposed; conduit shown concealed shall be installed concealed.

D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.

E. Verify the exact locations and mounting heights of lighting fixtures, switches, and receptacles prior to installation. Any adjustments required in the field shall be provided at no additional cost to the OWNER and coordinated and approved by the ENGINEER.

F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the ENGINEER during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the ENGINEER and furnish all labor and materials necessary to complete the work in an approved manner.

G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of the approved equipment at no additional cost to the OWNER.

H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the ENGINEER for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

I. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by ½-inch spacers to provide a clearance between wall and equipment.

J. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45-degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

K. The Contractor shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor without additional expense to the OWNER. In case interference develops, the ENGINEER is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

1.12 PHASE BALANCING

A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.

B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 16120.

1.13 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.14 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings".

B. Record Drawings shall accurately show the installed condition of the following items:

1. One-line Diagram(s).
2. Equipment elevations (front views).
3. Raceways and pullboxes.
4. Conductor sizes and conduit fills.
5. Panel Schedule(s).
6. Control Wiring Diagram(s).
7. Lighting Fixture Schedule(s).
8. Lighting fixture, receptacle, and switch outlet locations.
9. Underground raceway and duct bank routing.
10. Plan view, sizes and locations of switchgear, distribution transformers, substations, motor control centers and panelboards.

C. Submit a schedule of control wiring raceways and wire numbers, including the following information:

1. Circuit origin, destination and wire numbers.
2. Field wiring terminal strip names and numbers.

D. In addition to the schedule, provide point-to-point connection diagrams showing the same information submitted in the schedule of control wiring raceways including all designations and wire numbers.

E. Submit the record drawings, schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams to the ENGINEER. The schedule of control wiring raceways and wire numbers and the point-to-point connection diagrams shall be computer generated (i.e., no hand-written or drawn schedules, drawings, or diagrams will be accepted).

F. Provide electrical enclosures with a drawing jacket with laminated panel schedules and wiring schematics showing all conformed changes, updates, and record installation. This shall include, but not be limited to, PLCs, MCCs, VFDs, starters, panelboards, control panels, contactor panels, etc.

1.15 EQUIPMENT INTERCONNECTIONS

A. Review shop drawings of equipment furnished under other Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with the Record Drawings.

B. Furnish and install all equipment interconnections.

1.16 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.

B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

C. Warrant all equipment furnished under Division 16 as per Division 1. Refer to individual equipment sections for additional warranty items.

1.17 EQUIPMENT IDENTIFICATION

A. Identify equipment (disconnect switches, separately mounted motor starters, control stations, etc.) furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, transformers, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two-sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate, the nameplate shall be permanently fastened to the adjacent mounting surface. Cemented nameplates shall not be drilled.

D. All voltages (e.g., 12,470 volts, 480 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Signs shall be red background with white engraved lettering, lettering shall be a minimum of 1" high.

E. All receptacles, wall switches, lighting fixtures, photocells, emergency lights, exit lights, etc. shall be identified with the panel and circuit to which it is connected. Identification shall be with machine generated labels with ¼” high letters.

F. Provide labels at all Electrical Building entries near the doors warning “Danger High Voltage – Keep Out” and “Authorized Personnel Only” with maximum voltage noted.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other sub- Contractor's and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the ENGINEER may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration, and slots as specified in Section 16110.

3.2 CUTTING AND PATCHING

A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete Division 3. Sawcut concrete and masonry prior to breaking out sections.

B. Core drill holes in existing concrete floors and walls as required.

C. Install work at such time as to require the minimum amount of cutting and patching.

D. Do not cut joists, beams, girders, columns or any other structural members.

E. Cut opening only large enough to allow easy installation of the conduit.

F. Patching to be of the same kind and quality of material as was removed.

G. The completed patching work shall restore the surface to its original appearance or better.

H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

I. Remove rubble and excess patching materials from the premises.

3.3 INSTALLATION

A. Any work not installed according to the Drawings and this Division or without approval by the ENGINEER shall be subject to change as directed by the ENGINEER. No extra compensation will be allowed for making these changes.

B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the OWNER, the

damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all cost associated with replacement shall be borne by the Contractor.

C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the ENGINEER's discretion.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting requirements Division 9, at no additional cost to the OWNER.

3.4 MANUFACTURERS SERVICE

A. Provide manufacturer's services for testing and start-up of the following equipment:

1.	Variable Frequency Drives	2 days, 2 trips minimum
2.	480 Switchboards	1 day, 1 trip minimum
3.	Automatic Transfer Switches	1 day, 1 trip minimum

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer’s warranty repairs.

C. The manufacturers of the above listed equipment shall provide experienced Field Service ENGINEER to accomplish the following tasks:

1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation complies with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.
2. The Field Service ENGINEERs shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.
3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.
4. A final report shall be written and submitted to the contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the contractor shall be submitted to the ENGINEER.

3.5 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment specified under Division 16.

1.	Variable Frequency Drives	2 days, 2 trips minimum
2.	480 Switchboards	1 day, 1 trip minimum
3.	Automatic Transfer Switches	1 day, 1 trip minimum

B. Conduct an electric training walk-thru of the complete electrical system: building to building, where feeders come from, etc., outside all equipment mentioned above.

C. The cost of training programs to be conducted with OWNER's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including troubleshooting of each system.

F. All training schedules shall be coordinated with and at the convenience of the OWNER. Shift training may be required to correspond to the OWNER's working schedule. The training shall be conducted with record "as-built" drawings sufficient for a class of eight personnel.

G. Within 120 days of contract award to the CONTRACTOR, submit an overview of the proposed training plan. This overview shall include, for each course proposed:

1. An overview of the training plan.
2. Course title and objectives.
3. Prerequisite training and experience of attendees.
4. Recommended types of attendees.
5. Course Content - A topical outline.
6. Course Duration.
7. Course Location - Training center or jobsite.
8. Course Format - Lecture, laboratory demonstration, etc.
9. Schedule of training courses including dates, duration, and locations of each class.
10. Resumes of the instructors who will actually implement the plan.

H. The ENGINEER will review the training plan submittal with the OWNER.

3.6 POWER SYSTEM STUDY

A. Provide a complete system Power System Study including preliminary short circuit, final short circuit, protective device coordination and arc flash study as specified herein.

B. Provide and install arc flash warning labels at equipment identified with the arc flash study.

END OF SECTION

Section 16100

RACEWAYS, BOXES AND CABINETS

PART 1 - GENERAL

1.01 SUBMITTALS

A. Provide submittals for all electrical equipment enclosures.

1.02 REFERENCES

A. Comply with NFPA 70 "National Electrical Code" for components and installation.

B. Comply with NECA "Standard of Installation."

1.03 LISTING AND LABELING

A. Provide products specified in this Section that are UL listed and labeled.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Liquid Tight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; Schedule 80, match to conduit or conduit/tubing type and material.

C. Aluminum Rigid Conduit

2.02 BOXES

A. Outlet and Device Boxes: Use 1 of the following:

1. Nonmetallic Boxes: NEMA OS2.

B. PWI and Junction Boxes: Use 1 of the following:

1. Small Boxes: NEMA OS 1, stainless steel.

2. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

C. Hinged Cover Enclosures: Stainless steel enclosure with continuous hinge cover and flush latch. The enclosure shall be provided with stainless panel insert for mounting equipment. Outdoor enclosures shall be 316 NEMA 4X Stainless Steel.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Seal all outdoor raceways using duct seal.

B. Use the following wiring methods:

1. Exposed: Rigid Aluminum

2. Underground: PVC Schedule 80

3. Instrumentation (shielded cable): Aluminum or PVC (dependent on location)

4. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquid tight flexible metal conduit.

5. Boxes and Enclosures:

a. 316 NEMA 4X stainless steel. All hardware shall be stainless steel.

C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

D. Install raceways level and square and at proper elevations. Provide adequate headroom.

E. Complete raceway installation before starting conductor installation.

F. Use temporary closures to prevent foreign matter from entering raceway.

G. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

H. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated keep the legs of a bend in the same plane and the straight legs of offsets parallel.

I. Raceways Embedded in Slabs: Install in middle third of the slab thickness where practical, and leave at least 1-inch (25 mm) concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

2. Space raceways laterally to prevent voids in the concrete.

3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

J. Install underground raceways:

1. At least 18" below grade.

2. At least 24" below driveways and roads.

3. All buried ductbanks to be concrete encased 3000 psi color red concrete.

K. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

1. Run parallel or banked raceways together, on common supports where practical.

2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

L. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

M. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

N. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

O. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb (90kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

P. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling, threaded inside for plugs, and set flush with the finished floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

Q. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

R. Install hinged cover enclosures and cabinets plumb. Support at each corner.

S. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

End of Section

SECTION 16108

MISCELLANEOUS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

B. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

1.2 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01330, detailed catalog information or drawings with sufficient detail to determine compliance with the specifications including describing electrical and physical characteristics of all equipment specified.

1.3 REFERENCE STANDARDS

A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16010.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle unless otherwise noted. Enclosure type shall be NEMA 4X 316 stainless steel enclosures unless otherwise noted on the drawings. All current carrying parts shall be copper.
2. NEMA 7 enclosures shall be cast aluminum.
3. Lugs shall be copper.
4. All exterior hardware shall be 316 stainless steel.
5. Switches shall be as manufactured by Eaton or Square D company.

B. Manual Motor Starters

1. Manual starters shall be furnished and installed for all type of single-phase motors. Manual starters shall be non-reversing, reversing or two speed type as required. NEMA sizes shall be as required for the actual horsepower of the motor furnished. Manual starters shall be motor overload protection in each phase. Built-in control stations shall be furnished as required or as shown on the Drawings.
2. NEMA 4X enclosures shall be 316 stainless steel.
3. NEMA 7 enclosures shall be cast aluminum.
4. Manual motor starters shall be as manufactured by Eaton or Square D Company.

C. Magnetic Motor Starters

1. Motor starers shall be 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Two speed starters shall be for single or two winding motors as required by the actual motor furnished or as shown on the Drawings.
3. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.
6. Built-in control stations and indicating light shall be furnished as specified herein, where shown on the Drawings.
7. NEMA 4X enclosures shall be 316 stainless steel.
8. NEMA Type 7 enclosures shall be cast aluminum.
9. Magnetic motor starters shall be as manufactured by Eaton or Square D Company.

D. Combination Magnetic Motor Starters

1. Motor starters shall be a combination motor circuit protector and contactor, 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required. Combination motor starters shall be fully rated for 100,00 Amps RMS symmetrical.
2. Two speed starters shall be for single or two winding motors as required by the actual motor furnished or as shown on the Drawings.
3. Each motor starter shall have a 120 Volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as required or as shown on the Drawings. A minimum of one N.O. and one N.C. auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
4. Overload relays shall be non-adjustable, ambient compensated and manually reset.
5. Control power transformers shall be sized for additional load where required. Transformer secondaries shall be equipped with time-delay fuses.
6. Built-in control stations and indicating lights shall be furnished as specified herein, where shown on the Drawings.
7. NEMA 4X enclosures shall be 316 stainless steel.
8. NEMA Type 7 enclosures shall be cast aluminum.
9. Combination magnetic motor starters shall be as manufactured by Eaton or Square D Company.

E. Control Stations and Indicators

1. Control stations shall be heavy-duty type, with full size (30.5mm) NEMA 4X or 7 operators, indicators, etc.
2. Indicators shall be full voltage and push-to-test type. Indicators located indoors shall be LED type and indicators located outdoors shall be incandescent lamp type.
3. NEMA 4X enclosures shall be 316 stainless steel.
4. NEMA 7 enclosures shall be cast aluminum.

5. Control stations shall be Square D Company Class 9001, similar by Eaton or General Electric Company.

F. General Purpose Dry Type Transformers

1. Transformers shall be dry type, two-winding with KVA and voltage ratings as shown on the Drawings.
2. Four full capacity taps shall be furnished, two 2-1/2 percent above and four 2-1/2 percent below rated primary voltage.
3. Maximum temperature rise shall be 80 degrees C. Windings shall be copper.
4. Transformers shall be built in accordance with ANSI C89.2 and NEMA ST-20.
5. Transformers shall be provided in NEMA 1 enclosures unless otherwise noted on the Drawings or as required by Section 16000. Where a NEMA 4X and/or stainless steel enclosure is required, the transformer shall be of the TENV type.
6. Transformers shall be furnished with hot dipped galvanized mounting hardware. Where a NEMA 4X and/or stainless steel enclosure is required, the required shall be 316 stainless steel.
7. Transformers shall be manufactured by the Eaton or Square D Company.

G. Combination Magnetic Motor Starters:

1. NEMA 1 wireway shall be gasketed painted steel with stainless steel screw covers.
2. NEMA 4Xwireway shall be 316 stainless steel with gasketed clamped covers.
3. NEMA 1 wireway shall be Square-Duct as manufactured by the Square D Co.; NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or equal.

H. Automatic Transfer Switches:

1. Automatic transfer switches shall be designed for a non-preferred source of 480 Volts, 3 Phase, 3 Wire, 60 Hz. Current ratings shall be as shown on the Drawings. Switches shall be listed under UL 1008. Transfer switches shall be molded case design.
2. The switches shall initiate transfer of the load to the source #1 when any phase of the source #2 drops below 90 percent of normal voltage and remain on that source until that source is not available.
3. The transfer switches shall be adequately constructed to carry full rated current on a continuous 24-hour basis in all approved enclosures and shall not show excessive heating or be subject to derating. The transfer switches shall be capable of withstanding inrush current vales to 20 times full load current rating without mechanical distortion of main contact poles or supports. The transfer switches shall be capable of withstanding all available system fault currents without parting of or damage to contacts during the fault clearing time of the system over current device.
4. The transfer switches shall be inherently 4 Pole double throw construction and shall have three position operation: closed to normal source, open, closed to emergency source. Transfer switches with circuit breakers or contactors are not acceptable. Time delay between opening of the closed contacts and closing of the open contacts shall be a minimum of 400 milliseconds to allow for voltage decay before transfer is complete.
5. Enclosure type shall be NEMA 1, wall mounted
6. A maintained contact test auto switch and source #1/source #2 pilot lights shall be mounted on the enclosure door.
7. Automatic transfer switches shall be Eaton ATC-900 or Russelectric, Inc., Type RMTD or equal.

I. Polyethylene Warning Tape

1. Warning tape shall be 5 mil red polyethylene film, 6-in minimum width. Tape shall be capable of being detected or located by either conductive or inductive location techniques.
2. Warning tape shall be Mutual Industries Part No. 17774 or equal.

J. Terminal Blocks

1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.
2. Terminal blocks shall be Bulletin 1492-CA1 as manufactured by the Allen-Bradley Co. or equal.

K. Corrosion Inhibitors

1. All equipment enclosures, terminal boxes, etc., located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical and electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.
2. The corrosion inhibitor pads shall be manufactured by Hoffman Engineering Co., 3M or equal.

L. Equipment Mounting Stands

1. Equipment mounting stands shall be custom fabricated from ¼-in 316 stainless steel plate and 3-in 316 stainless steel channel, unless otherwise shown on the Drawings
2. All hardware shall be 316 stainless steel.

M. Lighting Contactor

1. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings) with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand Off-Auto" switch on cover where shown on the Drawings.
2. Contactors shall be rated for 60 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co., Eaton/or equal.

O. Photocells

1. The photocells shall be suitable for power duty with individual fixture or for pilot duty with contactors as detailed on the Drawings. Enclosure shall be NEMA 3R or 4. Contacts shall be rated for 2,000 watts continuous at 120 Volts. The unit shall turn on at 1.5 footcandles and off at 5.5 footcandles.
2. Photocells shall be Tork, Model 2101or equal.

P. 24-Hour Programmable Timers

1. Unless otherwise specified, time switches shall be of the programmable type capable of being programmed at the intervals as noted on the Drawings over a 24-hour day. Program tabs shall be easily set by hand without tools to obtain or to change the desired programming schedule. The switching condition shall be maintained when adjacent tabs are set alike.
2. The unit shall be powered by a self-starting, enclosed, 120 Volt, synchronous motor capable of continuous accurate operation. A reserve power, precision wound spring and associated

escapement device shall be integrally mounted to maintain time settings during power failures of up to 24 hours.

3. The switch mechanism shall be a self-contained unit rated at not less than 20 Amps, 120 Volts, single pole, double throw and shall be readily replaceable in the field.
4. An omitting device shall be furnished as an integral part of the time switching operation to be skipped for any preselected day or days of the week.
5. Unless otherwise specified, time switches shall be as manufactured by Intermatic; Tork; Paragon or equal.

Q. Electrical Insulating Matting

1. Electrical Switchboard matting shall be provided in the electrical rooms and control rooms around all electrical gear including but not limited to Switchgear, Switchboard, MCC's, distribution/lighting panels, transformers and PLC's.
2. The rubber matting shall provide a floor covering to prevent shock around high voltage electrical apparatus, fuse boxes, switchgear, control panels, and heavy machinery.
3. The matting shall meet current ASTM and ASNI (plus IEC Division of ANSI, Tech Committee-78) specifications for this material.
4. The matting shall be ¼-inch thick, Class 2 as manufactured by The Mat King or approved equal.
5. Provide floor sealant, suitable of electrical/control rooms.

PART 3 – EXECUTION

3.1 INSTALLTION

A. Mounting Stand

1. Field mounted disconnects, pushbutton control stations, etc., shall be mounted on 316 stainless steel stands as specified herein or as shown on the Drawings. Where clearance requirements for stand may not be maintained, the ENGINEER may direct equipment to be wall-mounted adjacent to the motor or device, but in no case shall the distance from the motor or device to the control station exceed 3-ft.

B. Miscellaneous Equipment

1. Perform tests and adjust as required per Section 16010.
2. Provide and install identification as required per Section 16195.
3. All wiring shall be done in a neat and workmanlike manner.
4. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean lint-free rags. Do not use compressed air.

END OF SECTION

SECTION 16110

RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

1.3 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01300, the manufacturers' names and product designation or catalog numbers with cut-sheets of all materials specified. Indicate in the submittal, the areas where specific materials are used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rigid Aluminum Conduit

1. Rigid aluminum conduit shall be 6063 alloy and shall be as manufactured by New Jersey Aluminum Corp.; Reynolds Aluminum International Services Inc.; Alumax Extrusions, Inc; VAW of America, Inc. or equal.
2. Rigid aluminum conduit shall be for use under the provisions of NEC Article 344.

B. Rigid Nonmetallic Conduit

1. PVC conduit shall be rigid polyvinyl chloride schedule 80 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.
2. PVC conduit used in underground concrete encased duct banks shall be polyvinyl chloride Schedule 40 as manufactured by Carlon; An Indian Head Co.; Cantex; Queen City Plastics or equal.
3. PVC conduit shall be for use under the provisions of NEC Article 352.

C. Liquidtight Flexible Metal Conduit, Couplings and Fittings

1. Liquidtight flexible metal conduit shall be Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.
2. Fittings used with Liquidtight flexible metal conduit shall be of the 3-piece screw-in type malleable iron as manufactured by the O.Z. Gedney Co. or equal.
3. Liquidtight flexible metal conduit shall be for use under the provisions of NEC Article 350.

D. Flexible Couplings

1. Flexible couplings shall be type ECGJH as manufactured by the Crouse-Hinds Co.;

Appleton Electric Co.; Killark Electric Manufacturing Co. or equal.

E. Boxes and Fittings

1. Pressed steel switch and outlet boxes shall be hot-dipped galvanized with hot-dipped galvanized tile rings as manufactured by the Raco Manufacturing Co.; Adalet Co.; O.Z. Manufacturing Co. or equal.
2. NEMA 1 and NEMA 12, junction boxes, pull boxes etc., shall be sheet steel unless otherwise shown on the Drawings or located in Corrosive Areas including all pretreatment and hypochlorite facilites. Boxes shall be galvanized and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies and covers shall not be less than 14-gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16108 for additional requirements). Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal. All boxes shall be shop primed and painted by the box manufacturer.
3. NEMA 4X stainless steel, junction boxes and pull boxes shall be 316 stainless steel with 316 stainless steel hardware and gasketed covers. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies and covers shall not be less than 14-gauge metal. Covers shall be gasketed and fastened with stainless steel screws. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets (refer to Section 16108 for additional requirements.) Boxes shall be as manufactured by Hoffman Engineering Co.; Lee Products Co.; ASCO Electrical Products Co., Inc., or equal.
4. Explosion-proof boxes shall be designed for Class 1, Group D, Division 1 hazardous locations. They shall be cast aluminum, with stainless steel hinged covers and stainless steel hardware and bolts; Type EJB-N4 as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; Adalet-PLM or equal.
5. Cast aluminum boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co..; Crouse-Hinds Co.; Appleton Electric Co.; or equal.
6. Cast aluminum device boxes shall be Type FD. All cast aluminum boxes and fittings shall be copper-free aluminum with cast aluminum covers and stainless steel screws as manufactured by the Killark Electric Co.; Crouse-Hinds Co.; L. E. Mason Co. or equal.
7. Cast aluminum fittings (C's, T's, LB's, etc.) shall be of the mogul design (with rollers) as manufactured by Appleton Electric Co.
8. Conduit hubs shall be of the grounding type as manufactured by Myers Electric Products, Inc. or equal.
9. Conduit wall seals for new concrete walls below grade shall be O.Z./Gedney Co., Type WSK; Spring City Electrical Manufacturing Co., Type WDP or equal.
10. Conduit wall seals for cored holes shall be Type CSML as manufactured by the O.Z./Gedney Co. or equal.
11. Conduit wall and floor seals for sleeved openings shall be Type CSMI as manufactured by the O.Z./Gedney Co. or equal.
12. Combination expansion-deflection fittings embedded in concrete shall be Type XD as manufactured by the Crouse-Hinds Co.; O.Z./Gedney Co.; Spring City Electrical Mfg. Co. or equal.
13. Combination expansion-deflection fittings installed exposed shall be Type XJ as

manufactured by Crouse-Hinds Co.; O.Z. Gedney Co.; Spring City Electrical Mfg. Co. or equal.

14. Explosion proof fittings shall be as manufactured by the Crouse-Hinds Co.; Appleton Electric Co.; O.Z./Gedney Co. or equal.
15. Conduit sealing bushings shall be O.Z./Gedney, Type CSB or equal.
16. Elbows and couplings shall be aluminum.

F. Conduit Mounting Equipment

1. In administration and office areas, hangers, rods, backplates, beam clamps, channel, fasteners, anchors, nuts, washers, etc., shall be hot-dipped galvanized steel.
2. 316 Stainless steel channel with 316 stainless steel hardware (hangers, rods, backplates, beam clamps, fasteners, anchors, nuts, washers, etc.) shall be used in all other areas. All channel and hardware shall be resistant to the chemicals present in the area in which it is used.
3. Expansion anchors (minimum 3/8" diameter) shall be equal to Kwik-Bolt as manufactured by the McCullock Industries, Minneapolis, MI; Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO; or Kwik-Bolt II as manufactured by the Hilti Fastening Systems, Inc, Tulsa, OK. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1-in behind the steel reinforcement. Apply anti-seize compound to all nuts and bolts. Supports installed without the approved compound shall be dismantled and correctly installed, at no cost to the OWNER.

G. Wall and Floor Slab Opening Seals

1. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp.; Pro Set Systems; Neer Mfg. Co.; Specified Technologies, Inc. or equal.

H. Cold Galvanizing Compound

1. Cold galvanizing compound shall be 95% zinc rich paint as manufactured by ZRC Products Company, a Division of Norfolk Corp. or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATIONS

A. Except where otherwise shown on the Drawings, or specified, all exposed wiring shall be in rigid aluminum conduit.

B. All underground conduits shall be encased in red concrete.

C. Schedule 80 PVC conduit shall be used underground and in chemical rooms, chlorinator rooms and chlorine storage areas or areas designated "CORROSIVE" on the Drawings, including concrete encased conduits.

D. Where schedule 80 PVC is used all elbows shall be rigid aluminum PVC coated.

E. Electrical metallic tubing and fittings may be used only in NEMA 1 administration and office

areas. Electrical metallic tubing and fittings shall not be embedded in concrete, installed outdoors, in process areas, shops, maintenance areas, electrical rooms, etc.

F. All conduit of a given type shall be the product of one manufacturer.

3.2 BOX APPLICATIONS

A. Unless otherwise specified herein or shown on the Drawings, all boxes shall be metal.

B. Exposed switch, receptacle and lighting outlet boxes and condulet fittings shall be cast aluminum.

C. Concealed switch, receptacle and lighting outlet boxes shall be pressed steel. Welded seamed boxes will not be permitted.

D. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed, as specified in Section 16010.

3.3 FITTINGS APPLICATIONS

A. Combination expansion-deflection fittings shall be used where conduits cross structure expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.

B. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.

C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

3.4 INSTALLATION

A. No conduit smaller than ¾-inch electrical trade size shall be used, nor shall any have more than the equivalent of three 90-degree bends in any one run. Pull boxes shall be provided as required or directed.

B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.

C. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction.

D. Conduit supports, other than for underground raceways, shall be spaced at intervals of 8-ft or less, as required to obtain rigid construction.

E. Single conduits shall be supported by means of aluminum one-hole pipe clamps in combination with aluminum one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on trapeze type hangers with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-inch diameter. Surface mounted panel boxes,

junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-inch clearance between wall and equipment.

F. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, concrete expansion anchors shall be provided.

G. All conduits on exposed work, within partitions and above suspended ceilings, shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. All conduits shall be run perfectly straight and true.

H. Conduit terminating in pressed steel boxes shall have double locknuts (aluminum) and insulated grounding bushings.

I. Conduit terminating in gasketed enclosures shall be terminated with grounding type conduit hubs.

J. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings with lay-in type lugs.

K. Conduits shall be installed using threaded fittings unless otherwise specified herein.

L. Liquidtight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present.

M. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

N. Aluminum fittings and boxes shall be used with aluminum conduit. Aluminum conduit shall not be imbedded in concrete containing chlorides, unwashed beach sand, sea water, or coral bearing aggregates. Aluminum conduit shall be isolated from other metals with heat shrink tubing (Raychem or equal) or plastic-coated hangers. Strap wrenches shall be used for tightening aluminum conduit. Pipe wrenches, channel locks, chain wrenches, pliers, etc. shall not be used.

O. All threads on aluminum conduit and fittings shall be cleaned and coated with No-Oxide compound before installing.

P. Aluminum conduit installed in concrete or below grade shall be completely covered with heat shrink tubing (Raychem or equal).

Q. Where conduits pass through openings in walls or floor slabs, the remaining openings shall be sealed against the passage of flame and smoke.

R. PVC conduit to non-metallic and metallic box connections shall be made with sealing rings, with a stainless steel retainer as manufactured by Thomas & Betts Co.

S. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

T. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as provided per the NEC and approved by

the PVC conduit manufacturer.

U. All conduit entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated.

V. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 7.

W. Spare conduits and conduit stubouts for future construction shall be provided with threaded PVC end caps at each end.

X. No unbroken run shall exceed 300 feet in length. This length shall be reduced by 75 feet for each 90-degree elbow.

Y. Underground circuits shall be installed directly to the respective motor control centers, lighting panels, etc., except stainless steel pull boxes shall be wall mounted on structures to eliminate excessive bends. With prior written approval, below grade pull boxes may be used. Splices shall not be made in above or below grade pull boxes unless otherwise indicated on the plans and approved in writing by the ENGINEER.

Z. All conduits shall have a 4-inch concrete housekeeping pad at all slab and grade penetrations. The housekeeping pad shall have 45 degree, 3/4-inch chamfer at all exposed edges.

AA. All risers from underground, concrete pads, floors, etc. shall be provided with heat shrink tubing (Raychem Co. or equal) from a point 1 foot-0-inch below bottom of slab or grade to a point not less than 6 inches above grade or surface of slab.

BB. Existing conduits are to be reused only where specifically noted on the drawings. Mandrels shall be pulled through all existing conduits which will be reused and through all new conduits 2-in in diameter and larger prior to installing conductors.

CC. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.

DD. Where no size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314.

EE. Conduits shall not cross pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.

FF. The use of running threads is prohibited. Where such threads are necessary, a 3-piece cast aluminum union shall be used.

GG. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc, shall be sealed with "Duxseal" as manufactured by Manville or seal fitting to prevent the accumulation of condensation.

HH. All underground control and instrumentation conduits shall be separated from power conduits by a minimum of 12 inches unless specifically noted otherwise. Crossing of control and

instrumentation conduits with power conduits shall be kept to a minimum and where they must cross, they shall cross at 90-degree angles.

II. Cables passing through in-ground manholes shall be neatly racked within each manhole when installed.

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SECTION 16120

WIRES AND CABLES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

B. Install data highway, fiber optic, coaxial and I/O cables furnished under Division 13.

1.2 RELATED WORK

A. Refer to Section 16000 for electrical testing.

B. Refer to Division 13 for fiber optic cables.

1.3 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01330, samples of proposed wire. Each sample shall have the size, type of insulation and voltage stenciled on the jacket.

B. Approved samples will be sent to the project location for comparison by the OWNER's RESIDENT PROJECT REPRESENTATIVE (RPR) with the wire actually installed.

C. Installed unapproved wire shall be removed and replaced at no additional cost to the OWNER.

D. Submit results of insulation resistance testing as specified herein.

1.4 DELIVERY, STORAGE AND HANDLING

A. Carefully handle all conductors to avoid kinks and damage to insulation.

1.5 WARRANTY

A. The manufacturer shall warrant the cable against defects for a period of 20 years from the date of installation and shall remove and replace defective cables at his expense during this warranty period.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

D. Wire shall have 600V insulation except where indicated otherwise.

E. All wire of a given type shall be the product of a single manufacturer.

F. Acceptable manufacturers (when product type is available)

1. American Insulated Wire Corp.
2. Belden
3. General Cable
4. Okonite
5. Pirelli
6. Rockbestos
7. Southwire
8. Or equal

2.2 POWER WIRE

A. Wire for lighting, receptacles, and other circuits not exceeding 150 volts to ground shall be NEC type XHHW-2. Below grade and underground the wire shall be type XHHW-2.

B. Wire for circuits over 150 volts to ground shall be NEC type XHHW-2 for sizes No. 4/0 AWG and smaller and shall be NEC type RHW-2 for sizes 250 kcmil and larger.

C. Equipment grounding conductors shall be the same NEC type as the phase conductors described previously, green and sized per NEC Table 250.122.

D. Bare copper ground wire shall be stranded, tinned soft drawn annealed copper wire.

E. Ground grid conductors shall be uninsulated unless shown otherwise on the Drawings.

F. Multi-conductor power cable shall be stranded, 600V, cross-linked polyethylene insulated with PVC jacket, Type TC (XLP) with ground.

G. Variable Frequency Drive Output cable to motors shall contain three stranded tinned copper circuit conductors, three symmetrical bare copper ground wires, with XLPE insulation, two spiral copper tape shields (100% coverage), sun- and oil-resistant PVC jacket, 2000V. CONTRACTOR shall be responsible, at no additional cost to the OWNER, to increase conduit size per NEC if another manufacturer’s cable requires a larger conduit size.

2.3 CONTROL, STATUS AND ALARM WIRE

A. Wire shall be No. 14 AWG minimum NEC type XHHW-2 stranded.

B. Multi-conductor control cable shall be NEC type TC (tray cable), stranded, No. 14 AWG, XHHW-2 600V insulated color coded conductors, bare stranded ground wire, with overall PVC cable jacket. Cable shall be rated for cable tray or direct burial use and sunlight resistant. Number of conductors as listed on the Drawings.

2.4 INSTRUMENTATION WIRE

A. Process instrumentation wire shall be twisted pair, 600V, cross linked polyethylene insulated, aluminum tape shielded, polyvinyl chloride jacketed type "XLP".

B. Cable for 4-20 mA instrumentation, potentiometer, RTD and similar analog circuits shall be multi-conductor twisted and shielded.

1. Single pair cable:

   a. Conductors: 2 No. 16 AWG stranded and twisted
   b. Insulation: XLP
   c. Shield: 100 percent tape with drain wire
   d. Jacket: PVC with UL and manufacturers identification

2. Three conductor (triad) cable:

   a. Conductors: 3 No. 16 AWG stranded and twisted
   b. Insulation: XLP
   c. Shield: 100 percent tape with drain wire
   d. Jacket: PVC with UL and manufacturers identification

3. Multiple pair cables (where shown on the Drawings):

   a. Conductor: Multiple 2 No. 16 AWG stranded and twisted
   b. Insulation: XLP
   c. Shield: Individual pairs and overall shielded with 100 percent tape and drain wire
   d. Jacket: PVC with UL manufacturers identification

2.5 COMMUNICATION CABLE

A. Ethernet cable shall be designed for use with a high-speed (1000 Mbps/1Gbps) Ethernet communications network. The twisted pair cable shall have nominal impedance of 100 ohms at 1 Mhz and a maximum attenuation of 10 dB per 1000 feet at 1 Mhz. The twisted pair cable shall be non-plenum rated and shall have a minimum of four 22 AWG solid copper conductor pairs with an overall foil shield. Cable shall be Category 6, *Ethernet/IP* compliant with a voltage insulation rating of 600V. Cable shall be able to be terminated using RJ-45 terminations. Cable shall be Rockwell Automation or equal. RJ-45 terminations shall be industrial type, for shielded 8 conductor cable, Rockwell Automation Bulletin 1585J, or equal.

B. Profibus PA cable shall be 300V, 1 pair 18 AWG, stranded tinned copper, 100% foil shield, color blue and orange, 100 ohms at 31.25 kHz, PVC jacket, Belden Type 3076F or equal.

C. Profibus DP cable shall be 300V, 1 pair 22 AWG, stranded tinned copper, 100% foil shield, color red and green, 150 ohms, PVC jacket, Belden Type 3079E or equal. DeviceNet cable shall be Class 1 (600V), with 2 pairs, 16 and 18 AWG, stranded tinned copper conductors, 100% individually foil shielded, plus a 65% overall tinned copper braid, sunlight/oil-resistant PVC jacket. Power pair (16 AWG) color blue and white. Data pair (18 AWG) color red and black. ODVA (Open DeviceNet Vendor Association) Cable V, Belden Type 7896A or equal.

D. Telephone cable shall be No. 22 AWG, 4-pairs, solid copper PVC insulation and PVC jacket. UL rated Type CMR as manufactured by American Insulated Wire Corp., or equal.

E. Telephone cable shall be No. 22 AWG, multi-twisted pair as shown on Drawings, solid annealed copper conductors, foam and solid polyolefin insulation, entire core filled with ETPR compound to provide waterproofing, non-hygroscopic dielectric tape applied over the core, 8 mil corrugated copolymer coated aluminum tape shield applied longitudinally with an overlap, black low-density polyethylene jacket. Identification on outer jacket shall include cable code, pair count, AWG, date of manufacture and sequential length markings at 2-ft intervals. Type PE-89 as manufactured by Superior Essen or equal.

2.6 TERMINATIONS AND SPLICES (POWER CONDUCTORS)

A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the ENGINEER. Where splicing is approved by the ENGINEER, splicing materials for all 600V splices shall be made with long barrel, tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

B. Wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Use one hole lug for sizes No. 8 AWG to No. 4/0 AWG. Use two-hole lug for sizes 250 kcmil and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co.; Burndy; Amp; or equal.

C. Compression type connectors shall be insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem (Tyco); Ideal Industries; 3M Co. or equal.

D. Connectors (wire nuts) for pigtail splicing all wires and cables No. 10 AWG and smaller shall be solderless pressure type.

E. Connectors used at all exterior, wet or corrosive locations shall be pre-filled with silicone based sealant. Connectors shall be as manufactured by Ideal Industries, or equal.

F. All splices below grade shall be made waterproof using “Scotch-Cast”, or equal.

G. Splices in branch circuit conductors No. 8 AWG and larger shall be made with split bolt connectors.

2.7 MOTOR CONNECTIONS

A. Motor connections shall be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and spring washer. Connections shall be insulated with a Raychem Type RVC, roll-on stub insulator; Thomas & Betts, Shrink-Kon MSCV20; or equal. For wire sizes No. 8 AWG and larger, long barrel, tin plated copper compression (hydraulically pressed) type connections Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp., or equal).

2.8 TERMINATIONS AND SPLICES (CONTROL, STATUS AND ALARM CONDUCTORS)

A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the ENGINEER. Where splicing is approved by the ENGINEER, splicing materials shall be approved by the ENGINEER and cable manufacturer. Splicing materials and installation shall be as required by the ENGINEER. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

B. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

C. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

D. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc or equal.

2.09 TERMINATIONS AND SPLICES (INSTRUMENTATION CABLES)

A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

2.10 WIRE AND CABLE MARKERS

A. Wire and cable markers shall be type written, heat shrinkable type as manufactured by the W.H. Brady Co., Thomas & Betts Co., 3M Co., or equal.

B. Wire and cables with diameters exceeding the capacity of the heat shrinkable markers shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co., Panduit Corp., or equal.

2.11 WALL AND FLOOR SLAB OPENING SEALS

A. Wall and floor slab openings shall be sealed with UL approved expanding material which equals or exceeds the fire rating of the wall or floor construction such as "FLAME-SAFE" as manufactured by the Thomas & Betts Corp. or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end and in all manholes, hand holes and pull boxes with wire and cable markers. Label all future and spare wiring and cables.

B. Identify circuit number associated with lights, receptacles, and other miscellaneous loads at panelboards. Identify phase and neutral conductors.

C. Use lubrications to facilitate wire pulling. Pulling compound shall be nontoxic, nonflammable, noncombustible and noncorrosive. The material shall be UL listed and compatible with the cable insulation and jacket.

D. All wire and cable shall be continuous and without splices between points of connection to equipment terminals, except a splice will be permitted by the ENGINEER if the length required between the points of connection exceeds the greatest standard shipping length available from the manufacturer specified or approved by the ENGINEER as the manufacturer of the particular item or wire and cable.

E. The crimping tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tool shall be the ratchet type which prevents the tool from opening until the crimp action is completed. Such tools shall be a product of the connector manufacturer.

F. Equipment grounding conductors shall be installed in all power and control raceways.

G. Seal openings in slabs and walls through which wires and cables pass.

H. Steel fish tapes and/or steel pulling cables shall not be used in PVC conduit runs or in raceways that terminate into energized enclosures.

I. Pull cable from direction that requires the least tension. Feed cable into raceway with zero tension and without cable crossover at raceway entrance. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius. Use a dynamometer and constant velocity power pulling. Velocity should not be less than 15-ft./min or more than 50-ft/min. Do not exceed the cable manufacturer's maximum recommended tension.

J. If cable cannot be terminated immediately after installation, install heat shrinkable end caps.

K. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape by 3M Corp. or equal. Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape by 3M Corp. or equal over the last wrap.

L. Hydraulically or manually operated cable benders shall not be used unless approved in writing by the ENGINEER.

M. To protect wires prior to installation of devices, coil slack wires at outlets, inside the outlet boxes and seal the outlet opening with cardboard or fiber plug to prevent entrance of concrete, plaster or paint.

N. When solid conductors are to be connected directly to wiring devices without the use of lugs, the wires shall be formed into a loop to fit around the terminal screw. Under no circumstance shall the wire be wrapped completely around the screw with one conductor over-lapping the other.

3.2 INSTRUMENTATION AND COMMUNICATION CABLE INSTALLATION

A. Instrumentation cables shall be installed in raceways as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

B. Install shielded instrumentation wire from terminal to terminal with no splicing at any intermediate point. Shielded instrumentation wire, coaxial, data highway, I/O, fiber optic and communications cables shall be run without splices between instruments, terminal boxes, or panels.

C. Terminal blocks shall be provided at all instrument cable junctions, and all circuits shall be identified at such junctions.

D. Ground shielding on instrumentation wire at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own terminal block.

E. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e., power, control, etc.) cables in manholes.

F. All shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1-in minimum over the jacket end and extend ½-in minimum from the jacket end over the exposed conductors.

3.3 FIBER OPTIC CABLES

A. Unless otherwise indicated on the plans, no splices may be made in the cables without prior written approval of the ENGINEER. Where splicing is approved, then splicing material shall be approved by the ENGINEER and cable manufacturer.

B. Provide all material, equipment and labor to install the fiber optic cables as specified in Division 13.

C. Installation shall be in accordance with the NEC.

D. Install cables in the raceway systems as indicated. Inspect raceways prior to pulling in the cables. Notify the ENGINEER of any conditions which would prevent installation of the specified cables before proceeding with the installation.

E. Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation. Do not exceed cable manufacturers' specifications for pulling tension and bending radius. Pulleys used to aid in the installation of the fiber optic cable must be sized according to the minimum bending radius.

F. Installation tools and materials shall be approved by the cable manufacturer.

G. Label each termination point. Label all future and spare wiring and cables.

H. Tag each cable in junction boxes, manholes and handholes. Provide permanent nylon/plastic tie-wrap type tags with waterproof markings.

3.4 WIRE COLOR CODE

A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

B. The following coding shall be used:

System	Wire	Color
240/120 Volts	Neutral	White
Single-Phase, 3 Wire	Line 1	Black
	Line 2	Red
208Y/120, Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts	Neutral	White
3 Phase, 4 Wire	Phase A	Black
delta, center tap	Phase B (High)	Orange
ground on phase	Phase C	Blue
coil A-C		
480Y/277 Volts	Neutral	Gray
3 Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
Control (Individual Conductors)	AC	Red
	DC	Blue

C. Neutral or ground wires that terminate in a panelboard and require color tape shall have the color tape extend at least 6-in from the termination point.

3.5 TERMINATIONS AND SPLICES

A. Power conductors: Unless otherwise indicated on the Drawings, no splices may be made in the cables without prior written approval of the ENGINEER. Where splicing is approved, terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.

B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a

maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.

C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.

D. Except where permitted by the ENGINEER no splices will be allowed in manholes, handholes or other below grade located boxes.

E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc.), conduit bodies, etc.

F. Metallic shielding of VFD output motor cables shall be grounded at both ends in accordance with the cable manufacturer's instructions.

3.6 FIELD TESTING

A. Test all 600V wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 volts DC. Test duration shall be one minute. Submit a written test report of the results to the ENGINEER. Notify ENGINEER in writing 48 hours prior to testing in the presence of the Resident Project Representative.

B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association (NETA Standard ATS) unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

C. All service conductors shall be tested as in paragraph "A" above with the ENGINEER present.

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SECTION 16150

MOTORS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install the motors as hereinafter specified and as called for in other sections of these Specifications.

1.2 QUALIFICATIONS

A. Motor shall be sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity. Unless otherwise noted, motors driving pumps shall not be overloaded at any head or discharge condition of the pump.

1.3 SUBMITTALS

A. The motor manufacturer shall submit to the Engineer certified dimension prints showing nameplate data and outline dimensions within three weeks of the date they receive the order.

B. Guarantee: All equipment furnished and installed under this Section shall be guaranteed against defects of workmanship, materials and improper installation for a period of one year from date of acceptance. All such equipment or parts proven defective, due to the above noted causes, shall be replaced in the machines by the Contractor at no expense to the Owner.

C. Provide equipment warranty in accordance with Division I, section 01740.

PART 2 - PRODUCTS

2.1 RATING

A. Unless otherwise noted, all motors shall be of the low voltage type. All motors 1/2 through 100 horsepower shall be rated 230/460 volt, 3 phase, 60 Hertz A.C.; motors 125 horsepower through 500 horsepower shall be rated 460 volt, 3-phase, 60 Hertz, and motors below 1/2 horsepower shall be rated 115/230 volt, 1 phase, 60 Hertz A.C.

2.2 THREE PHASE INDUCTION MOTORS

A. Motors 20 HP and larger shall have a 120-volt space heater for moisture control.

B. Unless specifically noted in other sections of these Specifications, all motors shall have a minimum as indicated in the table below. All motors shall be "premium efficiency" type.

TABLE 1

Motor HP	Min. Eff.	Max. dba	Motor HP	Min. Eff.	Max. dba
1-2	84.0%	74	25-30	92.0%	92
3-5	86.5%	79	40-50	93.0%	97
7.5-10	90.2%	84	60-75	94.0%	100
15-20	91.0%	89	100	94.1%	102
			200	94.3%	105

C. Motors operating with variable frequency drives shall state that they are suitable for their intended applications. Motor nameplate shall read "Inverter Duty Rated". In addition, Motors operating with Variable Frequency Drives (VFDs) shall meet the requirements of NEMA MG1 Part 31.

D. Shaft grounding rings shall be provided on all motors 200HP and larger. Grounding rings shall be maintenance free, circumferential micro fiber type, AEGIS™ SGR by electro Static Technology or equal to discharge shaft currents to ground.

E. Motors larger than 15 Hp and operating with a VFD shall have imbedded a winding temperature switch. Motors larger than 300 horsepower shall have winding resistance temperature detectors (RTD's).

2.3 CONSTRUCTION

A. General:

1. All drip-proof and weather protected Type I motors shall have epoxy encapsulated windings. Totally enclosed motors shall not be encapsulated. Motors not readily available with encapsulated windings may be standard type. Motors exposed to the outside atmosphere shall be totally enclosed fan cooled (TEFC) unless otherwise specified.
2. Squirrel-cage rotors shall be made from high-grade steel laminations adequately fastened together and to the shaft, or shall be cast aluminum or bar-type construction with brazed end rings.

B. Low Voltage, Three Phase Motors:

1. Motors shall be of the squirrel-cage or wound rotor induction type as noted. Horizontal, vertical solid shaft, vertical hollow shaft, normal thrust and high thrust types shall be furnished as specified herein. All motors shall be built in accordance with current NEMA, IEEE, ANSI and AFBMA standards where applicable. Motors shall be of the type and quality described by these Specifications, fully capable of performing in accordance with manufacturer's nameplate rating, and free from defective material and workmanship.
2. Motors shall have normal or high starting torque (as required), low starting current (not to exceed 600 percent full load current), and low slip.
3. Motors shall be totally enclosed fan-cooled construction with 1.15 service factor unless

otherwise noted. Indoor motors shall be WPI unless otherwise noted.

4. Motors shall be suitable for operation in moist air with hydrogen sulfide gas present.
5. The output shaft shall be suitable for direct connection or belt drive as required.
6. Motors shall have a Class F non-hygroscopic insulation system but shall be limited to Class B temperature rise.
7. All motors shall have a final coating of chemical resistant corrosion and fungus protective epoxy fortified enamel finish sprayed over red primer over all interior and exterior surfaces. Stator bore and rotor of all motors shall be epoxy coated.
8. All fittings, bolts, nuts, and screws shall be 316 stainless steel. Bolts and nuts shall have hex heads.
9. All machine surfaces shall be coated with rust inhibiter for easy disassembly.
10. Conduit boxes shall be gasketed. Lead wires between motor frame and conduit box shall be gasketed.
11. Totally enclosed motors shall be provided with condensate drain hole and epoxy coated motor windings to protect against moisture.
12. Nameplates shall be stainless steel. Lifting lugs or "O" type bolts shall be supplied on all frames 254T and larger. Enclosures will have stainless steel screen and motors shall be protected for corrosion, fungus and insects.
13. Low voltage, three phase motors shall be manufactured by General Electric, U.S. Motors, Westinghouse or Reliance.
14. Fractional Horsepower:

    a. Fractional horsepower motors shall be rigid, welded-steel, designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight die-cast aluminum. Windings shall be of varnish-insulated wire with slot insulation of polyester film, baked-on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses and other hazards.
    b. Motor shaft shall be made from high-grade, cold-rolled shaft steel with drive-shaft extensions carefully machined to standard NEMA dimensions for the particular drive connection.
    c. For light to moderate loading, bearings shall be quiet all-angle sleeve type with large oil reservoir that prevents leakage and permits motor operation in any position.
    d. For heavy loading, bearings shall be carefully selected precision ball bearings with extra quality, long-life grease, and large reservoir providing 10 years' normal operation without relubrication.

15. Integral Horsepower:

    a. Motor frames and end shields shall be cast iron or heavy fabricated steel of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type of enclosure employed.
    b. Windings shall be adequately insulated and securely braced to resist failure due to electrical stresses and vibrations.
    c. The shaft shall be made of high-grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of the particular rating. Bearing journals shall be ground and polished.
    d. Rotors shall be made from high-grade steel laminations adequately fastened together, and to the shaft. Rotor squirrel-cage windings may be cast-aluminum or bar-type construction with brazed end rings.
    e. Motors shall be equipped with vacuum-degassed antifriction bearings made to

AFBMA Standards, and be of ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent lubrication, but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of lubricant out of the bearing cavity.

f. Bearings of high thrust motors will be locked for momentary up thrust of 30% down thrust. All bearings shall have a minimum B10 life rating of 100,000 hours in accordance with AFBMA life and thrust values.

g. Vertical hollow-shaft motors will have non-reverse ratchets to prevent backspin.

C. Low Voltage, Single Phase Motors:

1. Single phase motors shall be split-phase and capacitor-start induction types rated for continuous horsepower at the rpm called for on the Drawings. Motors shall be rated 115/230 volts, 60 Hertz, single phase, open drip-proof, or totally enclosed fan cooled as called for on the Drawings, with temperature rise in accordance with NEMA Standards for Class B insulation.
2. Totally enclosed fan cooled motors shall be designed for severe-duty.
3. Motors shall have corrosion and fungus protective finish on internal and external surfaces. All fittings shall have a corrosion protective plating.
4. Mechanical characteristics shall be the same as specified for polyphase fractional horsepower motors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motor Connections: All motors shall be connected to the conduit system by means of a short section 18-inch minimum of flexible conduit unless otherwise indicated. For all motor connections, the Contractor shall install a grounding conductor in the conduit and terminate at the motor control center with an approved grounding clamp.

3.2 TESTS AND CHECKS

A. The following tests shall be performed on all motors after installation but before putting motors into service.

1. The Contractor shall megger each motor winding before energizing the motor, and, if insulation resistance is found to be low, shall notify the Engineer and shall not energize the motor. The following table gives minimum acceptable insulation resistance in meg-ohms at various temperatures and for various voltages with readings being taken after one minute of megger test run.

TABLE 2

Degree Winding Temperature		**Voltage**		
^{0}F	**^{0}C**	**115V**	**230V**	**460V**
37	3.9	60	108	210
50	10	32	60	120
68	20	13	26	50
86	30	5.6	11	21
104	45	2.4	4.5	8.8
122	50	1	2	3.7
140	60	.5	.85	1.6

2. The Contractor shall check all motors for correct clearances and alignment and for correct lubrication, and shall lubricate if required in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

B. The following tests shall apply to the medium voltage motors:

1. See Paragraph 3.02 A for test requirements.

2. All motors shall be given the standard short commercial test prior to shipment. This shall consist of no load current, check current balance, winding resistance, air gap measurement, high potential tests, and bearing inspection. Six (6) copies of the certified short commercial test shall be mailed to the Engineer prior to shipment.

END OF SECTION

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SECTION 16160

PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.

B. All panelboard wiring shall include wiring numbers and terminal point numbers cross referenced to shop drawing and subsequent record drawing submittals.

1.2 SUBMITTALS

A. Submit to the ENGINEER, in accordance with Section 01330, shop drawings and product data, for the following as a minimum:

1. Equipment outline drawings showing elevation and plan views, dimensions and weight. Indicate all options, special features, ratings and deviations from this Section.
2. Bus arrangement drawings.
3. Product data sheets and catalog numbers for circuit breakers, etc. List all options, trip adjustments and accessories furnished specifically for this project.
4. Instruction and renewal parts books.
5. Test and inspection reports.
6. Complete bill of materials list.
7. The equipment drawings, summary tables, and bill of materials list shall be computer generated (i.e., no hand-drawn drawings, sketches, lists will be accepted).

1.3 REFERENCE STANDARDS

A. Panelboards shall be in accordance with the Underwriter Laboratories (UL) "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code (NEC).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 MANUFACTURERS

A. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Type NQ as manufactured by Square D; Type Pow-R-Line by Eaton; or Type AQ by ABB/General Electric.

B. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be; Type NF as manufactured by Square D; Type Pow-R-Line by Eaton; or Type AE by ABB/General Electric.

C. 480 Volt, 3 Phase, 3 Wire panelboards shall be; I-Line series as manufactured by Square D; Type Pow-R-Line by Eaton; or Type Spectra by ABB/General Electric.

D. NEMA 3R and 4X panelboards shall be as specified herein, provided in 316 stainless steel enclosures as manufactured by the Hoffman or equal and completely assembled by the panelboard manufacturer. The door shall be provided with a pad-lockable vault type 3-point latch with no other latches provided.

E. Refer to additional requirements for manufacturers in Section 16000. Alternate suppliers must be submitted for approval to the ENGINEER in writing four weeks prior to the original bid date with supporting documentation to confirm all aspects of the specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Rating

1. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.
2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

2.2 MATERIALS (NEMA 1)

A. Interiors

1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.
2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

B. Buses

1. Bus bars for the mains shall be of tin plated copper. Full size tin plated copper neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be tin plated copper. Each panel shall be provided with a ground bus bar, with removable link/jumper between neutral and ground bus. The ground bus shall be sized to the maximum number of circuit breakers that can be installed in the panelboard.
2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
4. Tin plated copper equipment ground bars shall be furnished.

C. Boxes

1. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.
2. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 2.04,D,4 below.
3. At least four studs for mounting the panelboard interior shall be furnished.
4. All conduit entrances shall be field punched.

D. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door. All trims shall be door-in-door type construction.
3. The trims shall be fabricated from code gauge sheet steel.
4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 49 or 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.
5. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface mounted panel trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

2.3 MATERIALS (NEMA 3R and 4X)

A. Interiors and Buses

1. Interiors and buses shall be as herein before specified for NEMA 1 construction.

B. Boxes and Covers

1. Boxes, covers and hardware shall be made from 316 stainless steel with natural finish.
2. Boxes and covers shall have continuous welded seams and shall be hinged (piano type) together and gasketed.
3. Conduit openings shall be tapped.
4. Maintain NEMA rating with all penetrations in the field.

2.4 CIRCUIT BREAKERS

A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.

B. Circuit breakers shall be molded case, bolt-in type.

C. Each circuit breaker used in 120/240 Volt and 120/208 Volt panelboards shall have an interrupting capacity of not less than 10,000 Amps, RMS symmetrical.

D. Each circuit breaker used in 277/480 Volt and 480 Volt panelboards shall have an interrupting capacity of not less than 65,000 Amps, RMS symmetrical.

E. GFCI (ground fault circuit interrupter) shall be provided for circuits as required and where indicated the Drawings. GFCI units shall be 1 Pole, 120 Volt, molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time) and an interrupting capacity of 65,000 Amps, RMS.

F. Circuit breakers shall be manufactured by the panelboard manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses. Record normal base load phase voltages and currents for each phase and the total neutral current and submit to the ENGINEER for review.

C. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.

D. Install a 1-in by 3-in nominal laminated plastic nameplate with 1/2-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

E. Unless otherwise noted on the Drawings, top of cabinets shall be mounted 6 feet-0-inch above the floor, properly aligned and adequately supported independently of the connecting raceways.

F. All wiring in panelboards shall be neatly formed, grouped, and identified to provide a neat and orderly appearance. A typewritten directory card identifying all circuits shall be placed in the card holder inside the front cover.

G. All panelboards shall be protected from physical damage, water damage, moisture, corrosion, dirt and dust during construction. Any panelboard judged to be unacceptable by the ENGINEER shall be replaced by the CONTRACTOR at no additional cost to the OWNER.

H. Standard factory testing shall be performed for the equipment furnished under this section and these tests shall be in accordance with the latest version of NEMA and UL standards. Certified copies of these tests shall be provided to the ENGINEER upon request.

I. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the InterNational Electrical Testing Association (NETA Standard ATS-2007) unless otherwise modified by this Section.

3.2 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-

free rags. Do not use compressed air.

END OF SECTION

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SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Nameplates and tape labels.

B. Wire and cable markers.

C. Color coding.

1.2 SCOPE

A. Provide engraved nameplates for the following equipment as indicated on the drawings:

1. Label all compartments.
2. Label all outdoor junction boxes.
3. Label control system panels.
4. Label all receptacles (circuit designation)

B. All wires shall be marked and color-coded.

C. All control wiring shall have wire numbers on each end.

D. All exposed conduits to be painted to match color of back wall.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Nameplates: Engraved three-layer laminated plastic, black letters on a white background.

B. Wire and Cable Markers: Pre-printed self-sticking type.

C. Color Coding Tape: Vinyl plastic insulating tape, colors as specified in part 3.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Degrease and clean surfaces to receive nameplates and tape labels.

B. Install nameplates and tape labels parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws, rivets, or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations.

D. Provide warning labels for automatic equipment indicating “Warning: Automated Machinery. This unit may start at any time. Stay clear. Lock-out / tagout before servicing.”

3.2 WIRE IDENTIFICATION

A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.

B. Any color coding schemes used in existing work shall be maintained in new work.

C. Conductor Color Coding: Provide color coding for feeder, and branch circuit conductors throughout the project secondary electrical system as follows:

240/120 Volts	120/208 Volts	Phase	480/277 Volts
Black	Black	A	Brown
Blue	Blue	B	Orange
Red	Red	C	Yellow
White	White	Neutral	White
Green	Green	Ground	Green

3.3 NAMEPLATE ENGRAVING

A. Provide nameplates to identify all electrical distribution and control equipment and loads served. Letter Height: 1/8 inch for individual switches and loads served for distribution and control equipment identification.

B. Panelboards: 1/4 inch; identify equipment designation. 1/8 inch; identify voltage rating and source.

C. Individual Circuit Breakers, Switches, and Motor Starters in Panelboards, Switchboards, and Motor Control Centers: 1/8 inch; identify circuit and load served, including location.

D. Individual Circuit Breakers, Switches, and in Panelboards: 1/8 inch; identify circuit and load served, including location.

3.4 CONDUIT IDENTIFICATION

A. Exposed conduits (in use and future spares) shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, condulets, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word “TO:” and the text in the ‘TO’ column of the conduit and wire schedule (e.g. TO: FFG-1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word “FROM:” and the text in the ‘FROM’ column of the conduit and wire schedule (e.g. FROM: MCC-USKB). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3. For conduits ¾" through 1½" in size, the text shall be a minimum 18 point font. For conduits 2" and larger, the text shall be a minimum 24 point font.
4. Label height shall be ¾" minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.
5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system. Handwritten labels are not acceptable.
6. Labels shall be made of permanent vinyl with adhesive backing as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal. Labels made of any other material are not acceptable.

B. Conduits (in use and future spares) that are not exposed but installed beneath free standing equipment enclosures and terminated into manholes & handholes (existing and new) shall be identified by means of a plastic tag with the following requirements:

1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.
2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.
3. Tags shall be White Tyvek as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

C. All receptacles shall be labeled with the panel name and circuit number feeding the outlets.

END OF SECTION

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SECTION 16370

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish all labor, materials, equipment and incidentals required to furnish and install variable frequency drives as shown on the Drawings and as specified herein.

B. These specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for the variable frequency drives herein specified.

1.2 DESCRIPTION OF SYSTEM

A. The variable frequency drives shall be furnished by the Division 16 CONTRACTOR and integrated into the control system by the SYSTEM SUPPLIER specified in Division 13. The Division 16 Contractor is responsible for complete system operation and necessary coordination.

B. VFDs shall be sized as shown on the electrical drawings.

C. The variable frequency drives will operate motors as specified in Division 11 and Division 16. The drives furnished herein under shall be totally compatible and adequately sized with the new motors.

1.3 QUALIFICATIONS

A. Variable speed drives shall be of sufficient size for the duty to be performed and shall not exceed their full-rated capacity when the driven equipment is operating as specified. To assure unity of responsibility, all equipment specified in this Section of the specifications shall be furnished and coordinated by the Contractor.

B. The drives covered by these Specifications are intended to be equipment of proven ability as manufactured by reputable manufacturers having long experience in the production of identical units. The equipment furnished shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

C. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other variable frequency drives are operated from the same bus.

D. The variable frequency drive manufacturer shall maintain and staff engineering service and repair shops through the United States, including the State of Florida, trained to do start up service, emergency service calls, repair work, service contracts and training of customer personnel.

E. Approved Manufacturers:

1. Square D by Schneider Electric Alitvar Process 660

2. Eaton

1.4 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
2. Descriptive literature, bulletins and/or catalogs of the equipment.
3. Data on the characteristics and performance of the variable frequency drives. Data shall include certification that the variable frequency drives are warranted for use with the motors specified in Division 11 and Division 16.
4. Complete drawings shall be furnished for approval before proceeding with manufacture and shall consists of master wiring diagrams, elementary or control schematics including coordination with other electrical control devices operating in conjunction with the variable frequency drive, and suitable outline drawings with sufficient details for locating conduit stub-ups and field wiring. Generic schematics not specific to this project shall not be acceptable.
5. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, packing, etc. on the list. List bearings by the bearing manufacturer's numbers only.

1.5 OPERATING INSTRUCTIONS

See Section 01730: Operating and Maintenance Data.

1.6 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided. If no special tools are required then a statement to this effect shall be provided.

B. Spare boards and cards for each type of VFD shall be provided. Each board shall be labeled and coded for ease of identification to its respective size VFD.

C. The Manufacturer shall furnish a complete list of recommended spare parts necessary for the first five (5) years of operation.

1.7 PRODUCT HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and spare parts must be properly protected against any damage during a prolonged period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.8 WARRANTY

A. Provide a five (5) year warranty for parts and labor from the date of substantial completion. All warranty work shall be performed by factory authorized technicians.

A. Capacitor-Inductor filter traps that require tuning to the power system are not acceptable. The Variable frequency drive manufacturer shall provide for the design, furnishing and installation of the filtering and appurtenances required to meet the requirements as specified herein. Any costs associated with provision of and installation, space, wiring, conduit, etc. for filtering equipment shall be provided at no additional cost to the OWNER.

B. The manufacturer shall be responsible to provide all data necessary to perform the study. This includes feeder cable sizes, approximate feeder length motor data, switchgear data, utility data, generator data, existing field data (if required) and any other information relevant to the study.

C. The report shall be provided prior to or with the variable frequency drive shop drawings for approval. Submittals for the variable frequency drives submitted prior to or without the study will be considered incomplete and returned to the CONTRACTOR unreviewed.

D. The variable frequency drive manufacturer is responsible to provide an up-to-date single line diagram with referenced data within the submittal for this study.

E. The study shall also address methods the manufacturer is providing to address the problems associated with “dv/dt” and “reflected waves” based on the installation (wiring, conduit, lengths, etc.) as required by the contract documents. The equipment to address any problems shall be included and provided at no additional cost to the OWNER.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall furnish and install complete variable frequency drives as described in this specification and as detailed on the applicable Drawings.

B. The Contractor shall be responsible for the erection, installation, and start up of the equipment covered by this specification.

C. The variable frequency drive shall be furnished by a VFD manufacturer who has actively been manufacturing variable frequency drives for a period of at least five (5) years.

D. The variable frequency drive shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and the National Electric Code.

E. Variable frequency drive shall operate as specified on standby generators or normal power sources.

F. The Contractor shall provide a listing of all programmable parameters that are different from the factory default values. For each indicate:

1. The factory default and meaning.
2. The revised value and meaning.

G. The Contractor shall provide Allen Bradley auxiliary I/O cards in each VFD for monitoring and control as described in the control functional descriptions defined under Division 13 and as shown on the electrical VFD wiring diagrams included in the Drawings.

H. The Contractor shall provide a copy of PC compatible remote programming/ diagnostic software to the supplier of the control system. Refer to Division 13.

2.2 CONSTRUCTION

A. Each variable frequency drive shall consist of a 460V, 3 phase rectifier, DC link and variable frequency inverter with features, functions and options as specified. The inverter shall be voltage source design using pulse width modulation (PWM) techniques.

B. The variable frequency drives shall be rated for the HP, full load current and rpm of the motor. The variable frequency drives shall be designed to provide continuous speed adjustment of three-phase motors. The variable frequency output voltage shall provide constant volts-per-Hertz excitation to the motor terminals up to 60 Hertz.

C. Inverters shall be capable of converting incoming three phase, 460V (+10 to -5%) and 60 Hertz (+/-2) Hertz power to DC bus levels. The DC voltage shall be inverted to a variable frequency drive output.

D. Controllers shall be rated for an ambient temperature of 0ºC to 40ºC, an altitude of up to 3,300 feet above sea level and humidity of 0 to 95% non-condensing.

E. VFDs shall have complete front accessibility. All VFD components shall be front facing, no side mounted equipment, components, etc. will be permitted. VFD enclosure shall provide dedicated 15% free space within the enclosure for future use.

F. The following standard basic control features shall be provided on the inverter:

1. Unidirectional operation, coast to rest upon stop.
2. Variable linear independent timed acceleration.
3. Variable torque performance from 4 to 60 Hertz.
4. AC input power line reactors
5. Output line reactors to protect both the motor power cable and motor from elevated voltage spikes.
6. Frequency stability of 0.5% for 24 hours with voltage regulation of +2% of maximum rated output voltage.
7. 115V AC control power for operator devices.
8. Phase insensitive to input power.
9. Cooling fans shall be controlled as follows: VFD start up and operation, fans shall run continuously; on VFD shutdown, fans shall operate for a period of time necessary to remove the excess heating within the VFD. A field adjustable timing relay shall be provided and set per VFD manufacturer recommendations.
10. Automatic restart upon return of power following a utility outage. Drive shall require manual reset after three (3) attempts in a 60 second period.

G. The following protective features shall be provided on the drive:

1. Input AC circuit breaker with an interlocked, pad lockable handle mechanism and AC input line current limiting fuses for fault current protection of AC to DC converter section and circuit breaker. Minimum short circuit rating of 85,000 AIC shall be provided.
2. Electronic overcurrent trip for instantaneous overload protection.
3. Undervoltage and phase loss protection of output.
4. Over-frequency protection.
5. Over-temperature protection.
6. Surge protection from input AC line transients.
7. Electrical isolation between the power and logic circuits, as well as between the 115V AC control power and the static digital sequencing.
8. Drive to be capable of withstanding output terminal line short or open circuits without component failure.
9. Di/dt and dv/dt protection for converter semiconductors.
10. Units shall have an English language (no codes) alphanumeric diagnostic display. LED indication of over frequency, instantaneous overcurrent, DC overvoltage, AC undervoltage/loss-of-phase, emergency stop, overload, overtemperature, inverter pole trip and standby modes shall be provided and door mounted. Additional door mounted status indicating LEDs for self-diagnostic including run, phase loss, micro-processor fault, as well as board mounted LEDs including one for each inverter pole gating signal, each inverter pole status and each logic level VDC used. A comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions is also approved.

H. The following standard independent adjustments shall be provided on the inverter:

1. Minimum speed (1 to 54 HZ).
2. Maximum speed (40 to 60 HZ).
3. Acceleration time 6 to 60 Sec. (minimum).
4. Deceleration time 6 to 60 Sec. (minimum).
5. Volts per Hertz.
6. Stability adjustment, if required.
7. Voltage boost (100 to 600 percent of nominal V/HZ ratio at 1 HZ tapering to 100 percent at 20 HZ).

I. The following shall be furnished with each VFD enclosure:

1. The VFD shall be housed in a standard metal-enclosed, free-standing enclosure, not more than 90 inches in height, and fabricated from formed sheet steel of not less than No. 14 gauge thickness. The enclosure shall be NEMA 1, finished with a baked enamel power interior/exterior enclosure coating, and white enamel coated steel backplate for mounting all internal components.
2. Mounted on the enclosure door shall be:

    a. Hand/Off/Remote selector switch
    b. VFD fault light (amber)
    c. Power "ON" light (white)
    d. Motor "ON" light (red)
    e. Motor elapsed time meter
    f. Motor High Temperature light (amber)

g. Pump No Flow light (amber)
h. Alarm reset pushbutton.

3. The VFD shall include a remote operator interface panel mounted on the enclosure front door which shall provide indication of VFD speed, ability to manually adjust the speed when in HAND, drive amp and voltage readings, and indication of overcurrent, overvoltage, overtemperature, undervoltage, phase loss, along with other diagnostic information for the drive as recommended by the manufacturer.
4. The auxiliary I/O for each drive shall provide inputs for pump locked out status, high motor temperature, and pump no flow alarms.
5. The EtherNet link to the plant PLC shall communicate the following:

a. Speed reference 0-100% input signal to adjust the drive speed when in REMOTE
b. Speed 0-100% output signal for actual drive speed
c. In REMOTE status signal output
d. Motor running signal output
e. Pump locked out status signal output
f. VFD fault signal output (for all VFD alarms other than overcurrent)
g. Motor high temperature signal output
h. Motor start command signal input
i. Motor overcurrent signal output
j. Pump No Flow signal output

6. Built-in self-diagnostics
7. Nameplates, Wire Labels, and Diagrams:

a. Unit nameplates shall be black and white laminated plastic having engraved letters approximately 3/16-inch high extending through the black face into the white layer. Nameplates shall identify equipment controlled or circuit designation as applicable. Provide nameplates for each relay, timer, and other control components used in the control circuitry.
b. All wiring shall be labeled using permanent heat-shrink labeling system clearly identifying each wire with corresponding wire numbers shown on the wiring diagram.
c. Provide a laminated copy of the wiring diagram permanently adhered to the interior face of the enclosure door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Field wiring shall be in accordance with manufacturer's recommendations. Anchor bolts shall be stainless steel and set in accordance with the manufacturer's recommendations.

3.2 SHOP PAINTING

A. Prior to shop painting, all surfaces shall be thoroughly cleaned, dry, and free from all mill/scale, rust, grease, dirt, and other foreign matter.

B. Drives shall be shop painted.

3.3 TESTING

A. Tests and Check

1. The drive manufacturer shall test the drive controller with a motor load prior to shipment. The motor shall have equal or greater full load current than the specified motor.
2. A certified copy of all tests and checks performed in the field, complete with meter readings and recordings, where applicable, shall be submitted to the Owner.

B. The Contractor shall provide the services of a competent and experienced equipment manufacturer's factory field engineer to supervise start-up and provide training to the Owner's personnel. The factory field engineer shall be available for one (1) - eight (8) hour day to inspect the installed equipment and supervise the start-up demonstration and testing as specified in Section 01650: Start-up, and additional testing and training as specified herein. The factory field engineer shall be available for two (2) additional eight (8) hour days (a total of three (3) - eight (8) hour days) to provide factory and on-site training to the Owner's personnel as specified herein. Training of the Owner's personnel will only be considered valid for approval by the Engineer if it takes place after the successful start-up and demonstration test.

3.4 TRAINING

A. The training and instruction shall be directly related to the System being supplied.

B. The Supplier shall provide classroom training detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project as included in the O&M manual.

C. The Supplier shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.

D. The training program shall represent a comprehensive program covering all aspects of the variable frequency drive and maintenance of the system.

E. All training schedules shall be coordinated with, and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

F. Factory Training: Factory training shall be conducted before the System is commissioned, and subsequent to final manual submittals. Two days of factory training shall be provided and consist of schooling and hands on experience for two people covering the following:

1. Theory of Operation
2. Use of Software
3. Troubleshooting

G. On-site Training: On-site (field) training shall be conducted at the Owner's Plant Site and shall provide detailed hands-on instruction to Owner's personnel covering: system debugging, program modification, trouble-shooting, maintenance procedures, calibration procedures, and system operation.

END OF SECTION

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SECTION 16440

GROUP-MOUNTED CIRCUIT BREAKER SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Free standing, dead-front type metal-enclosed distribution, low voltage switchboards, utilizing group mounted circuit protective devices.

B. Related sections:

1. Section 01330 - Submittal Procedures.
2. Section 16000 – Electrical – General Provisions.
3. Section 16195 - Identification for Electrical Systems.
4. Section 16709 - Surge Protective Devices.

1.2 REFERENCES

A. As specified in Section 16000.

B. National Electrical Manufacturers' Association (NEMA):

1. PB-2 - Dead-front Distribution Switchboards.

C. Underwriters' Laboratories, Inc. (UL):

1. 50 - Standard for Enclosures for Electrical Equipment.
2. 891 - Switchboards.

1.3 DEFINITIONS

A. As specified in Section 16000.

1.4 SYSTEM DESCRIPTION

A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including but not limited to, circuit breakers, bus and enclosure with accessories and features specified in this Section and indicated on the Drawings.

1.5 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16000.

B. Product data:

1. Manufacturer of switchboard.
2. Manufacturer of all component parts of switchboard.
3. Weight of switchboard.

4. Dimensions:
    a. Height.
    b. Length.
    c. Width.
5. Nameplate schedule.
6. Bill of material.
7. Ratings:
    a. Voltage.
    b. Phase.
    c. Current.
    d. Interrupting rating (circuit breakers and fuses).
    e. Momentary current rating.
8. List of recommended spare parts.
9. Name and telephone number of manufacturer's authorized parts and repair provider.

C. Shop drawings:

1. Layout drawings:
    a. Complete, detailed, and scaled switchboard layout:
        1) Front panel.
        2) Sub-panels.
        3) Interior panels.
        4) Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
    a. Point-to-point connections.
    b. Indicate wire numbers.

D. Installation instructions:

1. Detail the complete installation of the equipment including rigging, moving, and setting into place.

E. Operating and maintenance manuals:

1. Submit operating instructions and a maintenance manual for the switchboard(s) furnished and/or installed under this Contract.
2. Operating instructions.
3. Maintenance manual:
    a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.
    b. Manuals to include but are not limited to the following:
        1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.

F. Test forms and reports:

1. Submit complete factory acceptance test procedures and all forms used during the test.

2. Manufacturer to furnish a certified report after the shop tests.
3. Manufacturer to furnish a certified report after the start-up:

    a. Report must state that the installation is complete and satisfactory, or list items requiring additional work and a proposal for the corrective actions.

G. Certification letters:

1. Provide a letter from the switchboard manufacturer that lists every paragraph, subparagraph etc. of this Section and states compliance or non-compliance with said paragraph. If non-compliance is indicated, provide an explanation for the deviation and alternative method to address the non-compliance.

H. Calculations:

1. Detailed calculations or details of the actual physical testing performed on the switchboard to prove the switchboard is suitable for the seismic requirements at the Project Site.

1.7 QUALITY ASSURANCE

A. As specified in Section 16000.

B. Where indicated on the Drawings as service entrance equipment, the switchboard shall be UL labeled and listed “Suitable for Service Entrance”.

C. Sections and devices shall be UL listed and labeled.

D. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 DELIVERY STORAGE AND HANDLING

A. As specified in Section 16000.

B. Ship the switchboard to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment:

1. Energize space heaters in NEMA 3R switchboards.

C. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

1.9 PROJECT OR SITE CONDITIONS

A. As specified in Section 16000.

1.10 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16000 and submit results for Engineer’s review.

B. After successful review of the initial fault current study, submit complete equipment submittal.

C. Conduct factory acceptance test and submit certified test results for Engineer's review.

D. Ship equipment to Project Site after successful completion of factory acceptance test.

E. Assemble equipment in the field.

F. Conduct field acceptance test and submit results for Engineer's review.

G. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.

H. Conduct Owner's training sessions.

1.11 WARRANTY

A. As specified in Section 16000.

1.12 SYSTEM START-UP

A. As specified in Section 16000.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following:

1. Schneider Electric/Square D. "Power-Style QED."
2. No or equal.

B. Circuit breakers: Same manufacturer as the switchboard.

2.2 EQUIPMENT

A. Switchboard:

1. Furnish low voltage Class 1 switchboards as specified and indicated on the Drawings.
2. Provide complete and functional switchboards with required controls.
3. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.

B. Voltage ratings:

1. Voltage level and configuration: As indicated on the Drawings.
2. Frequency: 60 hertz.
3. Solidly grounded system insulation level:
    a. Twice the rated voltage plus 1,000 volts.

C. Bus:

1. General:

    a. Tin-plated copper.
    b. Bus cross-section in accordance with UL heat rise requirements.
    c. Current density of 1,000 amperes per square inch.
    d. Mounted on supports of high-impact, non-tracking insulators.
    e. Phase A-B-C bus arrangement:

        1) Top-to-bottom, left-to-right, front-to-back throughout the switchboard.

    f. Symmetrical short circuit current bracing of as indicated on the Drawings.
    g. Continuous current rating as indicated on the Drawings.

2. Horizontal bus:

    a. Provisions for future connections to additional switchboard sections.

3. Ground bus:

    a. Sized per UL 891.

4. Neutral bus, if shown on drawings:

    a. Sized for 100 percent of power bus rating.

D. Enclosure:

1. General:

    a. Self-supporting structures bolted together to form the required line-up.
    b. All sections rear aligned.
    c. Dead-front.
    d. Conduit entry:

        1) Open-bottom.
        2) Removable top cover.

2. Frame:

    a. Die-formed 12 gauge steel.

3. Covers:

    a. Bolt-on.
    b. Code gauge steel.
    c. Removable front covers.

        1) Held in place by captive screws.

4. Rating:

    a. NEMA Type 1.

2.3 COMPONENTS

A. Circuit breakers:

1. General:

a. Molded case circuit breakers shall be thermal magnetic, 480 volt, with not less than 65,000 amperes, RMS interrupting capacity. All circuit breakers with 225 amperes frames and larger shall have interchangeable trips.

2. Main circuit breaker, if shown on drawings:

a. Frame, trip, and short circuit ratings as indicated on the Drawings.
b. 100 percent rated.

3. Feeder breakers:

a. Frame, trip, and short circuit ratings as indicated on the Drawings.

B. Wiring:

1. Provide all necessary internal wiring, fuse blocks, and terminal blocks as required.
2. Number all wires at each end and indicate wire numbers on shop drawings.
3. Type SIS switchboard wire with at least 26 strands.
4. Minimum wire size:

a. No. 14 for control circuits.
b. No. 12 for potential and current transformer circuits.

5. Numbered and labeled in accordance with Section 16195.

2.4 ACCESSORIES

A. Surge protective devices:

1. Provide surge protective devices as indicated on the Drawings and as specified in Section 16709.

B. Nameplates:

1. Provide engraved plastic nameplates to identify:

a. Switchboard units.
b. Door mounted components.
c. Interior mounted devices.

2. As specified in Section 16195.
3. Engraved with the circuit number and circuit name as indicated on the Drawings.
4. Manufacturers labels:

a. Each vertical section shall have a label identifying:

1) Serial number.
2) Shop order number.
3) Bus rating.
4) Vertical section reference number.
5) Date of manufacture.

C. Warning signs:

1. Voltage:

a. Provide a minimum of 2 warning signs on the front of the switchboard lineup and 2 on the back.
b. Red laminated plastic engraved with white letters approximately 1/2 inch high.
c. Signs shall read:

1) "WARNING-HIGH VOLTAGE-KEEP OUT".

2. Arc flash:

a. Provide one warning sign for each switchboard compartment.
b. Signs shall have read a minimum of:

1) “DANGER ELECTRIC ARC FLASH HAZARD.”
2) Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.

D. Lugs:

1. For all external connections of No. 6 AWG or larger.
2. UL listed for copper or aluminum conductors.
3. Rated for 75-degree Celsius conductors.
4. Lugs shall be of the compression type in design requiring a hydraulic press and die for installation.

E. Power Monitors:

1. The 480V switchboard shall be equipped with a digital-metering device capable of communicating with the plant control system by an Ethernet interface using the Profinet protocol.
2. The meter shall have capability for measuring all three phases of Volts-Amps, KW, KWH, PF, for all three phases. The meter shall have wave form capture for 16 to 512 cycles of data at 512 samples/cycle and providing harmonic content up to the 255th harmonic for voltage and current on all three phases. The circuit monitor shall be accurate to .04% of readings +/- .025% of full scale for voltage and current metering and .08% of rating plus .025% for power.

a. Manufacturer, model, Siemens, PAC4200 with Profinet module

2.5 FINISHES

A. Chemically clean all steel surfaces before painting.

B. Exterior color manufacturer’s standard gray over phosphate-type rust inhibitor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. As specified in Section 16000.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:

1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the switchboard.
2. Assemble and install the switchboard in the location and layout indicated on the Drawings.
3. Perform work in accordance with manufacturer's instructions and shop drawings.
4. Furnish components and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install the switchboard on a 4-inch raised concrete housekeeping pad:
    a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
    b. Weld and/or bolt the switchboard frame to be to the leveling channels.

3.2 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

SECTION 16450

GROUNDING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code and as hereinafter specified and shown on the Drawings.

1.2 RELATED WORK

A. Conduit shall be as specified under Section 16110.

B. Wire shall be as specified under Section 16120.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ground rods: Ground rods shall be copperclad steel 3/4-inch x 20 foot. Ground rods shall be Copperweld or be an approved equal product.

PART 3 - EXECUTION

3.1 GENERAL

A. Tie into existing grounding system.

B. Grounding electrodes shall be driven as required. Where rock is encountered, grounding plates may be used in lieu of grounding rods.

C. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and similar items shall be grounded.

D. Exposed connections shall be made by means of approved grounding clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A or approved equal. All buried connections shall be made by welding process equal to Cadweld.

E. The grounding grid conductors shall be embedded in backfill material around the structures.

F. All underground conductors shall be laid slack and where exposed to mechanical injury shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard.

G. The Contractor shall exercise care to insure good ground continuity, in particular between the conduit system and equipment frames and enclosures. Where necessary, jumper wires shall be installed.

3.2 TESTS

A. The Contractor shall test the ground resistance of the system. The Engineer shall be notified forty-eight (48) hours before tests are made to enable the Owner to have designated personnel present. All test equipment shall be provided by the Contractor and approved by the Engineer. Dry season resistance of the system shall not exceed 5 ohms. If such resistance cannot be obtained with the system as shown, the Contractor shall provide additional grounding as directed by the Engineer, without additional payment. The Contractor shall submit all grounding system test results to the Engineer for review.

END OF SECTION

SECTION 16500

LIGHTING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install complete lighting systems including panelboards, transformers, lighting fixtures, receptacles, switches, contractors, clocks and all necessary accessories and appurtenances required as hereinafter specified and shown on the Drawings.

1.2 STANDARDS

A. All lighting fixtures shall be in accordance with the National Electrical Code and shall be constructed in accordance with the latest edition of the Underwriters Laboratories "Standards for Safety, Electric Lighting Fixtures." All lighting fixtures shall be Underwriters Laboratories labeled.

1.3 RELATED WORK

A. Conduit shall be as specified under Section 16110.

B. Wire shall be as specified under Section 16120.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches:

1. Wall switches shall be of the indicating, toggle action, flush mounting quiet type. All switches shall conform to Federal Specification W-S-896-D.
2. Wall switches shall be ivory and of the following types and manufacturer or approved equal.

a. Single pole - Arrow-Hart No. 1991 or Leviton No. 1221-2.
b. Double pole - Arrow-Hart No. 1992 or Leviton No. 1222-2.
c. Three way - Arrow -Hart No. 1993 or Leviton No. 1223-2.
d. Four way - Arrow-Hart No. 1994 or Leviton No. 1224-2.
e. Single pole, key operated - Arrow-Hart No. 1991-L or Leviton No. 1221-2L.
f. Momentary contact, 2 circuit, center off - Arrow-Hart No. 1895 or Leviton No. 1256.
g. Weatherproof cover for Arrow-Hart 2900 series tap action switches - Arrow-Hart Catalog No. 2881-G.

B. Receptacles:

1. Wall receptacles shall be ivory and of the following types and manufacturer or approved equal.

a. Single, 20A, 125V, 1P, 3W; Arrow-Hart No. 5361 or Leviton No. 5361.
b. Duplex, 20A, 125V, 2P, 3W; Arrow-Hart No. 5362 or Leviton No. 5362.

c. Corrosion-resistant, duplex, 20A, 125V, 2P, 3W; Arrow-Hart No. 5739-CR or Leviton No. 5362CR and Crouse-Hinds WLRD-1 cover.
d. 60A, 480V, 3P, 2W; weatherproof receptacle shall be Crouse-Hinds Catalog No. ARE6324 with Crouse-Hinds Catalog No. APJ 6385 plug.
e. Ground fault interrupter, duplex, 20A, 125V, 3P, 2W; Arrow-Hart No. GF5362 or Leviton No. 6899.
f. Stainless steel indoor mounting plate for G.F.I. receptacle; Arrow-Hart Catalog No. S-26.
g. Clock hanger, 15A, 125V, 2P, 3W; Arrow-Hart No. 452 or Leviton No. 628.
h. Single, 20A, 250V, 2P, 3W; Arrow-Hart No. 5461 or Leviton No. 5461.
i. Single, 30A, 125V, 2P, 3W; Arrow-Hart No. 5716N; cap: Arrow-Hart No. 5717N or Leviton No. 5371.
j. Clothes dryer, 30A, 125/250V, 3P, 3W; Arrow-Hart No. 9344N. Cap: Arrow-Hart No. 9352AN or Leviton No. 5209 and No. 9382-P.

2. Receptacles (Weatherproof/NEMA 4 Areas/Outside)

a. General Requirements: Receptacles in wet locations shall be installed with a hinged outlet cover/enclosure clearly marked “Suitable for Wet Locations While In Use” and “UL Listed”. There must be a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base to assure proper seal. Taymac; Specification Grade.

3. Special wiring devices shall be provided as noted of the drawings.

a. Tamper resistant duplex receptacle Leviton No. 5262-SG or approved equal.
b. Wall switch occupancy sensor Leviton No. 6775 or approve equal.
c. Scene select microprocessor dimmer Leviton No. 17765 or approved equal.
d. Surge protective duplex receptacle Leviton No. 5380 or approved equal.

C. Device Plates:

1. Plates for flush mounted devices shall be of the required number of gangs for the application involved and shall be 302 (18-8) high nickel stainless steel of the same manufacturer as the device.
2. Plates for surface mounted device boxes shall be of the same material as the box.

D. Lighting Fixtures:

1. Lighting fixture types shall be as shown on the "Lighting Fixture Schedule" on the Drawings.

E. Lamps:

1. All lighting fixture lamps shall be LED.
2. All lamps shall be of one manufacturer and shall be as manufactured by Hubble Lighting, Sesco Lighting, Sylvania Electric Products, Inc., General Electric Company, or Westinghouse Electric Corporation or approved equal.

F. Flexible Fixture Hangers:

1. Flexible fixture hangers used in nonhazardous areas shall be Type ARB and flexible fixture supports used in hazardous areas shall be Type ECHF as manufactured by the Crouse-Hinds Company or approved equal.
2. Steel channel, roll formed into U-shape, shall be used to span between building steel for mounting of fixtures where required by fixture location or as indicated on the Drawings. Channel shall be as manufactured by Unistrut Corporation or approved equal.

G. Lighting Contactor Enclosure

1. All conduit entry shall be from the bottom only.
2. The panel shall be provided with an isolated copper grounding bus to ground all signal shield connections.
3. Enclosure shall be NEMA 4X 316 stainless steel.
4. All internal components shall be equipped with identification tags
5. The panel shall be protected from internal corrosion by the use of corrosion – inhibiting vapor capsules. Provide:

    a. Northern Instruments Model Zerust VC-6-2
    b. Hoffman, model A-HC15E
    c. Approved equal.

6. Doors:

    a. The enclosure shall have a continuous piano hinge door for ease of access. A minimum of 80% of the panel interior shall be exposed by doors.
    b. The door shall use a lockable three-point latch mechanism and be able to accept a cyber lock with 3/8” shackle.
    c. The inside of each door shall be equipped with a print pocket.
    d. The panel nameplate shall be equipped with a screw mounted laminated plastic nameplate. The use of adhesive to mount the nameplate will not be acceptable.

7. Construction:

    a. Minimum metal thickness: 14-gauge.
    b. Stiffeners as required to prevent deflection under instrument loading and permit lifting without racking or distortion.
    c. When required, removable lifting rings and fill plugs to replace rings after installation.
    d. All components and terminals shall be accessible without removing other components except for covers.

8. The enclosure shall be a manufactured item, Hoffman Engineering, or equal.

H. Lighting Contactor:

1. Lighting contactor shall be of the electrically operated, mechanically held type in NEMA 4X stainless steel enclosures of the number of poles as called for on the Drawings.
2. Contactors shall be rated for 20A-600 volt contacts and be similar and equal to Automatic Switch Company bulletin 1255-166 RC.

I. Lighting Control Time Switches:

1. Time switches for the control of lighting shall have astronomic dials, reserve power and be similar and equal to the following types:

a. Where time switch is indicated for SPST maintained control it shall be similar and equal to Tork Time Controls Catalog No. 7100ZL (120V).
b. Where time switch is indicated for DPST maintained control it shall be similar and equal to Tork Time Controls Catalog No. 7200ZL (120V).

J. Photocell:

1. Tork 2101 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each fixture shall be a finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

B. When fixtures are noted to be installed flush, they shall be complete with the proper accessories for installing in the particular ceiling involved. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

C. Flexible fixture hangers shall be used for all pendant mounted fixtures.

D. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.

E. Receptacles in process areas and shops shall be mounted 36 inches above the floor unless otherwise noted on the Drawings.

F. Receptacles in office and other like areas shall be mounted 18 inches above the floor unless otherwise noted on the Drawings.

3.2 SPARE LAMPS

A. Spare lamp modules shall be provided for all fixture types supplied. Quantity shall be one of each type used on project.

3.3 CLEANING UP

A. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. A Lightning Protection System shall be provided and installed as shown on the drawings and for all new buildings and structures five (5) feet above grade level. They system shall be provided and installed in compliance with provisions of Code for Lightning Protection Systems as adopted by the National Fire Protection Association and Lightning Protection Institute. All equipment to that result shall be included whether specifically called for herein. Installers shall be LPI (Lightning Protection Institute) certified, master and Journeyman in accordance with LPI standards or of equal qualifications as approved by ENGINEER. An LPI label for the system shall be required.

B. Material shall comply in weight, size and composition with the requirements of the Lightning Protection Institute and the National Fire Protection Code relating to this type of installation and shall be LPI labeled.

1. All materials, where available by any one manufacturer, shall be cast. All bolts shall have hexagonal heads, no screw heads will be permitted. Where copper is mentioned or noted, tinned copper shall be required.
2. Lightning protection cable shall be Class I tinned copper. Grounding counterpoise shall be as shown. All components, fittings and straps shall be cast tinned copper.

1.2 SUBMITTALS

A. Shop Drawings: Shop drawings shall be submitted before work is done. Drawings shall include full layout of cabling and points, and connections.

B. Product Data: Product Data shall be submitted on all equipment to show compliance with this section of the specifications and shall include manufacturer's written recommendations for installation.

PART 2 - PRODUCTS

2.1 AIR TERMINALS

A. Air terminals shall be tinned copper as required to match roof conductors. They shall have proper base support for surface on which they are attached and shall be securely anchored to this surface. Terminals shall project a minimum of 10" above top of object to which attached.

2.2 CONDUCTORS

A. Roof conductors shall consist of tinned copper complying with the weight and construction requirements of the Code, and shall be coursed to interconnect with air terminals, and in general, provide a two-way minimum path to ground. The angle of any turn shall not exceed 90 degrees and shall provide an approximately horizontal or downward course. Down conductors shall be tinned copper, concealed within the structure. Radius of bends shall not be less than 8 inches. Roof conductor's material shall match and/or be compatible with roof flashing material.

2.3 FASTENER

A. Conductor fasteners shall be of the same material as the conductor, having ample strength to support conductor. Where fasteners are to be mounted in masonry or structural work, they shall be furnished to the Masonry or Structural CONTRACTOR so they may be installed during construction of the project.

2.4 GROUND CONNECTIONS

A. Ground connections shall be made in accordance with requirements of all applicable codes. Ground rods shall be placed in a minimum of two (2) feet from building foundations. In addition to above artificial grounds, one down conductor of each two-path system shall be connected to water piping system with approved water pipe type strap connector. All ground rods shall be 3/4" diameter, with a minimum length of 20' copperweld type. Each installed ground rod shall be checked for resistance to ground. If a 0 to 5-ohm reading is not obtained, extend 10' rod lengths and continue driving rods until the required reading is obtained. No rod can be connected to the bonding cable without the required ohm reading.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be made in an inconspicuous manner with conductors coursed to conceal equipment as much as possible. Down conductors shall be concealed within structure and shall be run in 1" PVC conduit. All metallic equipment within 6 feet of any lightning conductor shall be bonded to conductor. System shall also be tied to the main service electrical ground.

3.2 EQUIPMENT

A. Equipment shall be as manufactured by National Lightning Protection, Inc., Lightning Masters Corp., or Heary Bros Lightning Protection (premium lines).

END OF SECTION

SECTION 16709

SURGE PROTECTION DEVICES (SPD)

PART 1 – GENERAL

1.1 DESCRIPTION

A. The specified unit shall provide effective high energy transient voltage surge suppression, surge current diversion and high frequency noise attenuation in all electrical modes for equipment connected downstream from the facility's meter or load side of the main overcurrent device. The unit shall be connected in parallel with the facility's wiring system.

1.2 RELATED DOCUMENTS AND APPLICABLE STANDARDS

A. Systems shall be designed, manufactured, tested and installed in accordance with the following applicable documents and standards:

1. Underwriters Laboratories (UL1449 Latest Addition and UL 1283)
2. ANSI/IEEE (C62.41 and C62.45)
3. Military Standards (MIL – STD 220A)
4. National Electric Code (NEC)
5. Underwriter's Laboratories 248

PART 2 - PRODUCTS

2.1 DEVICES

A. Surge Protection Devices (SPD's) shall be UL listed at or above the available fault current level at the point of SPD application by UL, Per UL 1449 latest edition.

B. The SPD shall be a parallel design using fast-acting energy protection that will divert and dissipate the surge energy.

C. Units shall have:

1. Minimum 10 mode operation for all 3 phase Y and high leg Delta configurations and six modes of protection for all 3 phase Delta "no Neutral" configurations.
2. One nanosecond or less response time for any individual component, and shall be self restoring and fully automatic.
3. Extended noise filtration with a 10 kHz to 100 MHz range.
4. LED indication of unit failure to indicate the continuous positive operational status of each protected phase.
5. System Voltage shall be as indicated on the drawings.
6. The fusing system shall be capable of allowing the rated maximum single impulse surge current to pass through without fuse operation.
7. SPD's shall be installed with leads as shorts as possible (not to exceed 24 inches). SPD's may be mounted internally in Motor Control Centers, switchgear and switchboards. SPD's shall be mounted externally at panelboards and control panels.
8. All SPD panel units shall be guaranteed by the installing contractor and surge suppression manufacturer to be free of defects in materials and workmanship for a period of not less

than 10 years from the date of final completion of the system to which the suppressor is installed.

9. For each SPD type or size used on this project provide the following submittal data:

    a. Complete schematic data for suppressor, indicating part numbers, dimensional drawings and mounting arrangement.
    b. Cut sheets which include Peak Surge Current "per mode", Let Through Current, UL tested voltage protection rating (VPR) and maximum Continuous Operating Voltage (MCOV).
    c. Copy of Warranty Statement

2.2 APPLICATIONS

A. Surge Current RATING OF 40 kA PER MODE AT 208 or 240 Volt three phase or single-phase branch panels. Surge Current RATING of 80 kA PER MODE (160 kA PER PHASE) AT 480-volt three phase panels.

B. Surge Current RATING of 150 kA PER MODE (300 kA PER PHASE) AT 480-volt MCC's.

C. Surge Current RATING of 240 kA PER MODE (480 kA PER MODE) AT 480-volt MCC's with built in variable frequency drives (VFD's) or serving stand-alone variable frequency drives.

D. Surge Current RATING of 150 kA PER MODE (300 kA PER MODE) AT 480-Volt Switchgear.

E. Surge Current RATING of 40kA PER MODE (80kA PER PHASE) AT 208, 240 or 480 volt three phase or single phase Control Panels

2.3 FILTERING

A. The system shall provide a UL 1283 Listed Electromagnetic Interference Filter capable of attenuating noise levels produced by electromagnetic interference and radio frequency interference.

2.4 FUSING

A. Fuse component(s) identification and surge rating. The manufacture shall provide documentation demonstrating the tested surge current rating (8x20µsec) of the fuse. The surge rating of the fuse shall be greater than the combined surge current rating of all downstream connected suppression elements.

B. Fusing: Suppression component(s) identification and surge rating. The manufacturer shall provide documentation identifying the suppression element(s) connected in series with fuse element(s) and provide the suppression elements published 8x20µsec surge current rating. The rating of the suppression element(s) shall be less than the rating of upstream fusing element(s).

C. Fusing: Surge performance. All fusing shall be required to meet the single pulse surge current testing requirements of Section 2.2 above.

D. Fusing: Isolation. The unit shall have each MOV fused and designed to operate only in the event of an MOV failure within the SPD device.

E. Fusing Coordination: Units that can't demonstrate MOV-fuse coordination in 2.4.a and 2.4.d are not acceptable.

F. Fusing: UL Rating. All fusing shall be 200kAIC UL248 Recognized.

2.5 UL 1449 SUPPRESSED VOLTAGE RATING.

A. The unit shall be UL 1449 3rd Edition Listed and shall be as follows for L-N, L-G, N-G, and L-L, modes, inclusive of the disconnect switch (Select appropriate product rating from below):

1. 40kA – 80kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
2. 100kA – 150kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700
3. 200kA – 300kA rated products/120/208V units: L-N = 400V, L-G=500, N-G=500, and L-L=700

2.6 IN-FIELD TESTING

A. The unit shall be equipped with a performance data extraction protocol allowing unit performance data, including percent of protection remaining, to be transmitted to an internal, external status analyzer.

2.7 ENCLOSURE

A. Outside - Units shall be provided in a NEMA type 4X plastic enclosure.

PART 3 – EXECUTION

3.1 SYSTEM TESTING

A. Upon completion of installation, a factory-authorized local service representative shall provide product startup testing services. The tests shall include:

1. On-line Testing: Verification that all suppression and filtering paths are operating with 100% protection as well as verification of proper facility neutral-to-ground bond by measuring neutral-to-ground current and voltage.
2. Off-line Testing: Impulse injection to verify the system tolerances as well as verification of proper facility neutral-to-ground bond. To be compared to factory benchmark test parameters supplied with each individual unit.

3.2 DOCUMENTATION AND REPORTING

A. A copy of the startup test results and the factory benchmark testing results shall be supplied to the engineer and the owner for confirmation of proper system function. This letter shall also clarify that the integrity of all neutral-to-ground bonds were verified through testing and visual inspection, and that all grounding bonds were observed to be in place.

3.3 SYSTEM WARRANTY

A. The TVSS system manufacturer shall warranty the entire system against defective materials and

workmanship for a period of ten (10) years following project final completion.

END OF SECTION

DIVISION 22

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packless expansion joints.
3. Alignment guides and anchors.
4. Sleeves without waterstop.
5. Grout.
6. Silicone sealants.
7. Escutcheons.
8. Thermometers, filled system, lead free.
9. Thermometers, liquid in glass, lead free.
10. Thermometers, light activated, lead free.
11. Thermowells, lead free.
12. Pressure gauges, dial type, lead free.
13. Gauge attachments, lead free.

1.2 DEFINITIONS

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.

    a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
    b. Include operating characteristics and furnished accessories.

B. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of expansion joint,,gauge to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.6 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water expansion fittings and loops for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of **3300 ft.** above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Efficiency: Premium Efficient, as defined in NEMA MG 1.
2. Service Factor: 1.15.
3. Multispeed Motors: Variable torque.

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

4. Multispeed Motors, Two Winding: Separate winding for each speed.
5. Rotor: Random-wound, squirrel cage.
6. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
7. Insulation: Class F.
8. Code Letter Designation:

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

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

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

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

protected motors.

E. Single-Phase Motors:

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

    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

F. Electronically Commutated Motors:

1. Microprocessor-Based Electronic Control Module: Converts 120 V, or, 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
2. Three-phase power motor module with permanent magnet rotor.
3. Circuit board, or, digital speed controller/LED display.
4. Building Automation System Interface: Via DC voltage signal,Digital Serial Interface (DSI).

2.3 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Alignment Guides and Anchors:

1. Anchor Materials:

    a. Steel Shapes and Plates: ASTM A36/A36M.
    b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
    c. Washers: ASTM F844, steel, plain, flat washers.
    d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, zinc-coated carbon steel.
2) Expansion Plug: Zinc-coated carbon steel.
3) Washer and Nut: Zinc-coated carbon steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: Zinc-coated carbon steel.

2.4 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, **24 gauge** minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
4. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
5. Molded-PVC Sleeves: With nailing flange.
6. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: **5000 psi**, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.5 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermowells, Lead Free:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper <**Insert material**>.
4. Material for Use with Steel Piping: Type 304 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: **NPS 1/2, NPS 3/4, or NPS 1**, or as required to match threaded

opening in pipe.

7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend a minimum of 2 inches into fluid.
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

B. Gauge Attachments, Lead Free:

1. Snubbers: ASME B40.100, lead-free brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: Lead-free brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF GROOVED-JOINT EXPANSION JOINTS

A. Install grooved-joint expansion joints to grooved-end steel piping.

3.4 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by

ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.5 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.6 INSTALLATION OF SLEEVES - GENERAL

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

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment

areas or other wet areas 2 inches above finished floor level.

3. Using grout, or, silicone sealant, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide **1/4-inch** annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

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

3.7 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.

C. Secure nailing flanges to wooden concrete forms.

D. Using silicone sealant, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.8 INSTALLATION OF STACK-SLEEVE FITTINGS

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide **1/4-inch** annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to **2 inches** above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

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

3.9 INSTALLATION OF SLEEVE-SEAL SYSTEMS

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

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

3.10 INSTALLATION OF ESCUTCHEONS

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

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

3.11 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Install thermowells with extension on insulated piping.

E. Fill thermowells with heat-transfer medium.

F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

G. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks.

H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

I. Install remote-mounted pressure gauges on panel.

J. Install valve and snubber in piping for each pressure gauge for fluids.

K. Install test plugs in piping tees.

L. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.
5. Outlet side of hot-water-balancing valve.
6. Each main hot-water-recirculating line return pipe.
7. <**Insert location**>.

M. Install pressure gauges in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.
4. <**Insert location**>.

3.12 CONNECTIONS

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

3.13 ADJUSTING

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

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

3.14 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.15 SLEEVES APPLICATION

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

1. Exterior Concrete Walls above and below Grade:

    a. Sleeves with waterstops.

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

2. Concrete Slabs-on-Grade:

    a. Sleeves with waterstops.

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

3. Concrete Slabs above Grade:

    a. Sleeves with waterstops, or, stack-sleeve fittings.

4. Interior Wall and Partitions:

    a. Sleeves without waterstops.

3.16 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, steel with polished, chrome-plated finish.
3. Insulated Piping:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with polished, chrome-plated finish.
    d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with polished, chrome-plated finish.
    d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, stainless steel with polished stainless steel finish.
    c. One piece, cast brass with polished, chrome-plated finish.
    d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

B. Install floor plates for piping penetrations of equipment-room floors.

C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

3.17 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. Sealed, bimetallic-actuated type.
2. Direct-mounted, [**metal**] [**plastic**]-case, vapor-actuated type.
3. Metal case, compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each domestic water heat exchanger are to be the following:

1. Direct-mounted, metal-case, vapor-actuated type.
2. [**Metal**] [**Plastic**] case, compact-style, liquid-in-glass type.
3. Direct-mounted, light-activated type.
4. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Thermometer stems are to be of length to match thermowell insertion length.

3.18 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:

1. 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping:

1. 0 to 250 deg F.

C. Insert additional paragraphs for thermometer scale ranges and applications.

3.19 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:

1. Liquid filled, direct mounted, metal case.
2. Sealed, direct mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

3.20 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:

1. 0 to 100 psi.

B. Scale Range for Domestic Water Piping:

1. 0 to 100 psi.

C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

END OF SECTION 220500

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Gate valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer.

C. FKM: Fluoroelastomer.

D. NBR: Nitrile butadiene rubber (also known as Buna-N).

E. NRS: Nonrising stem.

F. OS&Y: Outside screw and yoke.

G. PTFE: Polytetrafluoroethylene.

H. RPTFE: Reinforced polytetrafluoroethylene.

I. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.
b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooved ends, press ends, solder ends, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set butterfly valves closed or slightly open.
5. Block check valves in either closed or open position.
6. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

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

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

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

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

G. Valve Bypass and Drain Connections: MSS SP-45.

H. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves NPS 4 and larger.
2. Hand Lever: For quarter-turn ball valves smaller than NPS 4.

I. Valves in Insulated Piping:

1. Provide **2-inch** extended neck stems.
2. Provide extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Provide memory stops that are fully adjustable after insulation is applied.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine press fittings to verify they have been properly pressed.

F. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

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

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Check Valves: Center-guided type, in horizontal or vertical position, between flanges.
2. Check Valves, Swing Type: In horizontal position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

I. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's written recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules

below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
7. For Grooved-End Copper Tubing: Valve ends may be grooved.
8. For Grooved-End Steel Piping: Valve ends may be grooved.
9. Wafer-Type Valves: Flanged connections.

3.5 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, lead free, threaded ends - brass, one piece.
2. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and brass trim; threaded ends.
3. Ball valves, lead free, threaded or soldered ends - brass, two piece with full port and stainless steel trim; threaded ends.
4. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and brass trim; threaded ends.
5. Ball valves, lead free, threaded or soldered ends - brass, two piece with regular port and stainless steel trim; threaded ends.
6. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and brass trim; threaded ends.
7. Ball valves, lead free, threaded or soldered ends - brass, three piece with full port and stainless steel trim; threaded ends.
8. Ball valves, lead free, threaded ends - bronze, one piece with bronze trim.
9. Ball valves, lead free, threaded ends - bronze, one piece with stainless steel trim.
10. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and bronze or brass trim; threaded ends.
11. Ball valves, lead free, threaded or soldered ends - bronze, two piece with full port and stainless steel trim; threaded ends.
12. Ball valves, lead free, threaded ends - bronze, two piece with regular port and bronze or brass trim.
13. Ball valves, lead free, threaded ends - bronze, two piece with regular port and stainless steel trim.
14. Ball valves, lead free, threaded ends - bronze, three piece with full port and bronze or brass trim.
15. Ball valves, lead free, threaded ends - bronze, three piece with full port and stainless steel trim.
16. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and bronze or brass trim; threaded ends.
17. Ball valves, lead free, threaded or soldered ends - bronze, three piece with regular port and stainless steel trim; threaded ends.
18. Ball valves, lead free, threaded or flanged ends - stainless steel, two piece with full port; threaded ends.
19. Ball valves, lead free, press ends - brass, two piece with full port and brass trim.

20. Ball valves, lead free, press ends - brass, two piece with full port and stainless steel trim.
21. Ball valves, lead free, press ends - bronze, two piece with full port and bronze or brass trim.
22. Ball valves, lead free, press ends - stainless steel, two piece with full port.
23. Ball valves, lead free, flanged or threaded ends - steel, with full port, Class 150; threaded ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Ball valves, lead free, flanged or threaded ends - iron, Class 125; flanged ends.

C. For CPVC Pipe:

1. CPVC Union-Type Ball Check Valve: NPS 2 and smaller at [**73 deg F**] <**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket, or, threaded.
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

D. For PVC Pipe:

1. PVC Union-Type Ball Check Valve: NPS 2 and smaller at [**73 deg F**] <**Insert temperature**>.

a. End Connections for Valves NPS 2 (DN 50) and Smaller: Socket, or, threaded.
b. End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket or threaded.

3.6 DOMESTIC HOT- AND COLD-WATER BUTTERFLY VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Butterfly valves, lead free, single flange (lug type) - iron, with aluminum-bronze disc; 150 CWP, [**EPDM**] [**NBR**] seat.

B. For CPVC Pipe: CPVC butterfly valve for NPS 2-1/2 and larger.

C. For PVC Pipe: PVC butterfly valve for NPS 2-1/2 and larger.

D. For Stainless Steel Pipe: Stainless steel, grooved-end butterfly valve for **NPS 2-1/2** and larger.

3.7 DOMESTIC HOT- AND COLD-WATER CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; threaded ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with metal seats, Class 125; flanged ends.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: Union ball valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: Union ball valve.

3.8 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded or soldered ends - bronze, with bronze disc, Class 125; threaded ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger for Domestic Water Pumps:

1. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and spring-closure control, Class 125; flanged ends.
2. Check valves, lead free, swing type, flanged or threaded ends - iron, with lever- and weight-closure control, Class 125; [**flanged**] [**threaded**] ends.

C. Pipe NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage:

1. Check valves, swing type, flanged ends - iron, with lever- and spring-closure control, Class 125.

3.9 DOMESTIC HOT- AND COLD-WATER GATE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Gate valves, lead free, threaded or soldered ends - bronze, NRS, Class 125; threaded ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Gate valves, lead free, flanged ends - iron, NRS, Class 125.

C. For CPVC Pipe:

1. NPS 2 (DN 50) and Smaller: Union gate valve.

D. For PVC Pipe:

1. NPS 2 (DN 50) and Smaller: Union gate valve.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Pipe hangers - FRP.
4. Fastener systems.
5. Equipment supports.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Rooftop-mounted strut support systems.
4. FRP strut support systems.
5. Pipe stands.
6. Equipment supports.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

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

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

2.2 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, 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 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.4 MATERIALS

A. Aluminum: **ASTM B221**.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so

strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination is to include weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. 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.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. 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.

F. 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. Thermal-hanger shield inserts may be used as an option. 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 are to span an arc of 180 degrees.

    a. Thermal-hanger shield inserts may be used as an option. 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 (DN 8 to DN 90): **12 inches** long and **0.048 inch**

thick.
b. NPS 4 (DN 100): **12 inches** long and **0.06 inch** thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): **18 inches** long and **0.06 inch** thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): **24 inches** long and **0.075 inch** thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): **24 inches** long and **0.105 inch** thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 in accordance with ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. FRP Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

J. Strut System Installation: Metal; arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

L. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than **4 inches** thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Install lag screw wood fasteners in accordance with manufacturer's written instructions.
4. Install fasteners in accordance with manufacturer's written instructions.

M. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand

and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

N. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

P. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers, and, equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas

immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

a. Apply paint by brush or spray to provide a minimum dry film thickness of **2.0 mils**.

2. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 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 finishes.

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 attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. 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. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to **1050 deg F** pipes **NPS 4 to NPS 24**, requiring up to **4 inches** of insulation.
3. 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.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes **NPS 1/2 to NPS 24** if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes **NPS 1/2 to NPS 4**, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes **NPS 3/4 to NPS 8**.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated,

stationary pipes **NPS 1/2 to NPS 8**.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes **NPS 1/2 to NPS 8**.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 8**.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes **NPS 3/8 to NPS 3**.
12. U-Bolts (MSS Type 24): For support of heavy pipes **NPS 1/2 to NPS 30**.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes **NPS 4 to NPS 36**, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes **NPS 2-1/2 to NPS 36** if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes **NPS 1 to NPS 30**, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes **NPS 2-1/2 to NPS 24**, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes **NPS 2 to NPS 42** if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24** if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30** if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. 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.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to **6 inches** for heavy loads.
2. Steel Clevises (MSS Type 14): For **120 to 450 deg F** piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F** piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): **750 lb**.
    b. Medium (MSS Type 32): **1500 lb**.
    c. Heavy (MSS Type 33): **3000 lb**.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. 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.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed **1-1/4 inches**.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.2 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than **6 ft.** of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within **3 ft.** of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within **3 ft.** of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of **125 deg F** or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste, and, Storm Drainage Piping: White letters on a black background.
5. Nonpotable Cold Water: Black letters on an ANSI Z535.1 safety-yellow background.
6. Nonpotable Hot Water: Black letters on an ANSI Z535.1-yellow background.
7. Nonpotable Hot-Water Recirculation: Black letters on an ANSI Z535.1 safety-yellow background.

3.6 INSTALLATION OF VALVE TAGS

A. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.
b. Domestic Hot Water: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.
c. Domestic Hot-Water Return: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.
d. Nonpotable Cold Water: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.
e. Nonpotable Hot Water: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.
f. Nonpotable Hot-Water Return: 1-1/2 inches, [**round**] [**square**] <**Insert shape**>.

2. Valve-Tag Colors:

    a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where indicated on Drawings.

END OF SECTION 220553

SECTION 220593 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. TAB of domestic water system.
2. TAB of plumbing equipment:

a. Domestic water booster pumps.
b. Domestic hot-water in-line circulation pumps.
c. General-duty air compressors.
d. Sanitary sewage pumps.
e. Drainage pumps.
f. Laboratory air compressors.
g. Laboratory vacuum pumps.

3. Pipe-leakage test verification.

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 independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. 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.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB, or, TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB, or, TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB, or, TABB.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. 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 plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens

used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Water treatment is complete.
e. Systems are flushed, filled, and air purged.
f. Strainers are clean.
g. Control valves are functioning in accordance with the sequence of operation.
h. Shutoff and balance valves are 100 percent open.
i. Booster-, and, hot-water circulating pumps are operational and proper rotation is verified.
j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
k. Variable-frequency controllers' startup is complete and safeties are verified.
l. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the

procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators 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 PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water booster pumps.
3. Domestic water in-line pumps.
4. Domestic water heaters.
5. Drainage pumps.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

A. Adjust pumps to deliver total design flow.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

D. Verify that memory stops have been set.

3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gauge heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

    a. Re-measure and confirm that total flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.8 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

B. Gas- and Oil-Fired Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in **Btu/h** of heating output.
6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

3.10 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check bearings and other lubricated parts for proper lubrication.
5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Bearings and other parts are properly lubricated.
3. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the system flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

3.11 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than **10 gpm**, within 10 percent.

3.12 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Fuel type in input data.
    g. Output capacity in **Btu/h**.
    h. Ignition type.
    i. Burner-control types.

j. Motor horsepower and speed.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in **inches**, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in **inches**.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in **cfm**.
b. Entering-water temperature in **deg F**.
c. Leaving-water temperature in **deg F**.
d. Low-fire fuel input in **Btu/h**.
e. High-fire fuel input in **Btu/h**.
f. High-temperature-limit setting in **deg F**.
g. Operating set point in **Btu/h**.
h. Heating value of fuel in **Btu/h**.

F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in **Btu/h**.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in **Btu/h**.
b. Entering-water temperature in **deg F**.
c. Leaving-water temperature in **deg F**.
d. High-temperature-limit setting in **deg F**.
e. Operating set point in **deg F**.
f. Voltage at each connection.
g. Amperage for each phase.

G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.

e. Model number and serial number.
f. Water flow rate in **gpm**.
g. Water-pressure differential in **feet of head or psig**.
h. Required net positive suction head in **feet of head or psig**.
i. Pump speed.
j. Impeller diameter in **inches**.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in **feet of head or psig**.
b. Pump shutoff pressure in **feet of head or psig**.
c. Actual impeller size in **inches**.
d. Full-open flow rate in **gpm**.
e. Full-open pressure in **feet of head or psig**.
f. Final discharge pressure in **feet of head or psig**.
g. Final suction pressure in **feet of head or psig**.
h. Final total pressure in **feet of head or psig**.
i. Final water flow rate in **gpm**.
j. Voltage at each connection.
k. Amperage for each phase.

H. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.14 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.15 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.

END OF SECTION 220593

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: **12 inches** long by **NPS 2**.
2. Jacket Materials for Pipe: **12 inches** long by **NPS 2**.
3. Sheet Jacket Materials: **12 inches** square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. [**All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
3. [**All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.4 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

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. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136 Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.7 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal **3/4-inch-** wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer **5 mils** thick and an epoxy finish **5 mils** thick if operating in a temperature range of between **140 and 300 deg F**. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between **32 and 300 deg F** with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
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 **4 inches** o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

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**] <**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. 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. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof 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 roof flashing at least **2 inches** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. 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 Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is 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 of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges 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 Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated 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. Install insulation to flanges as specified for flange insulation application.
4. 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.

3.8 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated 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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at **12-inch** intervals, and tighten bands without deforming insulation materials.

2. Install two-layer insulation with joints tightly butted and staggered at least **3 inches**. Secure inner layer with **0.062-inch** wire spaced at **12-inch** intervals. Secure outer layer with stainless steel bands at **12-inch** intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges 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 Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin 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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. 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.

3.11 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with **1-1/2-inch** laps at longitudinal seams and **3-inch-** wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with **1-inch** overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with **2-inch** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with

stainless steel bands **12 inches** o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, [**three**] <**Insert number**> locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.14 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. Drainage piping located in crawl spaces.

2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation is one of the following:

   a. Cellular Glass: 1-1/2 inches thick.
   b. Flexible Elastomeric: 1/2 inch thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation is one of the following:

   a. Cellular Glass: 1-1/2 inches thick.
   b. Flexible Elastomeric: 1 inch thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation is one of the following:

   a. Cellular Glass: 1-1/2 inches thick.
   b. Flexible Elastomeric: 3/4 inch thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/2 and Larger: Insulation is one of the following:

   a. Cellular Glass: 1-1/2 inches thick.
   b. Flexible Elastomeric: 1 inch thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation is one of the following:

   a. Cellular Glass: 1-1/2 inches thick.
   b. Flexible Elastomeric: 1 inch thick.
   c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   d. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation is one of the following:

   a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
   b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation is one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: 1/2 inch thick.

F. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation is one of the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
b. Mineral Wool, Preformed Pipe Insulation, Type II: 1-1/2 inches thick.

G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below **60 Deg F**:

1. All Pipe Sizes: Insulation is one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 3/4 inch thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: 1/2 inch thick.

H. Hot Service Drains:

1. All Pipe Sizes: Insulation is one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
c. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

I. Hot Service Vents:

1. All Pipe Sizes: Insulation is one of the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation is one of the following:

a. Cellular Glass: 2 inches thick.
b. Flexible Elastomeric: 2 inches thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation is one of the following:

a. Cellular Glass: 2 inches thick.
b. Flexible Elastomeric: 2 inches thick.
c. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
d. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation is one of the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
b. Mineral Wool, Preformed Pipe Insulation, Type II: 2 inches thick.

D. Hot Service Drains:

1. All Pipe Sizes: Insulation is one of the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

E. Hot Service Vents:

1. All Pipe Sizes: Insulation is one of the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
b. Mineral Wool, Preformed Pipe Insulation, Type II: 1 inch thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.

3.18 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 20 mils thick.
2. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: 0.024 inch thick.

3. Painted Aluminum, Smooth: 0.020 inch thick.

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. PVC: 30 mils thick.
2. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: 0.032 inch thick.
3. Painted Aluminum, Smooth: 0.024 inch thick.

D. Piping, Exposed:

1. PVC: 30 mils thick.
2. Painted Aluminum, Smooth: 0.024 inch thick.

3.20 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings - domestic water.
2. CPVC piping - domestic water.
3. PEX tube and fittings - domestic water.
4. Piping joining materials - domestic water.
5. Encasement for piping.
6. Transition fittings - domestic water.
7. Dielectric fittings - domestic water.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Copper tube and fittings - domestic water.
2. CPVC piping - domestic water.
3. PEX tube and fittings - domestic water.
4. Piping joining materials - domestic water.
5. Encasement for piping.
6. Transition fittings - domestic water.
7. Dielectric fittings - domestic water.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

1.6 WARRANTY

A. Polypropylene (PP-R and PP-RCT) Pipe and Fittings Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of piping system due to defects in materials or manufacturing.
2. Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PIPING MATERIALS

A. Potable-water piping and components are to comply with NSF 14, NSF 61, and NSF 372.

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than **NPS 4**.

B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than **NPS 4**.

C. Cast 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. Do not use solder joints on pipe sizes greater than **NPS 4**.

D. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than **NPS 4**.

2.4 PEX TUBE AND FITTINGS - DOMESTIC WATER

A. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS - DOMESTIC WATER

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, **1/8 inch** thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

G. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller is to be the following:

1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
3. Polypropylene (PP-R and PP-RCT), SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger is to be the following:

1. Annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
3. Push-on joint, ductile-iron pipe; standard-pattern, push-on joint fittings; and gasketed joints.
4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
5. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. Polypropylene (PP-R and PP-RCT), [**SDR 7.4**] [**SDR 11**] pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) is to be the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
2. Push-on joint, ductile-iron pipe; standard-pattern, push-on joint fittings; and

gasketed joints.
3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller is to be the following:

1. Drawn-temper, or copper tube, **ASTM B88, Type L**; wrought-copper, solder-joint fittings; and brazed joints.
2. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
3. Polypropylene (PP-R and PP-RCT), SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller is to be the following:

1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Drawn-temper copper tube, ASTM B88, Type L; cast-,wrought-copper, solder-joint fittings; and brazed joints.
3. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Drawn-temper copper tube, ASTM B88, Type L; copper push-on joint fittings; and push-on joints.
5. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints.[**NPS 1-1/2 and NPS 2 CPVC pipe with CPVC socket fittings may be used instead of tubing.**]
8. PEX tube, **NPS 1** and smaller.

    a. Fittings for PEX tube:

        1) ASTM F1807, metal insert and copper crimp rings.
        2) ASTM F1960, cold expansion fittings and reinforcing rings.
        3) ASSE 1061, push-fit fittings.

9. PEX-AL-PEX tube, **NPS 1** and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
10. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
11. Polypropylene (PP-R and PP-RCT), SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type L; [**cast-**] [**or**] [**wrought-**]copper, solder-joint fittings; and brazed joints.
2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Drawn-temper copper tube, ASTM B88, Type L; grooved-joint, copper-tube

appurtenances; and grooved joints.
4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
6. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
9. Polypropylene (PP-R and PP-RCT), SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), is to be the following:

1. Drawn-temper copper tube, ASTM B88, Type L; [**cast-**] [**or**] [**wrought-**]copper, solder-joint fittings; and brazed joints.
2. Drawn-temper copper tube, ASTM B88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
5. CPVC, Schedule 40; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. PVC, Schedule 40; socket fittings; and solvent-cemented joints.
8. Polypropylene (PP-R and PP-RCT) SDR 7.4 pipe and socket fusion, butt fusion, fusion outlet, or electrofusion fittings and joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) is to be the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Stainless steel [**Schedule 5**] [**Schedule 10**] [**Schedule 40**] pipe, grooved-joint fittings, and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab in accordance with CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

D. Install underground copper tube in PE encasement in accordance with ASTM A674 or AWWA C105/A21.5.

E. Install valves in accordance with Section 220523 "General-Duty Valves for Plumbing Piping."

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

H. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. 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.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX tube with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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 for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave

insertion marks on pipe after assembly.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints in accordance with AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints in accordance with AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints in accordance with AWWA C606. Square cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join in accordance with ASTM D2846/D2846M.
3. PVC Piping: Join in accordance with ASTM D2855.

N. Joints for PEX Tubing, ASTM: Join in accordance with ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

O. Joints for PEX Tubing, ASSE: Join in accordance with ASSE 1061 for push-fit fittings.

P. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings, or, unions.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for copper,and,pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install vinyl-coated hangers for CPVC pipe, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for PEX tube, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper,and,pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of CPVC pipe to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of PEX tube to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to 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. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for **NPS 2-1/2** and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

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 in accordance with either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least **50 ppm** of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least **200 ppm** of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.

e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after installation and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Hydrostatic testing and documentation of test results for polypropylene (PP-R and PP-RCT) pipe to be in accordance with manufacturer's written instructions and submitted to manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water pressure-reducing valves.
2. Automatic water shutoff valve systems.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Outlet boxes.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Trap-seal primer device.
10. Flexible connectors.
11. Water meters.

1.2 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

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

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in

emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: **400-psig** minimum CWP.
3. Size: **NPS 3/4**.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: **NPS 3/4**.
4. Body: ASTM B62 bronze.
5. Inlet: **NPS 3/4** threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves <**Insert drawing designation if any**>:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: **200-psig** minimum CWP or Class 125.
3. Size: **NPS 3/4**.

4. Body: Copper alloy or ASTM B62 bronze.
5. Drain: **NPS 1/8** side outlet with cap.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

C. Water Control Valves: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

D. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.

E. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

F. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Y-Pattern Strainers: For water, install on supply side of each control valve,and, pump.

H. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install **1-1/2-by-3-1/2-inch** fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

I. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install **1-1/2-by-3-1/2-inch** fire-retardant-treated-wood blocking, wall

reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

J. Ground Hydrants: Install with 1 cu. yd. of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

K. Nonfreeze, Draining-Type Post Hydrants: Install with 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.

L. Nonfreeze, Nondraining-Type Post Hydrants: Set in concrete or pavement.

M. Nonfreeze, Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.

N. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

O. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

P. Supply-Type, Trap-Seal Primer Device: Install 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.

Q. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

R. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valve systems.
5. Balancing valves.
6. Temperature-actuated, water mixing valves.
7. Outlet boxes.
8. Hose stations.
9. Wall hydrants.
10. Ground hydrants.
11. Post hydrants.
12. Roof hydrants.
13. Trap-seal primer device.
14. Trap-seal primer systems.
15. Water meters.

B. 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. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each pressure vacuum breaker in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. PVC pipe and fittings.
5. Specialty pipe fittings.
6. Encasement for underground metal piping.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Ductile-iron pipe and fittings.
5. Copper tube and fittings.
6. PVC pipe and fittings.
7. Specialty pipe fittings.
8. Encasement for underground metal piping.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10 ft. head of water.
2. Waste, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.4 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Sheet, or, tube.

D. Color: natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: Two percent downward in direction of flow for piping **NPS 3** and smaller; 1 percent downward in direction of flow for piping **NPS 4** and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.
3. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.

N. Install steel piping in accordance with applicable plumbing code.

O. Install stainless steel piping in accordance with ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping in accordance with ASTM D2661.

R. Install aboveground PVC piping in accordance with ASTM D2665.

S. Install underground ABS, and, PVC piping in accordance with ASTM D2321.

T. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

U. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.

2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

V. Install underground, copper, force-main tubing in accordance with CDA's "Copper Tube Handbook."

1. Install encasement on piping in accordance with ASTM A674 or AWWA C105/A 21.5.

W. Install force mains at elevations indicated.

X. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

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

1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join stainless steel pipe and fittings with gaskets in accordance with ASME A112.3.1.

F. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe in accordance with AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join in accordance with ASTM D2235 and ASTM D2661 appendixes.
3. PVC Piping: Join in accordance with ASTM D2855 and ASTM D2665 appendixes.

J. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
    b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES

A. General valve installation requirements for general-duty valve installation are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate valve for piping **NPS 2** and smaller.
3. Install gate valve for piping **NPS 2-1/2** and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

C. Install hangers for cast-iron,and, copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for ABS, and, PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping and tubing within **12 inches** of each fitting, valve, and coupling.

F. Support vertical runs of cast-iron,and, copper soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of ABS, and, PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and, drains specified in Section 221319 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections **NPS 2-1/2** and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections in accordance with 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.
2. Install flanges, in piping **NPS 2-1/2** and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than **10 ft. head of water**.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of **1 inch wg**.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of **50 psig** above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed Plastic Piping: Protect ABS, PVC plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller are to be the following:

1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

6. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings, sealing rings, and gasketed joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, **Type M**; copper pressure fittings; and soldered joints.

6. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
7. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
8. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 (DN 125) and larger is to be the following:

1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller are to be the following:

1. Extra-heavy cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Stainless steel pipe and fittings, gaskets, and gasketed joints.
4. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.

5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 (DN 125) and larger are to be the following:

1. Extra-heavy, cast-iron soil piping; [**gaskets; and gasketed**] [**caulking materials; and caulked**] joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:

1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) are to be the following:

1. Hard copper tube, **Type L**; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller are to be the following:

1. Hard copper tube, **Type L**; [**wrought-**]copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than **NPS 1-1/2** and pressure transition coupling for **NPS 1-1/2** and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger are to be the following:

1. Hard copper tube, **Type L**; wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221316

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Trench drains.
4. Channel drainage systems.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene.

D. PE: Polyethylene.

E. PP: Polypropylene.

F. PVC: Polyvinyl chloride.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. 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.
3. 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.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for

backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. 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. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

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 221319.13

SECTION 22 13 29.16

SUBMERSIBLE SEWERAGE PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

Submersible pumps, motors, and accessories

1.2 RELATED SECTIONS

A. Section 02240 - Dewatering
B. Section 02315 - Excavation and Fill
C. Section 02530 - Sanitary Sewer Systems
D. Section 02535 - Sanitary Sewer Force Main Systems
E. Section 02605 - Precast Structures and Accessories
F. Section 13300 - Instrumentation and Controls

1.3 PERFORMANCE REQUIREMENTS

A. Provide all material, labor, equipment, tools, and incidentals to install a submersible sewage pump and related appurtenances and all items shown or inferred on the drawings and reasonably specified herein. It is the intent of these documents that operatable submersible sewage pumps be installed. If any items for a complete job are omitted or not shown, the Contractor shall furnish and install the same without additional cost to the Owner.
B. The Contractor shall have the sole responsibility for proper functioning of the equipment.

1.4 SUBMITTALS

A. Manufacturer's specification data and descriptive literature.
B. Performance curves showing capacity of GPM, NPSH, head, and pump horsepower from 0 GPM to 110 percent of design capacity
C. Motor efficiencies and power factors at all design operating points.
D. The following data shall be submitted for each motor:

1. Manufacturers designation
2. Number of phases
3. Horsepower output
4. Voltage
5. Time rating
6. Full load amperes
7. Temperature rise
8. Code
9. RPM at full load
10. Design letter
11. Frequency
12. Service factor

E. Drawings showing general dimensions, openings, connections, construction details of the equipment, wiring diagrams, piping drawings, and weights of major components.
F. Procedures for proper installation.
G. Manufacturer's guarantee.
H. Provide a notarized statement by the pump supplier which shall certify that the pump supplier shall at all times maintain in stock at least one set of spare parts for each model of pump furnished, and that if any of the parts are not in stock when ordered by the Utility, the pump supplier shall either provide a pump or reimburse the Utility for rental of a pump to maintain the station in operation until the ordered part(s) are delivered.

1.5 QUALIFICATIONS

The equipment specified under this section shall be provided by manufacturers who are fully experienced, reputable, qualified, and regularly engaged in the manufacture of the components and equipment to be furnished. All equipment and manufacturers shall be approved by the utility that will own and operate the lift station.

1.6 CERTIFICATIONS

After all installation is complete, the equipment manufacturer shall provide a field service specialist to completely inspect all related work for proper operation. The manufacturer shall notify the Engineer, in writing, when this service is complete and any/all deficiencies corrected.

1.7 DELIVERY TIMES

The equipment shall be placed into production as soon as the shop drawings have been approved. The Engineer shall be notified of the estimated length of time until the delivery of equipment in the shop drawings submitted.

1.8 STORAGE AND PROTECTION

All parts and equipment shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation. Finished surfaces of all exposed pump openings shall be protected by wooded planks, strongly built and securely bolted thereto. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

1.9 WARRANTY

The pump manufacturer shall warrant the pumps being supplied to the Owner and Utility against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, the manufacturer shall replace certain parts which shall become defective through normal use and wear on a progressive schedule of cost for a period of five years; parts included are the mechanical seal, impeller, pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

1.10 OPERATION AND MAINTENANCE MANUALS

The manual shall include, but not be limited to, installation, operation, maintenance instructions, spare parts lists giving manufacturer's stock or part number for each replaceable item, approval submittals and drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The pumps, motors, guide bars, and discharge elbows shall be supplied by the pump supplier to insure unit responsibility.
B. Pump manufacturer shall be Xylem Flygt exclusively.

2.2 GENERAL

A. The pumps and motors shall be capable of handling raw, unscreened, sanitary sewage containing heavy sludge and fibrous materials without injurious damage during normal operation. The pump design shall be such that pumping units will be automatically connected to the discharge piping when lowered into place on the discharge connection.
B. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or other fastening to be removed for this purpose and no need for personnel to enter the lift station wet well. Each pump shall be supplied with a stainless-steel grip ring-type lifting system of adequate strength and length to permit raising the pump for inspection and removal.
C. Each pump motor cable shall be suitable for submersible pump application as indicated on the pump cable. The cable shall be sized in accordance with the NEC Standards for the actual motor load.
D. The submersible pumping units, complete with motor, to be furnished and installed in the pumping station shall satisfy the operating conditions, electric power requirements, and control requirements of these specifications.
E. The pumps shall be capable of running continuously in a non-submerged condition under full load without damage for extended periods.
F. The pumps shall be automatically controlled by a liquid level transducer that shall signal the motor control panel alternator for pump operation.
G. The motor shall be capable of a minimum of ten (10) starts per hour.
H. If required by the Owner or Engineer, before final acceptance, a field running test demonstrating this ability, with 24 hours of continuous operation under the above conditions, shall be performed for all pumps being supplied.

2.3 PUMP OPERATING CONDITIONS AND CONTROL REQUIREMENTS

A. Pump Discharge Size = 6 in
B. Pump Speed (Max) = 1760 RPM
C. Single Pump Design Operating Condition = 1,150 GPM at 50.6 ft of head
D. Dual Pump Design Operating Condition = 2,030 GPM at 54.9 ft of head

1. Single Pump Operating point with Dual Pump Operation = 1,015 GPM

2.4 PUMPS

A. Major pump components shall be of ASTM A-48, Class 35-B, gray cast iron construction. All gray iron components shall have smooth surfaces and be devoid of blow holes and other irregularities.
B. All parts coming into contact with wastewater shall be protected by a coat of rubber asphalt paint. All exposed nuts, bolts, washers and other fastening devices shall be Type 304 stainless steel.
C. Pump exterior shall be sprayed with an epoxy primer and two (2) coats of a polyamide cured epoxy finish coating. Minimum total finish coating thickness shall be 30 mils, dry film thickness.
D. All mating surfaces requiring watertight sealing shall be machined and fitted with nitrile rubber O-rings.
E. Each pumping unit shall be provided with a cooling system allowing unsubmerged continuous operation at any power output to and including rated power in ambient air of 40°C.
F. Each pump shall be provided with a tandem mechanical shaft seal system. The seals, both upper and lower shall be of the lapped silicone carbide design and operating in an oil bath.
G. Seal faces shall be self-aligning, positively driven. Each seal shall be held by separate spring systems. The seals shall require neither maintenance nor adjustment and shall be easily replaceable. Conventional double mechanical seals with a single or double spring between the rotating faces, requiring constant differential pressure to effect sealing shall not be considered equal to the tandem seal specified.
H. The pump/motor shaft shall be AISA Type 420 stainless steel and shall rotate on two grease lubricated bearings.

I. The shaft and bearings shall be adequately designed to meet the maximum torque required for any start-up or operating condition and to minimize vibration and shaft deflection.
J. The upper bearing shall be single row ball or roller bearing and the lower bearing shall be a double row angular contact bearing to compensate for axial thrust and radial forces.
K. Each pump shall be provided with an oil chamber for the shaft sealing system. The drain and inspection plug, with positive anti-leak seal, shall be easily accessible from the outside. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity.
L. The impeller shall be of gray cast iron, ASTM A-48, Class 35-B, statically and dynamically balanced, double shrouded non-clogging design having a long thrulet without acute turns. All external hardware shall be Type 316 stainless steel. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal raw, unscreened wastewater applications. The pump manufacturer shall furnish mass moment of inertia data for the proposed impeller. The fit between the impeller and the shaft shall be a sliding fit with one key.
M. A wear ring system shall be installed to provide efficient sealing between the volute and impeller. The wear ring system shall consist of a stationary ring made of nitrile rubber molded over a steel ring insert which is drive fitted to the volute inlet and a rotating ring made of Type 316 stainless steel which is drive fitted to the impeller skirt.
N. A sliding guide bracket shall be an integral part of the pumping unit and the pump casing shall have a machined connecting flange to connect with the cast iron discharge connection. The discharge connection shall be bolted to the floor of the pump chamber and so designed as to receive the pump connecting flange without the need of any bolts or nuts.
O. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided by no less than two stainless steel guide rails and pressed tightly against the discharge connection elbow; no portion of the pump shall bear directly on the floor of the sump and no rotary motion of the pump shall be required for sealing.

2.5 CABLES AND CABLE CONNECTION

A. Cables shall be designed specifically for submersible pump applications and shall be properly sealed.
B. A type CGB watertight connector with a neoprene gland shall be furnished with each pump to seal the cable entry at the control panel. The pump cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder in the pump top. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top. Secondary sealing systems utilizing epoxy potting compounds may be used. When this type of sealing system is used, the manufacturers shall supply a cable cap as part of the spare parts for each pump.
C. All cables shall be continuous, without splices from the motor to the control panel, unless otherwise approve by the Owner.

2.6 MOTORS

A. All motors shall be built in accordance with latest NEMA, IEEE, ANSI, and AFBMA Standards where applicable.
B. The pump motor shall be of the induction type with a squirrel cage rotor, shell type, NEMA B design housed in a watertight chamber. The motor shall be designed for use with a VFD. The stator shall be copper wound and insulated with Class F insulation rated for 115°F rise over 40°C minimum.
C. A minimum of three (3) thermal sensors shall be provided to sense excessive motor temperatures or seal leakage. These sensors shall be wired to the control panel for use in conjunction with the external

motor overload protection. Moisture sensors shall be provided to sense excessive seal leakage if recommended by the pump manufacturer for complying with the pump warranty.

D. The pump motor shall be suitable for operation on a power supply as specified in Article 2.02(A) with a service factor of 1.15 or greater.
E. Pump motors shall have cooling characteristics suitable to permit continuous operation in a totally, partially, or non-submerged condition.
F. Lift Station Pump Motors shall be 20 Hp, 480V, 3-phase.
G. The pump motor shall be air cooled and guaranteed to run continuously in a totally, partially, or non-submerged condition without damage to the pump motor. The motor shall be designed for continuous duty, capable of sustaining a minimum of ten (10) starts per hour. The pump motor shall be of sufficient horsepower as to be non-overloading, over the entire range of the pump curve without the use of the service factor. Pump motors shall be rated for the horsepower and motor speed (RPM) specified herein.

2.7 PUMP MOTOR CABLE

A. The pump motor cable shall be sized according to NEC and ICEA and shall be installed with a double-jacketed protection system suitable for submersible pump application and the rating shall be indicated by a code or legend permanently embossed on the cable.
B. Provide adequate length of submersible cable for the intended installation without splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.
C. Provide conductors for power, thermal shutdown, and seal fail.

2.8 PUMP GUIDE RAILS

A. A sliding guide bracket shall be an integral part of the pump casing and shall have a machined connecting flange to connect with the cast iron discharge connection, which shall be bolted to the floor of the wet well with Type 316 stainless steel anchor bolts and so designed as to receive the pump discharge flange without the need of any bolts or nuts. Sealing of the pumps to the discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided by no less than two (2) parallel Type 316 seamless tubular stainless steel guides which will press it tightly against the discharge connection. No portion of the pump shall bear directly on the floor of the wet well and no rotary motion of the pump shall be required for sealing. Sealing at the discharge connection by means of a diaphragm or similar method of sealing will not be accepted as an equal to a metal to metal contact of the pump discharge and mating discharge connection specified and required. Approved pump manufacturers, if necessary to meet the above specification, shall provide a sliding guide bracket adapter. The design shall be such that the pumps shall be automatically connected to the discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts, or fastenings to be removed for this purpose, and no need for personnel to enter the wet well.
B. The guide rail system shall be seamless, tubular, Schedule 40, Type 316 stainless steel suitably sized for the pumps furnished. The minimum rail size shall be two (2) inches in diameter.
C. Lower guide holders shall be integral to the pump discharge elbow connection.
D. Upper and intermediate guide brackets shall be Type 316 stainless steel mounted with Type 316 stainless steel anchor bolts or hardware. Provide intermediate guide brackets as recommended by the pump manufacturer.

2.9 PUMP LIFTING CABLES

A. Lift cables shall be of Type 316 stainless steel with a minimum diameter of 5/16- inch. Cables shall have adequate strength to lift the pump out of the wet well with a safety factor of three (3).
B. Lift cables shall be shackled to a yoke attached to the stator housing for removal and installation of the unit. A shackle shall be provided on the upper end of the cable to fasten the cable to a hook on the cable holder.

C. Provide five (5) feet of excess cable above the top of the wet well over to facilitate the removal of the pumping units.
D. Cable holders of Type 316 stainless steel shall be suitably sized to accommodate lift cables provided without deformation.
E. A cable holder shall be provided with an adequate number of hoods to secure float control cables and pump lifting system tethers/ chains.
F. The cable holder shall be suitable for wall or access door frame mounting. The cable holder shall be Type 316 stainless steel mounted with Type 316 stainless steel anchor bolts.

2.10 PUMP DISCHARGE ELBOW

A. The pump discharge fitting shall be a quick disconnect type compatible with the guide rail system and allowing the pump to be lifted from the wet well for service and lowered in place for pumping without unbolting any flange, lowering the liquid level, or requiring personnel to enter the wet well.
B. The entire weight of the pump shall rest on the discharge elbow; no part of the pump shall bear directly on the floor of the wet well sump. The pump discharge shall seal to the discharge elbow by a metal to metal contact. Sealing at the discharge elbow by means of a rubber diaphragm or O- ring will not be acceptable. Discharge elbows shall be fastened to J-type anchor bolts grouted in the bottom of the wet well. The length and diameter of anchor bolts shall be as required by the pump manufacturer.
C. Each anchor bolt shall be furnished with a flat washer, lock washer and nut. All materials for anchor bolts, washers and nuts shall be Type 316 stainless steel.

2.11 VALVES AND PIPING

A. Provide valves and piping as required on the Contract Drawings and specified in Section 33 31 23, “Sanitary Sewer Force Main Piping”.
B. The emergency pump bypass blind flange shall be compatible with the Owner’s equipment.

2.12 SHOP PAINT

A. Before exposure to weather and prior to shop painting, all surfaces shall be thoroughly cleaned dry and free from all mill-scale, rust, grease, dirt, and other foreign matter. All pumps and motors shall be shop coated with a corrosion resistant paint proven to withstand an environment of raw wastewater. All nameplates shall be properly protected during painting.
B. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating as recommended by the manufacturer for the service to be provided. This coating shall be maintained as necessary to prevent corrosion during periods of storage and erection and shall be satisfactory to the Owner and Engineer up to the time of the final acceptance test.

2.13 TOOLS AND SPARE PARTS

A. One (1) set of all special tools required for normal operation and maintenance shall be provided. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys. The manufacturer shall furnish the following spare parts for each pump supplied:

1. 1 - Upper bearing
2. 1 - Lower bearing
3. 1 - Set of upper and lower shaft seals
4. 1 - Set of o-rings or gaskets required for replacement of bearings and seals
5. 1 - Set of impeller wear ring
6. 1 - Shaft sleeve (if applicable)

B. Cable cap (if applicable) Spare parts shall be properly packaged and labeled for easy identification without opening the packaging and suitably protected for long term storage under humid conditions. Spare parts and tools shall be delivered to the Owner or Utility at or prior to the time of pump station start-up.

2.14 SOURCE QUALITY CONTROL

A. The pump manufacturer shall perform the following tests on each pump before shipment from the factory:

1. Impeller, motor rating, and electrical connections shall first be checked out for compliance to the customer's purchase order.
2. Perform motor and cable insulation test for moisture content or insulation defects.
3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
4. The pump shall be run for 30 minutes submerged, a minimum of six feet under water.
5. After operational test (item 4), the insulation test (item 2) is to be performed again.
6. A written certified test report giving the above information shall be supplied with each pump at the time of shipment.
7. All end of pump cables will then be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

PART 3 - EXECUTION

3.1 GENERAL

All equipment shall be installed and mounted as shown in the drawings and in accordance with the manufacturer's recommendations. Piping shall be run as shown on the plans and be connected to all units in a manner to prevent leakage of water or sewage. Any departures from the locations or arrangements of units or connections thereto, as shown on the plans, shall be detailed by the Contractor and approval thereof obtained from the Engineer.

3.2 MOUNTING

The manufacturer shall provide cast-iron or galvanized steel fast-out fixtures which shall be permanently mounted in the wet well as shown on the plans. The fixtures shall incorporate stainless steel rails that will guide the pump into position. The pump shall be automatically connected to discharge piping by means of leakproof sealing system. The pumps shall be equipped with stainless steel lifting chains that have a normal working load of 300 percent of the pumps' operating weight. In addition, the pumps shall be equipped with an attachment system for attaching the hoist to the lifting chains. The system shall be the Flygt "Grip-Eye" system, or equal.

3.3 FLOAT CONTROLS

Install away from pump leads and out of the flow of influent sewage.

3.4 MANUFACTURER'S FIELD SERVICES

A. Provide two working days of mechanical start-up services. Operate the pump station a minimum of one day after all system checks to verify proper operation.
B. Provide one working day of initial instruction in one trip.

C. Provide one trip of one working day each of follow-up instruction.

END OF SECTION

DIVISION 23

230010	Basic Mechanical Requirements
230500	Common Work Results for HVAC
230517	Sleeves and Sleeve Seals for HVAC Piping
230518	Escutcheons for HVAC Piping
230529	Hangers and Supports for HVAC Piping and Equipment
230546	Coatings for HVAC
230553	Identification for HVAC Piping and Equipment
230593	Testing, Adjusting, and Balancing for HVAC
230719	HVAC Piping Insulation
232300	Refrigerant Piping
237313.13	Indoor, Basic Air-Handling Units
238126	Split-System Air-Conditioners

SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.

B. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.02 SUMMARY

A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices, and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered, and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.03 APPLICABLE STANDARDS

A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.

B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).

C. Comply: With the International Fire Code (IFC) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.

D. Comply: With the International Fire Code (NFPA) Standards and other Codes and Standards indicated.

E. International Building Code 2018: Conform in strict compliance to the International Building Code (IBC) and the amendments which are enforced by the local authority having jurisdiction.

1. International Building Code – Mechanical (2018)
2. International Building Code – Plumbing (2018)
3. International Building Code – Fuel Gas (2018)
4. International Building Code – Energy Conservation (2018)
5. International Fire Code – Fire (2018)

F. NATIONAL FIRE PROTECTION (NFPA) Standards:

1. NFPA-1, Uniform Fire Code™, 2006 Revision
2. NFPA-10, Standard for Portable Fire Extinguishers, 2002 Revision
3. NFPA-13, Standard for the Installation of Sprinkler Systems, 2002 Revision
4. NFPA-14, Standard for the Installation of Standpipe and Hose Systems, 2003 Revision
5. NFPA-15, Standard for Water Spray Fixed Systems for Fire Protection, 2001 Revision
6. NFPA-20, Standard for the Installation of Stationary Pumps for Fire Protection, 2003 Revision
7. NFPA-70, National Electrical Code, 2005 Revision
8. NFPA-72, National Fire Alarm Code, 2002 Revision
9. NFPA-75, Standard for the Protection of Information Technology Equipment, 2003 Revision
10. NFPA-88A, Standard for Parking Structures, 2002 Revision
11. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilation Systems, 2002 Revision
12. NFPA-90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems, 2006 Revision
13. NFPA-91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids, 2004 Revision
14. NFPA-92A, Recommended Practice for Smoke-Control Systems, 2006 Edition
15. NFPA-101B, Standard on Means of Egress for Buildings and Structures, 2002 Revision
16. NFPA-780, Installation of Lightning Protection Systems, 2004 Revision
17. NFPA-1963, Standard for Fire Hose Connections, 2003 Revision

G. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and provide notification to all parties concerned as to the use of toxic substances.

H. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

1.04 DRAWINGS AND SPECIFICATIONS

A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.

B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be

determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.

C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.

D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.05 DEFINITIONS

A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.

B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.

C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.

D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.

E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.

F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

1.06 SHOP DRAWINGS

A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:

1. Shop Drawings:

a. Submit shop drawings for the following:

(1) Each piping system
(2) Coordination drawings

1.07 RECORD DRAWINGS

A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.

B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the AutoCAD drawing files, package three (3) print sets of full size drawings and two (2) CDs of the AutoCAD drawing files with associated reference files and submit them to the Architect for review and approval.

1.08 SUBMITTAL

A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.

B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.

C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.

1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.

D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISED AS NOTED AND RESUBMIT", "REJECTED, REVISED AS NOTED AND RESUBMIT".

E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.

1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.

2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.

3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.

4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of

product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".

F. Substitutions:

1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.

    a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
    b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.

2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.

    a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
    b. If a deviation not listed is found anytime after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
    c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.

3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.

4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.

5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:

   a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
   b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
   c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
   d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
   e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
   f. The Owner prefers not to accept the submitted product.

G. Technical Information Brochure:

1. Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.

2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.

3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.

4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.

5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

1.09 SHOP DRAWINGS FOR PIPING SYSTEMS

A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in AutoCAD Version 2010 (or later) and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:

1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
2. Fabrication and erection dimensions.
3. Arrangements and sectional views.
4. Necessary details, including complete information for making connections to equipment.
5. Descriptive names of equipment.
6. Modifications and options to standard equipment required by Contract Documents.

B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.

C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

D. Additional Requirements: See specific Sections for additional requirements.

1.10 COORDINATION DRAWINGS

A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).

B. Coordination of Space: Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.

C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:

1. Structure has highest priority.
2. Walls systems.
3. Ceiling grid/light fixtures.
4. Gravity drainage lines.
5. Large pipe mains.
6. Ductwork/diffusers, registers and grilles.
7. Sprinkler heads.
8. Small piping and tubing/electrical conduit.
9. Access panels.

D. Drawings shall be developed on AutoCAD Version 2010 (or later), and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.

E. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp.

F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

G. Additional Requirements: See specific Sections for additional requirements.

1.11 MANUFACTURER'S CHECKOUT

A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.12 INSTRUCTION TO OWNER

A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.

B. Training Period: Unless otherwise indicated training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.

1. Training periods:
    a. 4 hours Classroom
    b. 6 hours Classroom
    c. 8 hours Classroom
    d. 12 hours Classroom
    e. 4 hours Hands-on
    f. 6 hours Hands-on
    g. 8 hours Hands-on
    h. 12 hours Hands-on

C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner, in writing, that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and

"Completed Demonstration" have been made will by signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.13 ALLOWANCES

A. General: Division 1.

1.14 ALTERNATES

A. Refer to Division 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Specified Products: Manufacturer’s names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.

B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.02 MATERIAL AND EQUIPMENT

A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.

B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.

C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality

installation. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.

B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.

C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.02 AIR CONVEYANCE SYSTEM MECHANICAL CLEANING (NEW DUCT INSTALLATION)

A. General: The following criteria shall be used for the installation of all new HVAC air conveyance systems (ACS).

B. Qualifications: The enhanced air conveyance system cleaning procedures shall be performed by the Contractor. Microbiological analysis shall be performed by a firm which is acceptable to the Architect and which can demonstrate their ability to conduct the required analysis and reporting according to the NADCA and National Institute for Occupational Safety and Health (NIOSH) Methods. Submit for review and acceptance by the Architect the proposed procedure methodologies to be utilized, a listing of the proposed equipment to be used, and the proposed chemical agents to be used. A mock-up cleaning station and procedural presentation of cleaning process shall be performed at least three months prior to any ductwork installation for review by the Architect

C. Cleaning Procedure: All ductwork transported to the project shall be protected from weather and debris. Each HVAC duct section shall, prior to installation, be cleaned and disinfected at an approved cleaning station established on-site. Exhaust ductwork shall only require surface preparation from Note 1 below. All air distribution devices (diffusers, grilles, registers) including backpans of supply devices in critical areas, as defined by AIA, shall be decontaminated pursuant to Note 3 below. Four stages of ACS cleaning shall occur:

1. Surface dirt shall be removed by mechanical means, HEPA filtered vacuum and washed down with disposable cleaning cloths and 1:200 solution of trisodium phosphate (TSP) detergent.
2. Wipe down surface with TSP solution again, frequently disposing contaminated cloths.
3. Decontaminate duct section with a diluted solution (4-6 tablespoons per gallon or as directed by manufacturer for use) of chlorhexidine diacetate, similar to Aveco Company Nolvasan, for an appropriate contact period then wipe down and rinse with clean cloths per the application processes defined by manufacturer guidelines.
4. Cap ducts with a 6 mil. plastic fastened completely to duct openings.

D. Cleaning Station: Provide a conditioned, positively pressurized, ventilated temporary enclosure to perform duct cleaning procedures. Perform all work and use protective measures as prescribed by cleaning, decontaminating solution manufacturer guidelines.

E. Sterilization, Occupied Facility: After the ACS has been cleaned and installed, provide surface sampling shall be performed by firm to confirm absence of Aspergillis fumigatus. Upon installation of a zone, the entire ACS shall then be flooded with Bioclean, or another low-odor dual quaternary ammonium compound, EPA registered for use in HVAC systems, and acceptable to the Architect, to

sterilize the ACS. The ACS shall be tested in compliance with NADCA Level III sampling protocol until all air samples indicate a colony forming unit (CFU) count of 1.0 CFU per cubic meter or less; re-clean, re-sterilize and retest until all samples achieve results at or below this threshold level.

F. Reporting: Provide a complete report detailing the above processes. The report shall contain, as a minimum, the procedure methodologies utilized; the listing of the equipment used; a description of the portions of the ACS which were treated; the chemical agents which were used; the test results from the analysis.

3.03 CLEANING AND PROTECTION

A. General: Refer to Division 1.

B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.

C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.

D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.

E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.

F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)

G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.

H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.

I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.

J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.

K. Air Handling Unit Operation During Construction Phase: Do not operate air handling equipment during building construction phase unless filter fabric is fastened to all duct systems' inlets and all specified and scheduled air filters are installed to minimize dirt entry into ductwork and air moving equipment. When running air handling units to dry out the building, control the building temperature to drop very slowly, and verify all HVAC insulation is completed and doors and windows are installed and closed, to prevent condensation of water from humid air on building interior surfaces, equipment, materials and ductwork.

3.04 CORRECTION OF WORK

A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.

B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.05 COORDINATION AND ASSISTANCE

A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.

B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.

C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.06 PREPARATIONS FOR PERFORMANCE VERIFICATION

A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:

1. That air filters have been replaced and are in clean condition.

2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.

3. That ductwork specialties are in their normal operating positions.

4. That fans are operating at the correct rotation and specified RPM.

5. That ductwork has been pressure tested and accepted.

6. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.

7. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.

8. That air vents at coils and high points of the piping systems have been inspected and installed and operating freely.

9. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.

10. That linkages between valves and their actuators are secure, non-overloading and non-binding.

11. That pressures for hydronic reducing valves have been set.

12. That operating temperatures have been set for chillers, regulating valves, etc.

13. That pumps are operating at the correct rotation and specified horsepower.

14. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.

15. That pressures for steam reducing valves have been set.

16. That operating temperatures have been set for boilers, regulating valves, etc.

17. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.

18. That equipment has been lubricated and can be operated without damage.

19. That the systems are operational and complete.

20. That no latent residual work remains to be completed.

3.07 ACCEPTANCE TESTING PROCEDURE

A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.

B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.

C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.

D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to final inspections in the affected areas/systems.

E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.

F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.

G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.

H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.08 PROTECTION OF MATERIALS AND EQUIPMENT

A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.

B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.

C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.

D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.

3.09 ASBESTOS AND HAZARDOUS MATERIALS

A. General: Should asbestos or other hazardous material be encountered during execution of the work, or should the presence of asbestos or other hazardous material be suspected, immediately notify the Architect and suspend work in the affected area. The Owner will initiate a study to determine if asbestos or other hazardous materials are present and will determine what action will be taken. Removal of asbestos or other hazardous materials will be done under a separate contract.

3.10 COORDINATION OF SERVICES

A. General: Coordinate interruption of services to Owner-occupied areas in writing in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

B. General: Coordinate interruption of existing services in writing at least 1 week in advance with the Architect. Shutdown time and duration of services interruption shall be decided by the Owner. Provide shutoff valves at points of interconnection to minimize downtime. Procedures incidental to the outage shall be prepared in advance to minimize downtime.

C. Fire Safety in Existing facilities: Do not decrease the fire rating of walls, partitions, ceilings, floors, doors or combinations thereof in adjacent areas or means of egress. Do not interrupt fire sprinkling or life safety systems without prior coordination with the Architect. Inform all necessary parties (Fire Department, Owner's insurance carrier, etc.) in advance, prior to and immediately after shutdown, disconnection or isolation of any portion of life safety or fire sprinkler system.

D. Protection of Facilities: Portions of the building may be operational during construction. Maintain operation of the equipment and systems whenever the installation interfaces with existing equipment or systems. Provide protection for the building, its contents and occupants wherever installation under the contract is performed. As necessary, move, store, and protect furniture, office fixtures and carpets. Provide acoustical isolation of the work area with temporary doors, partitions, etc., to allow normal work functions. Provide exhaust fans, temporary dust barrier partitions and any containment measures required to prevent dirt, dust or fumes from reaching adjacent occupied spaces as required by the Owner or Architect. Access to the building, including exit stairs, doors and passageways, and loading dock and other delivery areas shall be kept open and continuously accessible to the occupants. Workmen shall be confined to those areas directly involved in the project installation, and only during time periods indicated and approved by the Owner.

3.11 OWNERSHIP OF REMOVED EQUIPMENT

A. General: Construction materials and items of mechanical and electrical equipment which are removed and not reused shall be removed from the job-site unless indicated as to be retained for the Owner. Include rigging, removal and hauling cost, as well as any salvage value, in the contract.

3.12 CLEAN-UP

A. General: Debris and rubbish shall not be disposed into the Owner's containers.

END OF SECTION 230010

REQUEST FOR SUBSTITUTION (Must be Submitted Prior to Bid)

Project Name: _____ Location: _____

Date of Request: _____

Name of Party Requesting Substitute:

_____

Reason for Substitution Request:

_____

Drawing	Spec. Sect. No.	Paragraph	Specified Item	Manu	Model
_____	_____	_____	_____	_____	_____

Proposed Substitute: _____

Manufacturer and Model Number:

_____

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:
(Submit brochures, samples, drawings, etc.)

REQUEST FOR SUBSTITUTION (Continued)

Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;

The proposed substitution will be warranted under the same terms required for the specified product;

Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and

Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

$_____

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by: _____
Signature Title

Typed Name: _____

Company: _____

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. 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. Equipment installation requirements common to equipment sections.
8. Painting and finishing.
9. Concrete bases.
10. Supports and anchorages.

1.3 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 and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.

2. Mechanical sleeve seals.

3. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

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 manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 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.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 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.

1. Manufacturers:

a. Epco Sales, Inc.

b. Watts Industries, Inc.; Water Products Div.

c. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.

b. Epco Sales, Inc.

c. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. 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.

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 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. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.7 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.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

2.8 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 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 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 according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

    b. Insulated Piping: One-piece, stamped-steel type with spring clips.

    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

    d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

2. Existing Piping: Use the following:

    a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

    b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.

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

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

    b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

        1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. 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.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. 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 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 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. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. 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. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

3. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 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.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 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.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi , 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 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.

3.8 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 230500

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, **anti-corrosion coated or zinc coated**, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig (137-kPa) minimum).
3. Sealing Elements: **EPDM-rubber** or **Nitrile (Buna N)** interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: **Stainless steel**.
5. Connecting Bolts and Nuts: **Stainless steel** of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

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

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

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

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

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

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide **1-inch (25-mm)** annular clear space between piping and concrete slabs and walls.

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas **2 inches (50 mm)** above finished floor level.

3. Using **grout or** s**ilicone sealant**, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches (76 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

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

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using **grout or silicone sealant**, seal space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

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

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves.
2. Interior Partitions:
   a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

B.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With [**polished, chrome-plated**] finish and setscrew fastener.

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

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

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; [and spring-clip fasteners.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece **split-plate steel** with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with [**polished, chrome-plated**] finish.
d. Insulated Piping: One-piece cast brass with [**polished brass**] finish.
e. Insulated Piping: One-piece stamped steel [**or split-plate, stamped steel with concealed hinge**] with polished, chrome-plated finish.
f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with p**olished, chrome-plated** finish.
g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
h. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
i. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. **Section 230548.13 "Vibration Controls for HVAC"** for vibration isolation devices.
4. **Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts"** for duct hangers and supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

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

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

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Hangers and supports for 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, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment[**and obtain approval from authorities having jurisdiction**].

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of **copper-plated steel**

2.3 TRAPEZE PIPE HANGERS

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

2.4 PLASTIC PIPE HANGERS

A. Description: Similar to MSS SP-58, Types 1 through 58, factory-fabricated steel pipe hanger except hanger is made of plastic.

B. Hanger Rods: Continuous-thread rod, nuts, and washer made of [**galvanized steel**] [**stainless steel**] <**Insert material**>.

C. Flammability: ASTM D635, ASTM E84, and UL 94.

2.5 PIPE STANDS

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

B. Compact Pipe Stand:
1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single Base, Single-Pipe Stand:
1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two, [**galvanized**] steel, continuous-thread 1/2-inch (12-mm) rods.
4. Horizontal Member: Adjustable horizontal, [**galvanized**] -steel pipe support channels.
5. Pipe Supports: **Strut clamps**
6. Hardware: [**Galvanized**] steel.
7. Accessories: Protection pads.
8. Height: [**12 inches (300 mm) above roof**]

D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M).

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

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

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus [**200 lb (90 kg)**].

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. 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-58. 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 A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. **Metal** framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

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

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

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

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

J. 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.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, [**NPS 2-1/2 (DN 65)**] <**4”**> 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.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. 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.

O. 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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1**-1/2 inches (40 mm)**] .

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in architectural plans and specifications for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 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 attachments for general service applications.

F. Use **stainless-steel pipe hangers** and **stainless-steel or corrosion-resistant** attachments for hostile environment applications.

G. Use copper-plated pipe hangers and [**copper**] attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. 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 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. 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.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use **mechanical-expansion anchors** instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230546 - COATINGS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. 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 application of coating systems on internal HVAC components and external equipment surfaces, including the following systems:

1. Bake-cured corrosion-resistant coating systems.
2. Air-dried corrosion-resistant coating systems.

1.3 DEFINITIONS

A. Salt Water Acetic Acid Test (SWAAT): A salt fog-spray test of corrosion resistance performed in accordance with ASTM G85, Annex 3.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include Safety Data Sheets, preparation requirements, and application instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Source Quality-Control Reports:

1. Certification of coating material testing.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in clean, dry, well-ventilated areas with ambient temperatures continuously maintained between 50 and 75 deg F (10 and 24 deg C).

1. Keep containers out of direct sunlight; avoid excessive heat and keep from freezing.
2. Maintain containers in clean condition, free of foreign materials and residue.
3. Remove rags and waste from storage areas daily.

1.8 CONDITIONS FOR COATING APPLICATION

A. Comply with manufacturer's recommendations.

B. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between [**50 and 75 deg F (10 and 24 deg C)**]

C. Do not apply coatings when temperature of surfaces to be coated or surrounding air temperatures are below 45 deg F (7 deg C).

D. Do not apply coatings when relative humidity exceeds 85 percent or at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 CORROSION-RESISTANT COATING SYSTEMS, GENERAL

A. Material Compatibility:

1. Provide materials for application within each coating system that are compatible with one another and with metal substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coating material in coating system, submit compatibility certification from manufacturer of each coating product that products are compatible with substrate base material and with substrate-coating products applied as earlier coats.
3. Products shall be of same manufacturer for each coat in a coating system.

2.2 BAKE-CURED CORROSION-RESISTANT COATING SYSTEMS

A. Base Coat Performance Requirements:

1. Corrosion Resistance: ASTM B117: 4000 hours.
2. Cross-Hatch Adhesion: ASTM D3359: **5B** .
3. Cyclic Weathering: ISO 12944-9, **4200** hours.
4. Mandrel Flexibility: ASTM D522/D522M: 1**/4 inch** without cracking or delamination of film after full cure.
5. Adhesion - Elcometer: ASTM D4541: **1100 psi**.
6. pH Range: 14-Day Liquid Spot Test: **3 to 12**.
7. Dry Heat Resistance: ASTM D2485: **320 deg F** maximum.
8. Dry Film Thickness: **0.6 to 1.5 mils**.
9. Heat-Transfer Reduction: **1 percent maximum**
10. Hardness: ASTM D3363 Pencil Test: **5H-6H**.

B. Acceptable for Equipment Serving Food-Preparation Areas: In accordance with **NSF 51 or 21 CFR 175.300**.

C. Top Coat Performance Requirements: Provide product with UV shielding properties, color stability, and maintenance of manufacturer's standard sheen, after exposure to outdoor conditions.

D. Baked-Cured, Immersion-Applied Coating System.

2.3 SOURCE QUALITY CONTROL

A. Certification of Coating Material Testing: Submit manufacturer's test report of corrosion-resistance performance testing, as performed by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with coating manufacturer's requirements and other conditions affecting performance of the Work.

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

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

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

3.2 PREPARATION

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

1. Thinning: Thin coating material with manufacturer's recommended thinning products when recommended or permitted by coating system manufacturer.

B. Comply with coating system manufacturer's recommendations to clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

3.3 APPLICATION

A. Verify with coating manufacturer whether coatings required must be applied and cured in factory-certified application shop.

B. Apply coating systems with equipment designed to deposit coating of specified uniform thickness over HVAC components, in complex, three-dimensional geometries.

1. Apply coatings with manufacturer-recommended tools and techniques suited for specified coating system and each coated HVAC component.
2. Do not apply coatings over labels or equipment name, identification, performance rating, or nomenclature plates.

C. Perform inspection and coating system manufacturer's recommended tests to verify coating integrity and thickness. Where coating was damaged by testing, repair damage in accordance with coating system manufacturer's written recommendations.

END OF SECTION 230546

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: **anodized aluminum, 0.032-inch (0.8-mm)**] minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: **White**.
3. Background Color: **Black**.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel **rivets**.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.
2. Letter Color: **White**
3. Background Color: **Black**.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel **rivets**.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.

B. Letter Color: **Red**.

C. Background Color: **Yellow**

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .

F. Minimum Letter Size: 1/4 inch or name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel **rivets**.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to **partially cover** circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: **At least 1/2 inch (13 mm) for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances**.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.

B. Letter Color: **Black**

C. Background Color: **White**.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: **At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances**].
2. Stencil Material: **Fiberboard or metal**.
3. Stencil Paint: Exterior, gloss, **acrylic enamel**in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, **acrylic enamel** in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches (32 mm) for viewing distances up to 15 feet (4-1/2 m) and proportionately larger lettering for greater viewing distances.
2. Stencil Material: **Fiberboard or metal.**
3. Stencil Paint: Exterior, gloss, **acrylic enamel**. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, **acrylic enamel**. Paint may be in pressurized spray-can form.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.
2. Stencil Material: **Fiberboard or metal**.
3. Stencil Paint: Exterior, gloss, **acrylic enamel**. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, **acrylic enamel**. Paint may be in pressurized spray-can form.

2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: **Brass, 0.032-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass **beaded chain**.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or

space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: **3 by 5-1/4 inches minimum Approximately 4 by 7 inches**.
2. Fasteners: **Brass grommet and wire**.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in “**Section 099123 Interior Painting”**

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1,[**with painted, color-coded bands or rectangles**] on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of [**50 feet (15 m)**] along each run. Reduce intervals to [**25 feet (7.6 m)**] in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Chilled-Water Piping: **White letters on a blue background**.
2. Condenser-Water Piping: **White letters on a safety-green background**.
3. Heating Water Piping: [**White letters on a-red background**]
4. Refrigerant Piping: **Black letters on a safety-white background**.

3.5 DUCT LABEL INSTALLATION

A. Install **self-adhesive** duct labels with permanent adhesive on air ducts in the following color codes:

1. **Blue**: For cold-air supply ducts.
2. Y**ellow:** For hot-air supply ducts.
3. **Green**: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of **25 feet** in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose

connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Chilled Water: **1-1/2 inches**, **round**.
b. Condenser Water: **1-1/2 inches**, **round**.
c. Refrigerant: **1-1/2 inches**, **round**.
d. Hot Water: **1-1/2 inches**, **round**.
e. Gas: **1-1/2 inches**, **round**.

2. Valve-Tag Colors:

a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
b. Flammable Fluids: Black letters on a safety-yellow background.
c. Combustible Fluids: White letters on a safety-brown background.
d. Potable and Other Water: White letters on a safety-green background.
e. Compressed Air: White letters on a safety-blue background.
f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Dual-duct systems.
c. Variable-air-volume systems.
d. Multizone systems.
e. Induction-unit systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.
c. Primary-secondary hydronic systems.

3. Balancing steam systems.
4. Testing, Adjusting, and Balancing Equipment:

a. Heat exchangers.
b. Motors.
c. Chillers.
d. Cooling towers.
e. Condensing units.
f. Boilers.
g. Heat-transfer coils.

5. Testing, adjusting, and balancing existing systems and equipment.
6. Sound tests.
7. Vibration tests.
8. Duct leakage tests.
9. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at **Project site** after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of **14** days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within **30** days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within **30** days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. 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.

D. System Readiness Checklists: Within **30** days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.7 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by **NEBB or TABB** .

1. TAB Field Supervisor: Employee of the TAB specialist and certified by **NEBB or TABB** .
2. TAB Technician: Employee of the TAB specialist and certified by **NEBB or TABB** as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.8 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in **AABC's "National Standards for Total System Balance"** and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping 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. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "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. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from **Construction Manager** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.

6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Adjust the dual-duct systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge. On systems with separate hot-deck and cold-deck fans, verify the location of the sensor on each deck.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit's hot deck and cold deck for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for full cooling. Some controllers require starting with minimum set point. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factors as required for design cold-deck maximum airflow and hot-deck minimum airflow. Record calibration factors.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for full heating.
    e. Measure airflow and adjust calibration factors as required for design cold-deck minimum airflow and hot-deck maximum airflow. Record calibration factors. If no minimum calibration is available, note any deviation from design airflow.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity (cooling coil or fan), adjust terminals for maximum and minimum airflow so that connected total matches cooling coil or fan selection and simulates actual load in the building. In systems with separate hot-deck and cold-deck fans, diversity consideration applies to each individual fan.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure the fan(s) static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that all terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, rpms, volts, amps and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

10. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.

c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
d. Adjust controls so that terminal is calling for minimum airflow.
e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.

c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR MULTIZONE SYSTEMS

A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.

B. The procedures for multizone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.

C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.

D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

   a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
   b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
   c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from **Construction Manager** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

F. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

G. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.9 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.

b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from **Construction Manager** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.

F. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

   a. Re-measure and confirm that total water flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.

3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.

b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.14 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.15 PROCEDURES FOR HEAT EXCHANGERS

A. Adjust water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Measure inlet steam pressure.

D. Check settings and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.17 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator **and condenser** to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.18 PROCEDURES FOR COOLING TOWERS

A. Balance total condenser-water flows to towers. Measure and record the following data:

1. Condenser-water flow to each cell of the cooling tower.
2. Entering- and leaving-water temperatures.
3. Wet- and dry-bulb temperatures of entering air.

4. Wet- and dry-bulb temperatures of leaving air.
5. Condenser-water flow rate recirculating through the cooling tower.
6. Cooling-tower spray pump discharge pressure.
7. Condenser-water flow through bypass.
8. Fan and motor operating data.

3.19 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.20 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

B. Steam Boilers:

1. Measure and record entering-water temperature.
2. Measure and record feed water flow.
3. Measure and record leaving-steam pressure and temperature.
4. Record relief valve pressure setting.

3.21 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. 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.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. 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.

3.22 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.23 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.24 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.

6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.25 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: **Plus or minus 10 percent**
2. Air Outlets and Inlets: **Plus or minus 10 percent**
3. Heating-Water Flow Rate: **Plus or minus 10 percent**
4. Cooling-Water Flow Rate: **Plus or minus 10 percent**

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.26 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare **weekly** progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.27 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. 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 specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans 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 and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches , and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches .
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches , and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches .

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm .
b. Total system static pressure in inches wg .
c. Fan rpm.
d. Discharge static pressure in inches wg .
e. Filter static-pressure differential in inches wg .

f. Preheat-coil static-pressure differential in inches wg .
g. Cooling-coil static-pressure differential in inches wg .
h. Heating-coil static-pressure differential in inches wg .
i. Outdoor airflow in cfm .
j. Return airflow in cfm .
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm .
b. Average face velocity in fpm .
c. Air pressure drop in inches wg .
d. Outdoor-air, wet- and dry-bulb temperatures in deg F .
e. Return-air, wet- and dry-bulb temperatures in deg F .
f. Entering-air, wet- and dry-bulb temperatures in deg F .
g. Leaving-air, wet- and dry-bulb temperatures in deg F .
h. Water flow rate in gpm .
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F .
k. Leaving-water temperature in deg F .
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F .
o. Inlet steam pressure in psig (kPa).

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.

e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h (kW).
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches , and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches .

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm .
b. Entering-air temperature in deg F .
c. Leaving-air temperature in deg F .
d. Air temperature differential in deg F .
e. Entering-air static pressure in inches wg .
f. Leaving-air static pressure in inches wg .
g. Air static-pressure differential in inches wg .
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F .
l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm .
i. Face area in sq. ft.
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h (kW).
b. Airflow rate in cfm .
c. Air velocity in fpm (m/s).
d. Entering-air temperature in deg F .

e. Leaving-air temperature in deg F .
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches , and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches .

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches , and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches .
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm .
b. Total system static pressure in inches wg .
c. Fan rpm.
d. Discharge static pressure in inches wg .
e. Suction static pressure in inches wg .

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F .
d. Duct static pressure in inches wg .
e. Duct size in inches .
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm .
h. Indicated velocity in fpm (m/s).
i. Actual airflow rate in cfm .
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig .

K. Air-Terminal-Device Reports:

1. Unit Data:

   a. System and air-handling unit identification.
   b. Location and zone.
   c. Apparatus used for test.
   d. Area served.
   e. Make.
   f. Number from system diagram.
   g. Type and model number.
   h. Size.
   i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

   a. Airflow rate in cfm .
   b. Air velocity in fpm (m/s).
   c. Preliminary airflow rate as needed in cfm .
   d. Preliminary velocity as needed in fpm (m/s).
   e. Final airflow rate in cfm .
   f. Final velocity in fpm (m/s).
   g. Space temperature in deg F .

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

   a. Airflow rate in cfm .
   b. Entering-water temperature in deg F .
   c. Leaving-water temperature in deg F .
   d. Water pressure drop in feet of head or psig (kPa).
   e. Entering-air temperature in deg F .
   f. Leaving-air temperature in deg F .

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

   a. Unit identification.
   b. Location.
   c. Service.

d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm .
g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches .
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches .
d. Full-open flow rate in gpm .
e. Full-open pressure in feet of head or psig (kPa).
f. Final discharge pressure in feet of head or psig (kPa).
g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm .
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.28 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **Construction Manager** .

B. **Construction Manager** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, **Owner** may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.29 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 230593

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Requirements:

1. Section 230713 "Duct Insulation" for duct insulation.
2. Section 230716 "HVAC Equipment Insulation" for equipment insulation.
3. Section 232113.13 "Underground Hydronic Piping" loose-fill pipe insulation in underground piping outside the building.
4. Section 232213.13 "Underground Steam and Condensate Heating Piping" for steam and condensate piping for steam-type tank heaters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. [**All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]
3. [**All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating

materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.4 MASTICS AND COATINGS

2.5 SEALANTS

A. Materials are as recommended by the insulation manufacturer and are compatible with insulation materials, jackets, and substrates.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
5. PSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 SECUREMENTS

A. Staples: Outward-clinching insulation staples, nominal **3/4 inch** wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and

specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
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.
4. For below-ambient services, apply vapor-barrier mastic over staples.
5. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged

areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. 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.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof 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 roof flashing at least **2 inches** below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. 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.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. 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 Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using prefabricated fitting insulation, or, mitered or routed fittings made from same material and density as that of adjacent pipe insulation. Each piece is 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 prefabricated fitting insulation, or, sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using prefabricated fitting insulation, or, sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using prefabricated fitting insulation, or, sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC

covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation conforms to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least **2 inches** over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of 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 jackets on above-ambient services, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus

twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges 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 Pipe Fittings and Elbows:

1. Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.
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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.
2. When prefabricated 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. Install insulation to flanges as specified for flange insulation application.
4. 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.

3.8 INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at **6 inches** o.c.
4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install prefabricated pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least **1 inch**, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.

2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where metal jackets are indicated, install with **2-inch** overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands **12 inches** o.c. and at end joints.

3.10 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Do not field paint aluminum or stainless steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and [**three**] <**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. 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.

C. 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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below **60 Deg F**:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 3/4 inch thick.

B. Chilled Water and Brine, **40 Deg F** and below:

1. NPS 3 and Smaller: Insulation is the following:

a. Cellular Glass: 1-1/2 inches thick.

2. NPS 4 to NPS 12: Insulation is the following:

a. Cellular Glass: 2 inches thick.

3. NPS 14 and Larger: Insulation is one of the following:

a. Cellular Glass: 3 inches thick.

C. Chilled Water and Brine, Above **40 Deg F**:

1. NPS 12 and Smaller: Insulation is the following:

a. Cellular Glass: 2 inches thick.

2. NPS 14 and Larger: Insulation is the following:

a. Cellular Glass: 3 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

E. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 2 inches thick.

B. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation is the following:

a. Flexible Elastomeric: 1 inch thick.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.
2. Aluminum, Stucco Embossed: 0.016 inch thick.
3. Painted Aluminum, Smooth: 0.016 inch thick.

D. Piping, Exposed:

1. None.
2. Aluminum, Smooth: 0.016 inch thick.
3. Painted Aluminum, Smooth: 0.016 inch thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Exposed:

1. PVC: 30 mils thick.
2. [**Painted**]Aluminum, Stucco Embossed, with Z-Shaped Locking Seam: 0.016 inch thick.

3.17 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Filter dryers.

B. Product Data Submittals: For each product.

1. Submit data for each type of refrigerant piping, fitting, valve, piping specialty, and refrigerant.

C. Delegated Design Submittals: For refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

D. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE
1.6 DELIVERY, STORAGE, AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Prepare valves and specialties for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and other end connections.

C. Use the following precautions during storage:

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," for refrigerant piping size and layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

B. Comply with ASHRAE 15.

C. Comply with ASME B31.5.

D. Test Pressure for Refrigerant R-410A:

1. Suction Tubing for Refrigeration and Air-Conditioning Applications Other than Heat Pumps: 300 psig.
2. Suction Tubing for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Tubing Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B88, Type K or L.

B. Wrought-Copper Fittings, Solder Joint: ASME B16.22.

C. Wrought-Copper Fittings, Brazed Joint: ASME B16.50.

D. Wrought-Copper Unions: ASME B16.22.

E. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

F. Brazing Filler Metals: AWS A5.8M/A5.8.

G. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum **3/4-inch** misalignment in minimum **7-inch-** long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATION SCHEDULES

A. Refrigerant: R-410A

B. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with or joints.

C. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 4 (DN 100) and Smaller: Copper, [**Type ACR**] [**Type L**], drawn-temper tubing and wrought-copper fittings with or joints.

D. Suction, Hot-Gas, and Liquid Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, NPS 2 to NPS 4 (DN 50 to DN 100): Copper, [**Type ACR**] [**Type L**], drawn-temper tubing and wrought-copper fittings with or joints.

E. Safety-Relief-Valve Discharge Tubing for Conventional Air-Conditioning (Cooling-Only) Applications, Copper: or, or tubing and wrought-copper fittings with or joints.

F. Suction, Hot-Gas, and Liquid Tubing for Heat-Pump Applications, NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with or joints.

G. Safety-Relief-Valve Discharge Tubing for Heat-Pump Applications, Copper: Type K,Type L, or tubing and wrought-copper fittings with or joints

H. Safety-Relief-Valve Discharge Piping for Heat-Pump Applications, Steel: Schedule 40, black steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and

strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

D. Install a full-size, three-valve bypass around filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install safety-relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside in accordance with ASHRAE 15.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

I. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

J. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

K. Install receivers sized to accommodate pump-down charge.

L. Install flexible connectors at compressors.

M. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to authority having jurisdiction.

3.3 INSTALLATION OF PIPING, GENERAL

A. 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 Shop Drawings.

B. Install refrigerant piping in accordance with ASHRAE 15.

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 adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves in accordance with Section 230553 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with

requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

E. Brazed Joints: Construct joints in accordance with AWS BRH, "Brazing Handbook," Ch. 35, "Pipe and Tubing."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than **20 ft.** long.
2. Roller hangers and spring hangers for individual horizontal runs **20 ft.** or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping **20 ft.** or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for and, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting.

E. Support vertical runs of and to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System must maintain test pressure at the manifold gauge throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to **500 micrometers**. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to **2 psig**.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, in accordance with manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves but not bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 237313.13 - INDOOR, BASIC AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Indoor, basic air-handling units.
2. Unit casings.
3. Fan, drive, and motor section.
4. Coil section.
5. Air filtration section.
6. Dampers.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each type and configuration of indoor, basic, air-handling unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, basic air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For vibration isolation, supports, 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. Design Calculations: Calculate requirements for selecting vibration isolators, supports, and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Source quality-control reports.

C. Startup service reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: 2 set(s) for each air-handling unit.
2. Gaskets: 2 set(s) for each access door.
3. Fan Belts: 2 set(s) for each air-handling unit fan.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, basic, air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

2.2 CAPACITIES AND CHARACTERISTICS

A. Filters:

1. Minimum Efficiency Reporting Value:

2.3 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

D. Water Coils: Factory tested to **300 psig** in accordance with AHRI 410 and ASHRAE 33.

E. Refrigerant Coils: Factory tested to minimum **450-psig** internal pressure, and to minimum **300-psig** internal pressure while underwater, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION OF INDOOR, BASIC AIR-HANDLING UNITS

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate

sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, **ASTM B88, Type M** copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection.

G. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch** high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling unit and air-distribution systems, and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.13

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Split-system air-conditioners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

application.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS
PART 3 - EXECUTION

3.1 INSTALLATION OF SPLIT-SYSTEM AIR-CONDITIONERS

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing surface debris.
2. Removing designated paving, curbs, sidewalks, and other existing features.
3. Removing designated trees, shrubs, and other plant life.
4. Removing abandoned utilities.
5. Excavating topsoil.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

A. Conform to applicable code for environmental requirements and disposal of debris.
B. Perform Work in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction and as shown and specified herein.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
B. Verify existing plant life designated to remain is tagged or identified.
C. Identify waste area and salvage area for placing removed materials.

3.2 PREPARATION

A. Contractor shall contact Sunshine 811 for location of existing utilities at 811 or 1-800-432-4770 a minimum of 48 hours prior beginning Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.
B. Protect trees, plant growth, and features designated to remain.
C. Protect benchmarks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING

A. Remove trees and shrubs within the clearing limits shown. Remove stumps and main root ball.
B. Clear undergrowth and deadwood, without disturbing subsoil.
C. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from Site.
B. Partially remove paving, curbs, sidewalks, and other existing features as indicated on Drawings. Neatly saw cut concrete edges at right angle to surface.
C. Remove abandoned utilities as shown. Indicated removal termination point for underground utilities on Record Documents.
D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
E. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate topsoil from areas as shown to be further excavated, landscaped, or regraded, without mixing with foreign materials for use in finish grading.
B. Do not excavate wet topsoil.
C. Stockpile topsoil in storage piles in areas shown, or where otherwise approved by Engineer. Construct storage piles to freely drain surface water. Cover storage piles to prevent windblown dust.
D. Remove excess topsoil not intended for reuse from Site.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for excavation activities as shown and specified.
B. Related Requirements:

1. Section 31 23 23 - Fill.

1.2 REFERENCE STANDARDS

A. Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

1.3 DEFINITIONS

A. Rock: Material encountered in excavation that cannot be dislodged by a track-type hydraulic excavator, equipped with a 42-inch wide short-tip radius rock bucket, rated at not less than 120 horsepower flywheel power with bucket-curling force of not less than 25,000 lbs and stick-crowd force of not less than 18,000 lbs.

1. Rock shall not include materials such as hardpan, loose rock, concrete or other materials that can be removed by means other than drilling and blasting, but which for reasons of economy in excavating the Contractor chooses to remove by drilling or other means.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Shop Drawings:

1. Excavation Protection Plan:

a. Describe sheeting, shoring, and bracing materials and installation, as required, to protect excavations and adjacent structures and property.
b. Submit signed and sealed Shop Drawings with design calculations and assumptions to support plan.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
D. Qualifications Statement:

1. Submit qualifications for licensed professional.

1.5 QUALITY ASSURANCE

A. Perform Work according to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

1.6 QUALIFICATIONS

A. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Florida.

PART 2 - PRODUCTS (NOT USED)
PART 3 - EXECUTION

3.1 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Utility Service Locator:

1. Contractor shall contact Sunshine 811 for location of existing utilities at 811 or 1-800-432-4770 a minimum of 48 hours prior to beginning Work.
2. Request that underground utilities be located and marked within and immediately surrounding construction areas.
3. Identify required lines, levels, contours, and data.
4. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
5. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Coordinate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility Owner.

C. Existing Utilities:

1. Notify utility companies and coordinate protection or relocation of utilities.
2. Protect from damage utilities not indicated to be removed.
3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
4. Provide minimum of 48-hour notice to Engineer and receive written notice to proceed before interrupting any utility.
5. Demolish and completely remove from site existing under-ground utilities indicated to be removed. Coordinate with utility Owner for shut-off of services if lines are active.
6. In the event that an existing utility is broken, Contractor shall contact utility owner, Owner, and Engineer immediately. Coordinate repair with utility owner at their direction. The Contractor shall be responsible for all costs associated with damaged utilities.
7. Utility Poles: Contractor shall communicate directly with utility companies when performing work around utility poles. Contractor shall bear all costs associated with work, including expense of temporarily supporting poles.

D. When performing trench excavation in excess of 5-feet in depth, comply with OSHA requirements for trench safety standards, 29 CFR 1926, subpart b, and all subsequent revisions or updates adopted by the Department of Labor. Submission of bid and subsequent execution of Contract will serve as certification that all excavation in excess of 5-feet in depth will be in compliance with section 55 3. 62, Florida Statutes.
E. Use of explosives is not allowed.
F. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
G. Protect plant life, lawns, and other features designated to remain as portion of final landscaping.
H. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, curbs, and other existing facilities and objects from excavating equipment and vehicular traffic.
I. Do not close or obstruct driveways, roadways, sidewalks, or hydrants without permits.

J. Erect and maintain temporary barriers and security devices, including warning signs, warning lights, and similar measures, for protection of public, Owner, and existing improvements indicated to remain.

1. Temporary barriers shall be installed and maintained in compliance with authorities having jurisdiction.

3.2 EXCAVATION

A. Underpin adjacent structures which may be damaged by excavation Work.
B. Excavate subsoil to accommodate slabs on grade, paving, Site structures, and construction operations.
C. Coordinate excavation requirements with Drawings and geotechnical report for working elevation to install pile foundations.
D. Compact disturbed load-bearing soil in direct contact with foundations to original bearing capacity, as specified in Section 31 23 23 - Fill.
E. Slope banks with machine to angle of repose or less until shored.
F. Do not interfere with 45-degree bearing splay of foundations.
G. Grade top perimeter of excavation to prevent surface water from draining into excavation.
H. Trim excavation and remove loose matter.
I. Removal of Deleterious Materials:

1. Remove excess and unsuitable material from Site.
2. Notify Engineer of unexpected subsurface conditions.

J. No payment will be made for correction of unauthorized excavation. Correct over-excavated areas as directed by Engineer.
K. Remove excavated material from Site.
L. Stockpile excavated material in area designated on Site.
M. Repair or replace items indicated to remain that have been damaged by excavation.
N. Except where otherwise authorized, shown or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade and foundations shall be replaced by, and at the expense of, the Contractor, with concrete placed at the same time and monolithic with the concrete above.

3.3 ROCK REMOVAL

A. Excavate and remove rock by mechanical method.

1. Drill holes and use expansive tools or wedges to fracture rock.

B. Cut away rock at bottom of excavation to form level bearing.
C. Remove shaled layers to provide sound and unshattered base.
D. In utility trenches, excavate to twelve (12) inches below invert elevation of pipe and twenty-four (24) inches wider than pipe diameter.
E. Remove excavated materials from site.
F. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 23 unless otherwise directed by the Engineer. No payment will be made for unauthorized rock removal or correction thereof.

3.4 EROSION CONTROL, DRAINAGE, AND DEWATERING

A. Erosion Control:

1. In general, the construction procedures outlined herein shall be implemented to assure minimum damage to the environment during construction. Contractor shall take any and all

additional measures required to conform to the requirements of applicable codes and regulations.

2. Whenever possible, access and temporary roads shall be located and constructed to avoid environmental damage. Provisions shall be made to regulate drainage, avoid erosion, and minimize damage to vegetation.
3. Where areas must be cleared for storage of materials or temporary structures, provisions shall be made for regulating drainage and controlling erosion, subject to the Engineer's approval.
4. Temporary measures shall be applied to control erosion and to minimize the silting of the existing waterways, and natural ponding areas. Such measures shall include, but are not limited to, the use of berms, silt barriers, gravel or crushed stone, mulch, slope drains and other methods. These temporary measures shall be applied to erodible materials exposed by any activities associated with the Work.
    a. Special care shall be taken to eliminate depressions that could serve as mosquito pools.
    b. Temporary measures shall be coordinated with the construction of permanent drainage facilities and other Work to the extent practicable to assure economical, effective, and continuous erosion and silt control.
    c. Contractor shall provide special care in areas with steep slopes. Disturbance of vegetation shall be kept to a minimum to maintain stability.
5. Remove only those shrubs and grasses that must be removed for construction. Protect the remainder to preserve their erosion-control value.
6. Install erosion and sediment control practices where shown on the Drawings and according to applicable standards, codes, and specifications. The practices shall be maintained in effective working condition during construction and until the drainage area has been permanently stabilized.
7. After stabilization, remove all silt barriers, debris, etc., from the Site.
8. In the event of any temporary Work stoppage, Contractor shall take steps to stabilize the Site and prevent erosion.
9. In the event Contractor repeatedly fails to satisfactorily control erosion and siltation, the Owner reserves the right to employ outside assistance or to use its own forces to provide the corrective measures indicated. The Contractor shall be responsible for all costs associated with such corrective measures.
10. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce on and off-site damage and health hazards. Control may be achieved by irrigation in which the Site shall be sprinkled with water until the surface is moist. The process shall be repeated, as required.

B. Drainage and Dewatering:

1. Contractor shall provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and groundwater entering excavations, or other parts of the Work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the pipe or structure to be built, therein is inspected by the Engineer and backfill operations have been completed and approved.
    a. The different working areas on the Site shall be kept free of surface water at all times. Contractor shall install drainage ditches and dikes and shall perform all pumping and other Work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations and fill areas. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental.
    b. Water used for working or processing, resulting from dewatering operations, or containing

oils or sediments that will reduce the quality of the water downstream of the point of discharge, shall not be directly discharged. Such waters shall be diverted through a settling basin or filter before being discharged.

c. Contractor will be held responsible for the condition of any pipe, conduit, or channel used for drainage purposes and all such pipes, conduits, or channels shall be left clean and free of sediment.

d. Remove water from excavations as fast as it collects.

2. Contractor shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, etc., necessary to depress and maintain the ground water level below the base of the excavations during all stages of construction operations. The groundwater table shall be lowered in advance of excavation, for a sufficient period of time to permit dewatering of fine grain soils, and maintained two feet below the lowest subgrade excavation made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural ground water.

a. Design of dewatering system, including both drawings and calculations, shall be performed by a Registered Professional Engineer in the State of Florida and shall be employed by Contractor. Dewatering system shall be designed to avoid settlement or damage to existing structures and utilities.

b. The system shall be operated on a 24-hour basis and standby pumping facilities and personnel shall be provided to maintain the continued effectiveness of the system.

c. If, in the opinion of the Engineer, the water levels are not being lowered or maintained as required, Contractor shall install additional or alternate dewatering devices as necessary, at no additional cost to the Owner.

d. Elements of the system shall be located to allow a continuous dewatering operation without interfering with the construction of the permanent Work. Where portions of the dewatering system are located in the area of permanent construction, Contractor shall submit details of the methods proposed to construct the permanent Work in this location for the approval of the Engineer.

e. Controls of groundwater shall continue until the permanent construction provides sufficient dead load to withstand the hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until all waterproofing Work has been completed.

f. Dispose of all water removed from the excavation in a manner that does not endanger any portion of the Work under construction or completed.

g. Disposal of water removed shall comply with all State and Federal regulations.

h. Before discontinuing dewatering operations or permanently permitting the rise of the ground water level, computations shall be made to show that any structure affected by the water level rise is protected by backfill or other means to sustain uplift. Use a safety factor of 1.25 when making these computations.

i. Dewatering operations shall not be discontinued without the prior authorization of the Engineer.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

A. Inspecting: Request visual inspection of bearing surfaces by Engineer before installing subsequent Work.

3.6 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished

Work.

B. Prevent displacement or loose soil from falling into excavation, and maintain soil stability.
C. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
D. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for backfill activities as shown and specified.

1. Fill under paving.
2. Fill around manhole structures
3. Fill for Open cut piping

B. Related Requirements:

1. Section 02 32 00 – Trenching, Bedding and Backfill
2. Section 31 23 16 – Excavation.

1.2 REFERENCE STANDARDS

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg Rammer and a 457-mm Drop.
2. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
3. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D6031/D6031M - Standard Test Method for Logging In Situ Moisture Content and Density of Soil and Rock by the Nuclear Method in Horizontal, Slanted, and Vertical Access Tubes.
7. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer information for geotextile fabric, indicating fabric and construction.
C. Samples: Submit, in airtight containers, one 10-lb. sample of each type of fill to testing laboratory.
D. Materials Source: Submit name of imported materials suppliers.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.4 QUALITY ASSURANCE

A. Perform Work according to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Select Fill: Type S1, as specified in Section 02 32 00 – Trenching, Bedding and Backfill
B. Granular Fill: Type S3, as specified in Section 02 32 00 – Trenching, Bedding and Backfill
C. Concrete:

1. Description:

a. Structural, as specified in the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

b. Compressive Strength: 4,000 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that subdrainage, damp proofing, and waterproofing installations have been inspected.
C. Verify that underground structures are properly anchored to avoid flotation after backfilling.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Compact subgrade to specified density requirements for subsequent backfill materials.
C. Soft Subgrade:

1. Cut out soft areas of subgrade not capable of compaction in place.
2. Backfill with granular fill and compact to density equal to or greater than specified requirements for subsequent fill material.

3.3 BACKFILLING

A. Backfill areas to contours and elevations.
B. Systematically backfill to allow maximum time for natural settlement.
C. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces, and do not backfill with frozen materials.
D. Maximum Compacted Depths:

1. The Engineer may grant permission to increase lift depth to 12 inches upon proof of successful compaction to the specified densities at the lift depths specified.

E. Compaction:
   1. Fill under roadways: 98-percent Standard Proctor Density.
   2. Fill outside of roadways: 95-percent Standard Proctor Density elsewhere.

F. Use placement method that does not disturb or damage foundation perimeter drainage or utilities in trench.

G. Maintain optimum moisture content of fill materials to attain required compaction density.

H. Structures:
   1. Backfill simultaneously on each side of unsupported manhole.

I. Make gradual grade changes and blend slope into level areas.

1.2 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.

B. Top Surface of Backfilling under Paved Areas: Plus or minus 1 inch from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

1.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Inspecting: Request visual inspection of bearing surfaces by Engineer before installing subsequent Work.

C. Testing:
   1. Laboratory Material Testing: Comply with AASHTO T 180.
   2. In-Place Compaction Testing:
      a. Density Tests: Comply with ASTM D6938.
      b. Moisture Tests: Comply with ASTM D6031/D6031M.
   3. If tests indicate that Work does not meet specified requirements, remove Work, replace, compact, and retest.
   4. Testing Frequency: One (1) moisture and one (1) density test per lift for each 100 feet along the alignment shown.

D. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

E. The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from the Engineer or Owner.

1.4 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Reshape and recompact fills subjected to vehicular traffic during construction. ill under Asphalt Paving:

1. Compact subsoil to 95 percent of maximum density.

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for furnishing and installing erosion and sedimentation controls.
B. Related Sections:

1. Section 31 23 23 – Fill.
2. Section 33 05 61 – Concrete Manholes.
3. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping.
4. Section 33 31 23 – Sanitary Sewerage Force Main Piping.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T88 - Standard Specification for Particle Size Analysis of Soils.
2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:

1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data on geotextile.
C. Samples:

1. Submit two samples or rock, minimum 5 tons each or one-half total project quantity, whichever is smaller. Provide one sample in place at construction site and provide other sample at quarry. Construction site sample may be incorporated into the Work. Samples will be used as reference for judging size, and graduation of rock supplied and placed.

D. Test Reports: Indicate certified tests results for precast concrete at manufacturing facility, cast-in-place concrete in field, and granular backfill.
E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.5 QUALITY ASSURANCE

A. Perform Work according to Florida Department of Transportation and Florida Department of Environmental Protection standards.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one (1) week prior to commencing work of this section.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
B. Do not place grout when air temperature is below freezing.
C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS

A. Furnish rock and geotextile materials according to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.2 CONCRETE MATERIALS AND REINFORCEMENT

A. Furnish cement, aggregate, admixtures, and reinforcement in per Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
B. Water: Clean and not detrimental to concrete.

1.2 BLOCK, STONE, AGGREGATE, AND SOIL MATERIALS

A. Furnish block, stone, aggregate, and soil materials according to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.3 PLANTING MATERIALS

A. Seeding, Soil Supplements, and Mulch: Furnish according to Florida Department of Transportation standards.

2.4 PIPE MATERIALS

A. Pipe: Furnish according to Florida Department of Transportation standards.

2.5 ACCESSORIES

A. Furnish the following accessories in accordance with Florida Department of Transportation standards:

1. Joint Sealers.
2. Joint Fillers.
3. Building Paper.
4. Grout.
5. Steel Plate Vortex Device.
6. Welding Material.
7. Anti-Seep Collar.
8. Trash Racks.

2.6 MIXES

A. Concrete: Furnish according to Florida Department of Transportation standards.

2.7 SOURCE QUALITY CONTROL (AND TESTS)

A. Section 01 40 00 - Quality Requirements: Testing, inspection, and analysis requirements.
B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.
C. Test samples in accordance with ACI 301.
D. Make rock available for inspection at producer's facility prior to shipment. Notify Engineer at least seven (7) days before inspection is allowed.
E. Allow witnessing of inspections and test at manufacturer's test facility. Notify Engineer at least seven (7) days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
B. Verify compacted material is acceptable and ready to support devices and imposed loads.
C. Verify gradients and elevations of base or foundation for other work are correct.

1.3 INSTALLATION OF EROSION AND SEDIMENT CONTROLS

A. All erosion and sediment controls shall be installed as shown and in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

3.2 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.
B. Construct, stabilize, and activate erosion controls before site disturbance within tributary areas of

those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2:1 or flatter.
D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.

1. During non-germinating periods, apply mulch at recommended rates.
2. Stabilize disturbed areas which are not at finished grade, and which will be disturbed within one year with temporary seeding.
3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year with permanent seeding and/or sodding as shown and specified.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.3 FIELD QUALITY CONTROL

A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.
B. Field test concrete in accordance with Florida Department of Transportation standards.
C. Compaction Testing: As specified in Section 31 23 23 - Fill.
D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
E. Frequency of Compaction Testing: As specified in Section 31 23 23 - Fill.

3.4 CLEANING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove, and dispose of sediment.
C. Do not damage structure or device during cleaning operations.
D. Do not permit sediment to erode into construction or site areas or natural waterways.
E. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.5 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.
C. Do not permit construction traffic over paving until 75 percent design strength of concrete has been achieved.
D. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section general requirements for asphalt paving.
B. Related Requirement:

1. Section 31 23 16 – Excavation.
2. Section 31 23 23 – Fill.
3. Section 33 05 61 – Concrete Manholes.

1.2 REFERENCE STANDARDS

A. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
B. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
C. AASHTO M140 - Standard Specification for Emulsified Asphalt.
D. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
E. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
F. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
G. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
H. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.
I. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
J. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
K. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
L. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
M. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
N. ASTM D977 - Standard Specification for Emulsified Asphalt.
O. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
P. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
Q. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
R. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
S. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
T. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
U. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
V. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
W. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
X. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
Y. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete

and Asphalt Pavements.

Z. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.

AA. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.

BB. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.

CC. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for milling and paving equipment to be used.
2. Submit product information for asphalt and aggregate materials.
3. Submit mix design with laboratory test results supporting design.
4. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Certified by State of Florida.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum five (5) years of documented experience.

B. AMBIENT CONDITIONS

C. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

D. Do not place asphalt mixture when ambient air or base surface temperature is less than Florida Department of Transportation requirements.

PART 2 - PRODUCTS

2.1 ASPHALT PAVING

A. Performance / Design Criteria:

1. Pavement Design: Superpave Type SP-9.5 or Type SP-12.5 as shown or specified and in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Asphalt Materials:
3. Materials for asphalt paving shall comply with Florida Department of Transportation Standard

Specifications for Road and Bridge Construction.

2.2 MIXES

A. Asphalt Paving Mixtures:

1. Asphalt Paving Mixtures shall comply with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Use dry material to avoid foaming. Mix uniformly.

2.3 ACCESSORIES

1. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.
2. SOURCE QUALITY CONTROL
3. Section 01 40 00 - Quality Requirements: Testing, inspection, and analysis requirements.
4. Submit proposed mix design of each class of mix for review prior to beginning of Work.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
C. Verify compacted subbase is dry and ready to support paving and imposed loads.

1. Proof roll subbase with a vibratory roller weighing a minimum of eight (8) tons or a sheepsfoot roller, where appropriate, exerting a compression of at least 250 pounds psi on the tamper foot for at least five (5) passes in minimum two (2) perpendicular passes to identify soft spots.
2. Remove soft subbase and replace with compacted fill as specified in Section 31 23 23.
3. Verify gradients and elevations of base are correct.

D. Verify manhole frames and drainage structures are installed in correct position and elevation.

3.2 PREPARATION

A. Prepare subbase in accordance with Florida Department of Transportation standards.

3.3 DEMOLITION

A. Saw cut and notch existing paving as indicted on Drawings.
B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.
C. Repair surface defects in existing paving to provide uniform surface to receive new paving.
D. Remove demolished asphalt from Site and dispose of properly.

3.4 MILLING OF EXISTING ASPHALT PAVEMENT

A. Perform all milling operations in accordance with Florida Department of Transportation standards.

B. Remove existing raised pavement markers prior to milling.
C. Do not disfigure adjacent Work.
D. Provide a milling machine capable of maintaining a depth of cut and cross slope that will achieve the results specified in the Contract Documents.

1. Milling machine shall have a minimum overall length (out to out measurement excluding the conveyor) of eighteen (18) feet and a minimum cutting width of six (6) feet.
2. Milling machine shall be equipped with a built-in automatic grade control system that can control the transverse slope and the longitudinal profile to produce the specified results.
3. The Engineer will approve any commercially manufactured milling machine that meets the above requirements. If it becomes evident after starting milling that the milling machine cannot consistently produce the specified results, the Engineer will reject the milling machine for further use.
4. The Contractor may use a smaller milling machine when milling to lower the grade adjacent to existing curb or other areas where it is impractical to use the above-described equipment.
5. Milling machine shall be equipped with means to effectively limit the amount of dust escaping during the removal operation.
6. For complete pavement removal, the Engineer may approve the use of alternate removal and crushing equipment.
7. Execute removal to depth not less than the depth(s) shown on the Drawing(s) at each point across full width of surface without detrimental aggregate degradation.

E. Remove milled asphalt from Site and dispose of properly.

3.5 INSTALLATION

A. Subbase: Prepare subbase in accordance with Florida Department of Transportation standards.
B. Prime Coat and Tack Coat: Install in accordance with Florida Department of Transportation standards.
C. Single Course Asphalt Paving:

1. Install Work in accordance with Florida Department of Transportation standards.
2. Place asphalt within 24 hours of applying primer or tack coat.
3. Place asphalt wearing course to thickness indicated on Drawings.
4. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.
6. Double Course Asphalt Paving:
7. Install Work in accordance with Florida Department of Transportation standards.

8. Place asphalt binder course within 24 hours of applying primer or tack coat.
9. Place binder course to thickness indicated on Drawings.
10. Place wearing course within 24 hours of placing and compacting binder course.
    a. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
    b. Place wearing course to thickness indicated on Drawings.
    c. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
    d. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.
    e. Asphalt Paving Overlay
    f. Install Work in accordance with Florida Department of Transportation standards.
    g. Apply tack coat to existing paving surface at rate recommended by geotextile fabric manufacturer.
    h. Install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches.
    i. Place wearing course to thickness indicated on Drawings.
    j. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
    k. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.
    l. Place asphalt mixture when temperature is not more than 15 degrees F less than initial mixing temperature.

3.6 CURBS

A. Install extruded asphalt curbs of profile as indicated on Drawings.

3.7 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.
C. Scheduled Compacted Thickness: Within 3/16 inch.
D. Variation from Indicated Elevation: Within 1/2 inch.

3.8 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.
C. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1,000 square yards

compacted paving.

D. Asphalt Paving Density: Monitor the roadway density per Florida Department of Transporation standards with either 6-inch diameter roadway cores, a nuclear density gauge, or other density measuring device, at a minimum frequency of once per 1,500 feet of pavement.

3.9 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
B. Immediately after placement, protect paving from mechanical injury until surface temperature is less than 160 degrees F.
C. Keep sections of newly compacted asphalt concrete, which are to be covered by additional courses, clean until the successive course is laid.
D. Do not dump embankment or base material directly on the pavement. Dress shoulders before placing the friction course on adjacent pavement.

END OF SECTION

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SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aggregate subbase.
2. Concrete paving for:

a. Concrete sidewalks.
b. Concrete integral curbs and gutters.
c. Concrete parking areas and roads.

B. Related Requirements:

1. Section 31 23 23 - Fill.
2. Section 32 12 16 - Asphalt Paving.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

C. ASTM International:

1. ASTM A184 - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
2. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
3. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
4. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
5. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for

Concrete Reinforcement.

6. ASTM A767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
7. ASTM A775 - S Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
8. ASTM A884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
9. ASTM A934 - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
10. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33 - Standard Specification for Concrete Aggregates.
12. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
14. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. ASTM C150 - Standard Specification for Portland Cement.
16. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
17. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
18. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
20. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
21. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
22. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
23. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
24. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
25. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
26. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
27. ASTM C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
28. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.

29. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
30. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
31. ASTM C1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
32. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
33. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
34. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
35. ASTM E408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
36. ASTM E903 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
37. ASTM E1918 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
38. ASTM E1980 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.3 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.4 SUBMITTALS

A. Only request submittals needed to verify compliance with Project requirements.
B. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
C. Product Data:

1. Submit data on concrete materials, joint filler, admixtures, and curing compounds.

D. Design Data:

1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:

a. Hot and cold weather concrete work.

2. Identify mix ingredients and proportions, including admixtures.

3. Chloride can contribute to corrosion of metals embedded in concrete. Admixture manufacturers are not required to identify chloride content, unless requested.
4. Identify chloride content of admixtures and whether chloride was added during manufacture.

E. Source Quality Control Submittals: Indicate results of factory tests and inspections.

1.5 QUALITY ASSURANCE

A. Perform Work according to ACI 30 and in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
B. Obtain cementitious materials from same source throughout.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years documented experience.
B. Installer: Company specializing in performing work of this section with minimum five (5) years documented experience.

1.7 MOCKUP

A. Section 01 40 00 - Quality Requirements: Requirements for mockup.
B. Construct mockup, 5 x 5 feet, including paving, joints, surface texture, and exposed aggregate, as required.
C. Locate where shown on the Drawings or directed by Engineer.
D. Remove mockup when directed by Engineer.

1.8 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.
B. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 AGGREGATE SUBBASE

A. Aggregate Subbase: As specified in Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.2 CONCRETE PAVING

A. Performance / Design Criteria:

1. Pavement shall be designed for the intended service as shown on the Drawings in accordance with the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

B. All concrete, reinforcement, and formwork shall conform to the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.3 FABRICATION

A. Fabricate reinforcing according to Florida Department of Transportation standards.
B. Form standard hooks for 180-degree bends, 90-degree bend, and seismic hooks as indicated on Drawings.

2.4 MIXES

A. Concrete mix shall be in accordance with the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.5 CONCRETE CURB AND GUTTER

A. Concrete curb and gutter shall be in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.6 CONCRETE MATERIALS

A. Concrete:

1. All concrete shall be Class I as specified in Florida Department of Transportation Standard Specifications for Road and Bridge Construction, Section 346, "Portland Cement Concrete".

B. Forms:

1. Description: Forms shall be either wood or metal.
2. Forms shall be straight, free from warps or bends, and of sufficient strength and rigidity to resist the pressure of the concrete without distortion.
3. Height: Equal to full depth of finished sidewalk.
4. Flexible forms shall be used for all headers constructed on a radius.

C. Steel Reinforcement:

1. Deformed Reinforcing:

a. Steel: Comply with ASTM A615/A615M.
b. Yield Grade: 60 ksi.
c. Billet Bars: Deformed.
d. Finish: Uncoated.

2. Deformed Bar Mats:

a. Description: Steel bars.
b. Comply with ASTM A184/A184M.
c. Fabrication: Comply with ASTM A615 or ASTM A706.
d. Yield Strength: 60 ksi.
e. Finish: Uncoated.

3. Welded Plain-Wire Fabric:

   a. Comply with ASTM A1064/A1064M.

   b. Finish: Uncoated.

4. Dowels:

   a. Description: Plain steel bars.

   b. Comply with ASTM A615.

   c. Yield Strength: 60 ksi.

   d. Length: As indicated on Drawings.

   e. Ends: Square, with burrs removed.

   f. Finish: Uncoated.

5. Tie Wire:

   a. Type: Annealed.

   b. Minimum Size: 16 gauge.

   c. Finish: Uncoated.

6. Glass-Fiber Reinforcement:

   a. Description: Alkali-resistant, glass-fiber rovings specifically formulated for use in concrete.

   b. Length: Varying from 1-1/2 to 2 inches.

2.7 ACCESSORIES

A. Joint materials, curing compounds, liquid surface sealers, surface retarders, and joint sealers shall comply with Florida Department of Transportation standards.

2.8 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing and Inspection Services.
B. Submit proposed mix design of each class of concrete to appointed firm for review prior to commencement of Work.
C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.
D. Test samples according to ACI 301.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. When performance specifying is used coordinate section specifying compacted subbase section to suit intended loads.

C. Verify compacted subbase is dry and ready to support paving and imposed loads.
D. Identify type of vehicle or compactor and minimum load required for proof rolling subbase.
E. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Moisten substrate to minimize absorption of water from fresh concrete.
C. Coat surfaces of manhole, catch basin, and inlet frames with oil to prevent bond with concrete paving.
D. Notify Engineer minimum 24 hours prior to commencement of concreting operations.

3.3 INSTALLATION

A. Base Course:

1. Prepare base course according to Florida Department of Transportation standards.

B. Forms:

1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Reinforcement:

1. Place reinforcing as indicated on Drawings.
2. Interrupt reinforcing at expansion joints.
3. Place dowels to achieve paving and curb alignment as detailed.
4. Quantity of doweled joints requires consideration for frequency of traffic.
5. Provide doweled joints as shown on the Drawings
6. Repair damaged reinforcement finish to match shop finish.

D. Placing Concrete:

1. Place concrete according to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Ensure reinforcing, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
3. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
4. Place concrete to pattern indicated.

E. Joints

1. Place expansion joints at 20-foot intervals unless otherwise shown. Align curb, gutter, and sidewalk joints.

2. Place joint filler between paving components and building or other appurtenances. Recess top of filler 1/4 inch for sealant installation.
3. Provide scored joints at 3 feet intervals between sidewalks and curbs, and between curbs and paving.
4. Provide keyed joints as indicated.
5. Seal joints as indicated on Drawings.

F. Exposed Aggregate:

1. Apply surface retarder where exposed aggregate finish is required.
2. Wash exposed aggregate surface with clean water and scrub with stiff bristle brush exposing aggregate.

G. Finishing:

1. Concrete finish shall be as shown on the Drawings.

H. Curing and Protection

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
C. Maximum Variation from True Position: 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.
B. Perform field inspection and testing according to Florida Department of Transportation standards.
C. Inspect reinforcing placement for size, spacing, location, support.
D. Testing firm will take cylinders and perform slump and air entrainment tests according to ACI 301.
E. Strength Test Samples:

1. Sampling Procedures: ASTM C172.
2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured.
3. Sample concrete and make one set of three cylinders for every 50 cu yds or less of each class of concrete placed each day and for every 2,000 sf of surface area paving.
4. Make one additional cylinder during cold weather concreting, and field cure.

F. Field Testing:

1. Slump Test Method: ASTM C143.
2. Air Content Test Method: ASTM C173.
3. Temperature Test Method: ASTM C1064.
4. Measure slump and temperature for each compressive strength concrete sample.
5. Measure air content in air entrained concrete for each compressive strength concrete sample.

G. Cylinder Compressive Strength Testing:

1. Test Method: ASTM C39.
2. Test Acceptance: Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
3. Test one (1) cylinder at 7 days.
4. Test three (3) cylinders at 28 days.
5. Dispose remaining cylinders when testing is not required.

H. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.6 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.
C. Coordinate minimum requirements for concrete strength with expected traffic conditions.
D. Do not permit traffic over paving until 75 percent design strength of concrete has been achieved.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for posts.
4. Manual gates and related hardware.
5. Privacy slats.

1.2 REFERENCES

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
6. ASTM A817 - Standard Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
7. A1011/ 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
8. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
9. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
10. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
11. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
12. ASTM F626 - Standard Specification for Fence Fittings.
13. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
14. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
15. ASTM F934 - Standard Specification for Standard Colors for Polymer-Coated Chain Link

Fence Materials.

16. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
17. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
18. ASTM F1183 - Standard Specification for Aluminum Alloy Chain Link Fence Fabric.
19. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.
20. ASTM F1345 - Standard Specification for Zinc - 5% Aluminum -Mischmetal Alloy-Coated Steel Chain-Link Fence Fabric.

B. Chain Link Fence Manufacturers Institute:

1. CLFMI - Product Manual.

1.3 SYSTEM DESCRIPTION

A. Fence Height: as indicated on Drawings.
B. Line Post Spacing: At intervals not exceeding 10 feet.
C. Fence Post and Rail Strength: Conform to ASTM F1043 Light Industrial Fence quality.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
C. Product Data: Submit data on fabric, posts, accessories, fittings, and hardware.
D. Samples: Submit two 12x12 inch samples of fence fabric.
E. Manufacturer's Installation Instructions: Submit installation requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.
C. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALITY ASSURANCE

A. Perform Work according to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years of documented experience.
B. Installer: Company specializing in performing work of this section with minimum five (5) years of documented experience.

1.8 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and

protecting products.

B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.
C. Identify each package with manufacturer's name.
D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Materials and Components: Conform to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.2 COMPONENTS

A. Line posts, corner and terminal posts, gate posts, top and brace rails, gate frames, fabric, tension wires, tension bands, tension straps and tie wire shall be in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.3 ACCESSORIES

A. Caps, fittings, extension arms, and gate hardware shall be in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.4 GATES

A. General:

1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assemble gates.
3. Gates shall conform to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.5 FINISHES

A. Chain link fencing finishes shall be in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install framework, fabric, accessories, and gates according to Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
B. Set intermediate, terminal, and gate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
C. Line Post Footing Depth Below Finish Grade: As shown on the Drawings.
D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: As shown on the Drawings.
E. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

F. Install top rail through line post tops and splice with 6-inch long rail sleeves.
G. Install center and bottom brace rail on corner gate leaves.
H. Place fabric on outside of posts and rails.
I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
J. Position bottom of fabric 2 inches above finished grade.
K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
M. Install bottom tension wire stretched taut between terminal posts.
N. Install support arms sloped outward and attach barbed wire; tension and secure.
O. Support gates from gate posts. Do not attach hinged side of gate from building wall.
P. Install gate with fabric and barbed wire overhang to match fence. Install three (3) hinges on each gate leaf.
Q. Install posts with 6 inch maximum clear opening from end posts to buildings, fences and other structures.
R. Excavate holes for posts to diameter and spacing indicated on Drawings without disturbing underlying materials.
S. Center and align posts. Place concrete around posts, and vibrate or tamp for consolidation. Verify vertical and top alignment of posts and make necessary corrections.
T. Extend concrete footings 2 inches above grade, and trowel, forming crown to shed water.
U. Allow footings to cure minimum 7 days before installing fabric and other materials attached to posts.

3.2 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Maximum Variation From Plumb: 1/4 inch.
C. Maximum Offset From Indicated Position: 1 inch.
D. Minimum distance from property line: 6 inches.

END OF SECTION

SECTION 33 05 05.31
HYDROSTATIC TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Hydrostatic testing of pressure piping.
B. Related Requirements:

1. Section 33 31 23 - Sanitary Sewerage Force Main Piping.

1.2 REFERENCE STANDARDS

A. American Water Works Association:

1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gage calibration.

C. Test and Evaluation Reports: Indicate results of piping tests.
D. Qualifications Statement:

1. Submit qualifications of field personnel responsible for supervising hydrostatic testing.

1.4 QUALITY ASSURANCE

A. Perform Work according to Florida Department of Environmental Protection (FDEP) standards.

1.5 QUALIFICATIONS

A. Applicator: Company specializing in performing Work of this Section with minimum five (5) years of documented experience.

PART 2 - PRODUCTS

2.1 HYDROSTATIC TESTING

A. Equipment:

1. Pressure pump.
2. Pressure hose.
3. Water meter.
4. Test connections.
5. Pressure relief valve.
6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that piping is ready for testing.
C. Verify that trenches are backfilled.
D. Verify that pressure piping thrust restraints have been installed.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Testing of Pressure Piping:

1. Test system according to AWWA C600 and following:

a. Test Pressure: Not less than 150 psig or 50 psi in excess of maximum static pressure, whichever is greater.
b. Conduct hydrostatic test for a minimum of two (2) hours.
c. Slowly fill section to be tested with water of approved quality; expel air from piping at high points. If hydrants, blowoffs, or other outlets are not available at high points for releasing air, the Contractor shall make the necessary taps at such points, and shall plug said holes after completion of the test.
d. Install corporation cocks at high points.
e. Close air vents and corporation cocks after air is expelled.
f. Raise pressure to specified test pressure.
g. Observe joints, fittings, and valves under test.

h. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage, and retest.

i. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.

j. Maintain pressure within plus or minus 5 psi of test pressure.

k. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.

l. Compute maximum allowable leakage using following formula:

    1) L = SD x sqrt(P)/C.
    2) L = testing allowance, gph.
    3) S = length of pipe tested, feet.
    4) D = nominal diameter of pipe, inches.
    5) P = average test pressure during hydrostatic test, psig.
    6) C = 133,200.

m. If pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

n. Leakage:

    1) If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
    2) Correct visible leaks regardless of quantity of leakage.

2. HDPE Pipe Testing:

   a. In addition to the leakage requirements above, HDPE pipe shall not exceed the following allowable expansion rates:

HDPE Pipe Diameter	Allowable Expansion
2”	0.10 gallons/100 feet of pipe
3”	0.15 gallons/100 feet of pipe
4”	0.25 gallons/100 feet of pipe
6”	0.55 gallons/100 feet of pipe
8”	0.95 gallons/100 feet of pipe
10”	1.25 gallons/100 feet of pipe
12”	2.25 gallons/100 feet of pipe
14”	2.75 gallons/100 feet of pipe
16”	3.25 gallons/100 feet of pipe
18”	4.25 gallons/100 feet of pipe
20”	5.45 gallons/100 feet of pipe
24”	8.75 gallons/100 feet of pipe

3. If testing of piping indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.
4. Correct visible leaks regardless of quantity of leakage.
5. If, in the judgement of the Engineer, it is impractical to follow the foregoing procedures exactly for any reason, modifications to the procedure shall be made as required and approved by the Engineer. This shall not relieve the Contractor of the responsibility to meet the leakage and expansion requirements specified herein.

END OF SECTION

SECTION 33 05 05.33
INFILTRATION AND EXFILTRATION TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing of Manholes: Exfiltration testing.

B. Related Requirements:

1. Section 33 05 61 - Concrete Manholes.
2. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gauge calibration.

C. Test and Evaluation Reports: Indicate results of manhole and piping tests.
D. Qualifications Statement:

1. Submit qualifications for applicator.

1.3 QUALITY ASSURANCE

A. Perform Work according to Florida Department of Environmental Protection standards.

1.4 QUALIFICATIONS

A. Company specializing in performing Work of this Section with minimum five (5) years of documented experience.

PART 2 - PRODUCTS

2.1 EXFILTRATION TESTING

A. Equipment:

1. Plugs.
2. Pump.
3. Measuring device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that manholes and piping are ready for testing.
C. Verify that trenches are backfilled.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for preparation.
B. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Manhole Testing:

1. Repair both outside and inside of joint to ensure permanent seal.
2. Test manholes with manhole frame set in place.
3. Plug pipes in manhole.
4. Remove water from manhole.
5. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.
6. Determine ground water level outside manhole.
7. Fill manhole with water within 4 inches of top of cover frame.
8. Prior to testing, allow manhole to soak from minimum of four (4) hours to maximum of 72 hours.
9. After soak period, adjust water level inside manhole to within 4 inches of top of cover frame.
10. Measure water level from top of manhole frame.
11. At end of 4-hour testing period, again measure water level from top of manhole frame; compute

drop in water level during testing period.

12. Manhole exfiltration test is considered satisfactory when drop in water level is less than 0.1 percent (0.1%) of the water surface elevation within the manhole.
13. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.
14. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 05.36
VACUUM TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Vacuum testing of manholes.
B. Related Requirements:

1. Section 33 05 61 - Concrete Manholes.
2. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Submit following items prior to start of testing:

1. Testing procedures.
2. List of test equipment.
3. Testing sequence schedule.
4. Provisions for disposal of flushing and test water.
5. Certification of test gauge calibration.

C. Test and Evaluation Reports: Indicate results of manhole tests.
D. Qualifications Statement:

1. Submit qualifications for applicator.

1.4 QUALIFICATIONS

A. Company specializing in performing Work of this Section with minimum five (5) years of documented experience.

PART 2 - PRODUCTS

2.1 VACUUM TESTING

A. Equipment:

1. Vacuum pump.
2. Vacuum line.

3. Vacuum Tester Base:
    a. Compression band seal.
    b. Outlet port.
4. Shutoff valve.
5. Stopwatch.
6. Plugs.
7. Vacuum Gauge: Calibrated to 0.1 in. Hg.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that manholes are ready for testing.
C. Verify that manholes are backfilled.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Manhole Testing:
    1. Repair both outside and inside of joint to ensure permanent seal.
    2. Test manholes with manhole frame set in place.
    3. Vacuum Testing:
        a. Comply with ASTM C1244.
        b. Plug pipe openings; securely brace plugs and pipe.
        c. Inflate compression band to create seal between vacuum base and structure.
        d. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10 in. Hg.
        e. Close valve.
        f. Manhole Test Duration in Seconds:
            1) Manhole Diameter of 4 Feet: 60.
            2) Manhole Diameter of 5 Feet: 75.
            3) Manhole Diameter of 6 Feet: 90.
        g. Record vacuum drop during test period.
        h. If vacuum drop is greater than 1 in. Hg during testing period, repair and retest manhole.
        i. If vacuum drop of 1 in. Hg does not occur during test period, manhole is acceptable; discontinue testing.

j. If vacuum test fails to meet 1-in. Hg drop in specified time after repair, repair and retest manhole.

4. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.
5. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 61
CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular precast concrete manholes and structures with tongue-and-groove joints and transition to cover frame, covers, anchorage, and accessories.
2. Doghouse manhole connections to existing sanitary sewer lines.
3. Bedding and cover materials.
4. Modification of existing manholes and structures.

B. Related Requirements:

1. Section 33 05 05.33 - Infiltration and Exfiltration Testing.
2. Section 33 05 05.36 – Vacuum Testing.
3. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.

1.2 REFERENCE STANDARDS

A. American Association of State Highway Transportation Officials:

1. AASHTO M91 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
2. AASHTO M306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute:

1. ACI 530/530.1 - Building Code Requirements and Specification for Masonry Structures.

C. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
3. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
4. ASTM C877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
6. ASTM C923 - Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

7. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
8. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
9. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with connection to existing sewer facilities.

1.4 SUBMITTALS

A. Only request submittals needed to verify compliance with Project requirements.
B. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
C. Product Data: Submit manufacturer information for manhole covers, component construction, features, configuration, and dimensions.
D. Shop Drawings:

1. Indicate structure locations and elevations.
2. Indicate sizes and elevations of piping, penetrations, and manhole inverts.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Include separate Paragraphs for additional certifications.
G. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
J. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record actual locations of manholes and connections, and record invert elevations.

1.6 QUALITY ASSURANCE

A. Perform Work as shown and specified and according to applicable Florida Department of Environmental Protection and Florida Department of Transportation standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years of documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Handling: Comply with precast concrete manufacturer instructions and ASTM C913 for unloading and moving precast manholes and drainage structures.
D. Storage:

1. Store materials according to manufacturer instructions.
2. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
3. Repair property damaged from materials storage.

E. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

A. Section 01 50 00 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
B. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry Work.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
B. Furnish five (5) year manufacturer's warranty for concrete manholes.

PART 2 - PRODUCTS

2.1 CONCRETE MANHOLES

A. Manhole Sections:

1. General: Manholes shall be fabricated only from eccentric tapered sections or eccentric flat top sections and standard cylinder units with the proper internal diameter.
2. Materials:

a. Reinforced Precast Concrete: Comply with ASTM C478, with the exclusion of Section 10 (a) and as modified herein.
b. Cement shall meet the requirements of ASTM C150 for Portland Cement Type II.
c. Concrete shall meet the minimum requirements for Class III.

d. Minimum wall thickness shall be as shown on the Drawings.

e. The required minimum strength of concrete and conformance to the design parameters shall be confirmed by testing in accordance with ASTM C14. Contractor shall be responsible for all testing.

f. Use a minimum allowable steel hoop of No. 4 wire to be cast into each unit at adequate places as a precautionary measure for handling.

3. Gaskets: Comply with ASTM C923.

4. Joints:

a. Joint contact surfaces shall be formed exactly parallel with a 2-degree slope and nominal 1/16-inch clearance with the tongue equipped with a proper recess for the installation of an o-ring rubber gasket or pre-molded plastic joint sealer.

b. Pre-molded plastic joint sealer, if used, shall be Ramnek or approved equal and joints shall be pre-primed and wrapped on the exterior to provide a sealed manhole.

c. Comply with ASTM C913.

d. Maximum Leakage: 0.025 gal. per hour per foot of joint at 3 feet of head.

e. Manufacturers:

1) Del Zotto,

2) Taylor Precast,

3) or approved equal.

B. Coatings and Liners:

1. Coatings shall cover the interior and exterior surfaces of the manhole except the joint contact surfaces and the annular openings for pipe connections.

a. Exterior coating shall be bituminous coating as specified in Section 09 90 00 – Painting and Coating.

2. For mildly corrosive environments, interior coating shall be coal tar epoxy as specified in Section 09 90 00 – Painting and Coating.

3. For highly corrosive environments, manholes shall include a polyurea or high density polyethylene liner as shown on the Drawings or specified.

a. HDPE Liner:

1) HDPE liner shall be embedded into pre-cast concrete with anchoring ribs during manufacturing process. Anchoring ribs shall be placed a minimum of 30 per square foot of liner in one piece with the HDPE sheet and shall be of the same material.

2) Liner shall be 80 mils. thick minimum, with a minimum resistance to pull out of 125 pounds per square foot, and withstand a back pressure of 30 psi.

3) The HDPE material shall have a maximum working temperature of 140° F, fire classification of V2 as defined by UL-94, density of 0.945 g/cc as defined in ASTM D792-86, and puncture resistance of 170 lbs. as defined by ASTM D4833.

4) The liner shall be flexible to elongate to bridge up to a 1/4-inch setting or expansion.

b. Polyurea Liner:

1) Liner shall be a two component, 100% solids, zero (0) volatile organic compound, pure polyurea.

2) Liner system shall be designed for highly corrosive wastewater environments.

3) Liner system shall consist of the following:

a) Primer/Moisture Barrier: Minimum 30 to 100 mils dry film thickness (DFT)

b) Top Coat: Minimum 125 mils DFT.

4) Primer/Moisture Barrier shall be designed specifically for the lining system.

5) Surfaces shall be prepared in accordance with the manufacturer's requirements.

6) Lining shall be applied in accordance with the manufacturer's requirements.

7) Manufacturers:

a) GML Coatings, Inc., Green Monster Liner,

b) or approved equal.

4. For existing manholes undergoing modification, the Monoform™ lining process by Hydro-Klean Solutions Group, or approved process of similar effect, shall be utilized to modify the existing manholes to meet the requirements outlined within the contract drawings.

a. Requirements and installation process for liner shall be as outlined by the manufacturer.

C. Mortar and Grout shall be Embeco 167 and 381 or approved equal.

1. The Contractor shall apply Master Builders' Master Seal or approved equal membrane curing compound, conforming to ASTM C309, Type I, Class B, to interior and exterior finished grout.

D. Clear Inside Dimensions shall be as indicated on Drawings.

1. In no case shall the inside diameter be less than 48-inches.

E. Design Depth shall be as indicated on Drawings.

F. Clear Cover Opening:

1. As indicated on Drawings.

G. Pipe Entry:

1. Furnish openings as indicated on Drawings.
2. Pipes shall be connected to manholes with heavy duty flexible rubber connector boots conforming to ASTM C923 with stainless steel bands and hardware.

2.2 FRAMES AND COVERS

A. Standard Manhole Ring and Cover:

1. Manhole frames and covers shall be constructed of close-grained gray iron, smooth, clean, free from blisters and defects.
2. Material: Cast iron.
3. Comply with the following:
    a. ASTM A48/A48M, Class 30B.
    b. Federal Specification RR-F-621-C.
4. Manhole frames and covers shall meet or exceed requirements for AASHTO H-20 load rating and AASHTO M306.
5. Surface: Machined flat bearing.
6. Cover Design: Closed.
7. All components shall be black epoxy coated.
8. Cover shall be molded and marked as shown on the Drawings.
9. Manufacturers:
    a. U.S. foundry, USF 170CE (22-inch), USF 655CW-M (32-inch)
    b. Vulcan Foundry V-1337-2 (22-inch),
    c. or approved equal.

B. Hinged Manhole Ring and Cover:

1. Hinged manhole ring and cover shall be constructed of sound ductile iron, smooth, clean, free from blisters and defects.
2. Frames shall be circular and incorporate a seating gasket.
3. Cover hinge system shall include a 90-degree blocking system.
4. Hinge box shall be self-cleaning with dual wiper infiltration plug.
5. Covers shall include locks.
6. Comply with the following:

a. ASTM A48/A48M, Class 30B.

b. Federal Specification RR-F-621-C.

c. ISO 1083.

7. Manhole frames and covers shall meet or exceed requirements for AASHTO H-20 load rating and AASHTO M306.
8. Cover Design: Closed.
9. All components shall be black epoxy coated.
10. Cover shall be molded and marked as shown on the Drawings.
11. Manufacturers:

a. U.S. foundry, USF 750 (24-inch), USF 751 (32-inch)

b. East Jordan Iron Works, ERGO,

c. Pamrex,

d. or approved equal.

2.3 RISER RINGS:

A. Precast adjusting rings shall have 22-inch or 32-inch access entrance diameter.
B. Ring shall be constructed of 4,000 psi concrete, using 1/4-inch round steel ring, 1/4-inch diameter for reinforcing.
C. Thickness of 2 Inches, 4-inches, or 6 Inches
D. Comply with ASTM C478.
E. Manufacturers:

1. Del Zotto,
2. Taylor Precast,
3. or approved equal.
4. Accessories:

a. Joint Sealant: Comply with ASTM C990.

b. Bolts: Stainless steel; ASTM F593.

2.4 MATERIALS

A. Cover, Bedding, and Backfill:

1. Bedding, cover, and soil backfill materials shall be in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

2.5 ACCESSORIES

A. Foundation Slab:

1. Cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Top Surface: Level.

B. Joint Sealant: Comply with ASTM C990.
C. Fasteners: Stainless steel; ASTM F593.
D. Concrete: As specified in Section 03 30 00 - Cast-in-Place Concrete.

2.6 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of completed assembly.
C. Owner Inspection:

1. Make completed manholes available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that items provided by other Sections of Work are properly sized and located.
C. Verify that built-in items are in proper location and are ready for roughing into Work.
D. Verify that excavation base is ready to receive Work and excavations and that dimensions and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.
C. Coordinate placement of inlet and outlet pipe or duct sleeves as required by other Sections.
D. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.
E. Inspect precast concrete manholes and structures immediately prior to placement in excavation to

verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Manholes are considered confined spaces and the Contractor shall follow the requirements of the owner and all associated regulations for confined space entry.

1. Confined space is defined as large enough for a person to work with restricted means of entry and exit.
2. The Contractor is responsible for the safety of his/her personnel. The Contractor shall use a gas detector to measure the gases present. If no gases are present the structure may be entered. When gases are detected, fresh air shall be forced into the area until acceptable levels of air quality are obtained.
3. A tripod/hoist unit shall be set up and manned.

B. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.
C. Correct over-excavation in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
D. Remove large stones or other hard matter impeding consistent backfilling or compaction.
E. Protect manhole from damage or displacement while backfilling operation is in progress.
F. Excavating:

1. Excavation and backfill shall be performed in accordance with the Florida Department of Transportation Standard Specifications for Road and Bridge Construction to the locations and depths shown.
2. Excavate undesirable material to a minimum depth of 12-inches below the proposed grade and backfill as specified.
3. Place gravel under manholes located in wet soil conditions.
4. Provide clearance around sidewalls of manhole or structure for construction operations.
5. If ground water is encountered, prevent accumulation of water in excavations; place manhole or structure in dry trench.
6. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation as approved by Engineer.

G. Base and Alignment:

1. Place foundation slab and trowel top surface level.
2. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour as indicated on Drawings.
3. Place manhole sections plumb and level, trim to correct elevations, and anchor to foundation slab.

H. Attachments:

1. Set cover frames and covers level to correct elevations without tipping.

I. Backfilling:

1. As specified in the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches and compacted to the following requirements:

    a. Backfill under roadways: 98% Standard Proctor Density.
    b. Backfill not under roadways: 95% Standard Proctor Density.

J. Coating: All coating shall be factory applied.

K. Precast Concrete Manholes:

1. Precast manholes shall be installed in accordance with the manufacturer's recommendations.
2. Lift precast components at lifting points designated by manufacturer.
3. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
4. Assembly:

    a. Assemble multi-section manholes and structures by lowering each section into excavation.
    b. Install gasket joints between precast sections according to manufacturer recommendations.
    c. Lower, set level, and firmly position base section before placing additional sections.

5. Remove foreign materials from joint surfaces and verify that sealing materials are placed properly.
6. Maintain alignment between sections by using guide devices affixed to lower section.
7. Joint sealing materials may be installed on Site or at manufacturer's plant.
8. Verify that installed manholes meet required alignment and grade.
9. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
10. Cut pipe flush with interior of structure.

L. Doghouse Manholes and Structures:

1. Stake out location and burial depth of existing sewer line in area of proposed manhole or structure.
2. Carefully excavate around existing sewer line to adequate depth for foundation slab installation.

3. Protect existing pipe from damage.
4. Cut out soft spots and replace with granular fill compacted to 95 percent maximum density.
5. Bear firmly and fully on compacted crushed stone bedding.
6. Precast slabs must have keyways to connect walls to slab.
7. Formed-in-place slabs shall be a minimum of 12-inches thick.
    a. Concrete reinforcement shall be sized by the manufacturer.
8. Grout pipe entrances per grout manufacturer's installation procedures.
9. Coordinate with the Engineer to determine time of day for connections to existing facilities.
10. Block upstream flow at existing manhole or structure with expandable plug.
11. Use hydraulic saw to cut existing pipe at manhole or structure entrance and exit and along pipe length at a point halfway up OD on each side of pipe.
12. Bottom half of pipe is to remain as manhole flow channel.
13. Saw cut to smooth finish with top half of pipe flush with interior of manhole or structure.
14. Grout base of manhole or structure to achieve slope to manhole or structure channel and trowel smooth.

M. All grouting shall be performed in accordance with the grout manufacturer's recommended procedures so that there is zero leakage through openings or around pipes.
    1. The grout and/or mortar shall be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces.
    2. Grout mixed on-site shall be used with potable water and masonry sand from concrete supplier. Dirty pond water and existing excavated sand shall not be used.

N. Manhole Inverts:
    1. Manhole bases shall be formed of Class I concrete while the manholes are under construction.
        a. The Contractor shall not use fill, stone, brick, or other materials below concrete invert. The entire invert shall be constructed of concrete.
    2. Cut off pipes at inside face of the manhole and construct the invert to the shape and size of the pipe indicated.
    3. All inverts shall follow the grades of the pipe entering the manholes.
    4. Changes in direction of the sewer and entering branch or branches shall be laid out in smooth curves of the longest possible radius which is targeted to the centerlines of adjoining pipelines.
    5. Regardless of differences in entrance and exit elevations, flow channels for all pipes are to be formed to present a smooth transition of flow and shall be subject to the approval of the

Engineer.

6. Flow channels shall be constructed in accordance with the Drawings.

O. Entire interior of manhole shall be coated with coal tar epoxy or liner as specified, including adjustment rings.
P. Connect pipes to new manholes using pipe boots and clamps.
Q. Connect pipes to lined manholes after liners have been completed and sealed.
R. Sanitary Manhole Drop Connections:

1. Bottom 90-degree bend shall be cast in place using concrete.
2. Pipes shall be held firmly in place while concrete is being formed.
3. Drop connections shall be constructed in accordance with the Drawings.

S. Castings:

1. Set frames using mortar and masonry to the elevations indicated on Drawings. If specified tolerances cannot be met, manhole shall be modified.
2. Install radially laid concrete brick with 1/4-inch-thick, vertical joints at inside perimeter.
3. If more than one course of concrete brick is required, stagger vertical joints.
4. The Contractor shall prepare the base for the manhole frame to a condition satisfactory to the Engineer. All loose, broken or cracked brick shall be removed along with excess grout to provide a smooth, solid, level surface to receive the new buildup of the manhole top.
5. Frame shall be set concentric with the masonry and in a full bed of grout or mortar so that the space between the top of the manhole masonry and the bottom flange of the frame shall be completely filled and made watertight.
    a. The frame shall be completely embedded and sealed to the manhole with grout or mortar.
    b. Grout or mortar shall be applied so as to leave no air pockets or voids and shall cover the area from the top of the frame to the outside edge of the manhole.
6. Manhole frames and covers shall be set to conform accurately to the finished ground or pavement surface as established by the Contract Drawings, unless otherwise directed by the Engineer.
7. Only clean brick shall be used in brick adjustment. If required, the bricks shall be moistened prior to application of the grout or mortar.
    a. Each brick shall be laid in a full bed and joint of grout or mortar without requiring subsequent grouting, flushing, or filling, and shall be thoroughly bonded as directed.
    b. Grout shall be one-part cement and two parts sand. Lime shall not be used.
    c. Grout shall be coated with epoxy.

8. Outside faces of brick masonry or concrete adjusting rings shall be covered with grout or mortar from 3/8-inch to 1/2-inch thick. If required, brick concrete shall be properly moistened prior to application of the grout or mortar. The mortar or grout shall be carefully spread and troweled so that all cracks are thoroughly worked out. After hardening, the grout or mortar shall be thoroughly checked for bond and soundness by being tapped. Unbonded or unsound grout or mortar shall be removed and replaced.

T. Unless otherwise directed by the Engineer, the Contractor may elect to remove the manhole top completely to facilitate construction or leave in place until the base course is constructed.

1. The manhole shall be protected from damage if it is to be left in place until final adjustment.
2. If the Contractor elects to remove the manhole top, he shall place sufficient covering over the manhole, to the satisfaction of the Engineer, to eliminate infiltration of dirt, limerock, stone, brick, debris, etc., until the top is adjusted to grade.
3. In either of the cases above, the Contractor will be responsible for any undesirable material entering the manhole or sewer system as a result of the Work.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Testing:

1. Cast-in-Place Concrete: As specified in Section 03 30 00 - Cast-in-Place Concrete.
2. Concrete Manhole Sections: As specified in Section 33 05 05.33 - Infiltration or Exfiltration Testing.

C. At least one compaction density test shall be made on the prepared base for each manhole. It is expressly agreed and understood that the Owner reserves the right to perform additional compaction tests on its own or to increase or decrease the frequency of compaction testing.

2. Compaction tests shall be in accordance with the specifications. Should the test fail, the Contractor shall be required to take the appropriate action to satisfy the compaction requirement and at no time shall the manhole base be set in place without an approved compaction test or until satisfactory test is acquired.

D. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and retest.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
B. Vertical Adjustment of Existing Manholes and Structures:

1. Manhole frame and covers shall be adjusted with brick masonry or precast concrete adjusting rings.
2. Frames shall be adjusted to conform accurately to the grades shown on the Drawings and

specified herein.

3. The manhole shall be modified if tolerances cannot be met.
4. Frames, Grates, and Covers:
    a. Remove frames, grates, and covers and clean of mortar fragments.
    b. Reset to required elevation according to requirements specified for installation of castings.
5. Reinforcing Bars:
    a. Remove concrete without damaging existing vertical reinforcing bars if removal of existing concrete wall is required.
    b. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.
6. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 033000 - Cast-in-Place Concrete.

END OF SECTION

S SECTION 33 05 97
IDENTIFICATION AND SIGNAGE FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic ribbon tape for placement above direct-buried utility.
2. Trace wire for placement above direct-buried utility.

B. Related Requirements:

1. Section 33 31 11 - Public Sanitary Sewerage Gravity Piping.
2. Section 33 31 23 - Sanitary Sewerage Force Main Piping.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer catalog information for each specified product.
C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
D. Qualifications Statement:

1. Submit qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

1.5 QUALITY ASSURANCE

A. Perform Work according to AWWA standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years of experience.

PART 2 - PRODUCTS

2.1 MARKING TAPE, DETECTABLE UNDERGROUND

A. Description:

1. Underground Detectable Marking Tape shall be aluminum foil to mark the location of water mains, sewage force mains, reuse mains, and gravity sewers.
2. Tape shall have a minimum 5 mil overall thickness with 0.35 mil solid aluminum foil core.

3. Construction shall be 0.8 mil clear fiber, reverse print laminated to aluminum foil to 3.75 mil clear fiber, making a film permanently printed.
4. Tape shall meet the thickness requirements of ASTM D2103, 5.0 mil, and tensile strength meeting requirements of ASTM D882, 15,000 psi.
5. Color shall be blue for water, green for sewage force mains and gravity sewer, and purple for reuse mains, with “Potable Water”, “Sewer Force Main”, “Sewer”, or “Reclaimed Water” written on the tape accordingly.

2.2 TRACE WIRE

A. Locating Wire for Bored Mains:

1. Conductor: Magnetically detectable tracer wire shall be a #12 AWG (0.0808” diameter) fully annealed, high carbon 1055 grade steel, high strength solid copper clad steel conductor (HS-CCS).
2. Covering: Tracer wire shall be insulated with a 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts.
3. Color:
    a. Color shall be blue for water, green for sewage force mains, and purple for reuse mains.
4. Manufacturers:
    a. Copperhead Industries, SoloShot, Pro Trace HF-CCS PE45,
    b. or approved equal.

B. Locating Wire for Open Cut Mains:

1. Conductor: Magnetically detectable tracer wire shall be a #14 AWG (0.0641” diameter) fully annealed, low carbon 1010 grade steel, solid copper-clad steel (CCS) conductor.
2. Covering: Tracer wire shall be insulated with a 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts.
3. Color:
    a. Color shall be blue for water, green for sewage force mains and gravity sewer, and purple for reuse mains.
4. Manufacturers:
    a. Copperhead Industries, SoloShot, Pro Trace HF-CCS 30,
    b. or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install Marking Tape 12 inches to 18 inches above the top of the pipe.
B. Trace Wire shall be installed on the top and bottom of all nonmetallic pipe.

END OF SECTION

SECTION 33 31 11

PUBLIC SANITARY SEWERAGE GRAVITY PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section includes the minimum requirements for installing sanitary sewer gravity systems, which includes the furnishing, installing, laying, jointing, and testing of all sewer lines, manholes, fittings and appurtenances, including necessary service connections required for a complete system to connect to City sewer and as shown on the Drawings and specified herein. The Work shall also include such connections, reconnections, relocations, temporary services, abandonments, and all other provisions in regard to existing sewer operations and modifications as required.

B. Section Includes:

1. Sanitary sewerage piping.
2. Connection to existing manholes.
3. Wye branches and tees.
4. Sanitary laterals.
5. Bedding and cover materials.

C. Related Requirements:

1. Section 31 05 13 - Soils for Earthwork.
2. Section 31 05 16 - Aggregates for Earthwork.
3. Section 31 23 16 - Excavation.
4. Section 31 23 23 - Fill.
5. Section 33 05 05.33 - Infiltration and Exfiltration Testing.
6. Section 33 05 61 - Concrete Manholes.
7. Section 33 05 97 - Identification and Signage for Utilities.

1.2 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.
B. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.
C. EPDM: Ethylene-propylene-diene monomer.

1.3 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Water Works Association:

1. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
6. AWWA C153 - Ductile-Iron Compact Fittings.

C. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
2. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) coatings on Iron and Steel products.
3. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
4. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).
5. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
6. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
7. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
8. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric).
9. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
10. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
11. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
12. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
13. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl

Chloride) (PVC) Pipe and Fittings.

15. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
16. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.4 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with the Owner and all authorities having jurisdiction.
C. Contractor shall contact Sunshine 811 for location of existing utilities at 811 or 1-800-432-4770 a minimum of 48 hours prior beginning work.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.
C. Permits: Submit three (3) copies of all permits required for completion of the Work shown and specified.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.
F. The pipe or fitting manufacturer shall supply a "Certificate of Application" that the lining applicator has met the specified requirements.
G. Manufacturer Instructions:

    1. Indicate special procedures required to install specified products.
    2. Submit detailed description of procedures for connecting new sewer to existing sewer line and directional drilling installation.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
J. Qualifications Statement:

    1. Submit qualifications for manufacturer(s) and installer(s).

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, cleanouts, existing utilities adjacent to new utilities, and all other pertinent features associated with the Work.
C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Perform Work according to applicable Federal, State, and Local standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years of documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum five (5) years of documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

1. Pipe with cracked or chipped linings or defects in the pipe will be rejected.

C. Storage:

1. Store materials according to manufacturer instructions.
2. Store valves in shipping containers with labeling in place.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPING

A. Polyvinyl Chloride (PVC) Pipe:

1. Gravity sewer PVC pipe shall conform to ASTM 3034, SDR-26.
2. Color: Green.
3. Pipe manufacturer shall supply a Certificate of Application that the pipe has met requirements of ASTM 3034, SDR-26.
4. PVC fittings shall conform to ASTM 1336, SDR-26.

a. Fittings shall be gasketed bell joint type and green in color.

B. Ductile Iron Pipe:

1. Comply with AWWA C150 and AWWA C151.
2. Pipe shall be rated for a minimum working pressure of 200 psi plus a 100 psi minimum surge allowance, and a two to one (2:1) factor of safety, using a Type II laying condition and a depth of cover of 4 feet.
    a. Pipe diameters 4-inch through 12-inch shall be Class 350, minimum.
    b. Pipe diameters 14-inch through 20-inch shall be Class 250, minimum.
    c. Pipe diameters 24-inches and larger shall be Class 200, minimum.
3. End Connections: Bell and spigot.
4. Ductile iron pipe shall be manufactured in the U.S.A. and each piece shall be subjected to a hydrostatic pressure test of at least 500 psi at the point of manufacture.
5. The class or nominal thickness, new weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, country where cast, year in which the pipe was produced, and the letters "DI" or "Ductile" shall be cast or stamped on each length of pipe.
6. Pipe shall have an exterior bituminous coating applied by airless spray method.
7. Pipe shall have an interior Amine Cured Epoxy Lining.
8. PE Encasement: Comply with AWWA C105 for installation of PE Encasement when pipe is installed in corrosive soils.
9. Fittings:
    a. Material: Ductile iron with a pressure rating that meets, but does not exceed the specified pressure rating of connected pipe.
    b. Comply with AWWA C153 or AWWA C110.
    c. Lining: Factory applied amine cured epoxy.
    d. Coating: Exterior of fittings shall be epoxy coated as specified in Section 09 90 00 - Painting and Coating.
10. Joints:
    a. Push-On Joints:
        1) Comply with AWWA/ANSI C111/A21.11.
        2) Furnish complete with all accessories required.
    b. Restrained Joint:
        1) Restrained joints shall be restrained using grip gaskets of locking rings.

2) All restraints shall comply with applicable AWWA standards.

3) Manufacturers:

a) American, Fast-Grip Restrained Gaskets, Lok-Ring Restrained Rings,

b) McWane, Sure Stop Restrained Gaskets, Super Lok Restrained Rings,

c) Griffin, Talon Restrained Gaskets, Snap-Lok Restrained Rings,

d) U.S. Pipe, Field-Lok Restrained Gaskets, TR Flex Gripper Restrained Rings,

e) EBAA Iron, Mega-Lug Restraint Harness, Series 1700,

f) Sigma, Bell Joint Restraint Series PVP (16-inch and smaller), Series SLDH (18-inch and larger),

g) Tyler Union, Tuff Grip MJ Fitting Restraints,

h) or approved equal.

2.2 MANHOLES

A. As specified in Section 33 05 61 - Concrete Manholes.

2.3 FLEXIBLE COUPLINGS

A. Flexible Couplings for connection of Clay Pipe to Ductile Iron Pipe:

1. Couplings shall be constructed of heavy-duty rubber and conform to applicable AWWA standards.
2. Manufacturers:

a. Fernco, 1003,

b. Indiana Seal, 103,

c. Dallas Specialty, DS 03,

d. or approved equal.

B. Flexible Couplings for connection of Clay Pipe to PVC Pipe:

1. Couplings shall be constructed of heavy-duty rubber and conform to applicable AWWA standards.
2. Manufacturers:

a. Fernco, 1002,

b. Indiana Seal, 102,

c. Dallas Specialty, DS 02,

d. or approved equal.

2.4 FLEXIBLE PIPE BOOTS FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Heavy-duty rubber.
2. Comply with ASTM C923.
3. Attachment: Series-300 stainless-steel clamp and hardware.

2.5 MATERIALS

A. Bedding and Cover:

1. Excavation, trenching, and backfilling shall be in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches, tamp in place, and compact to 95 percent of maximum density.
3. Immediately after the pipe has been jointed and inspected, sufficient backfill shall be performed to protect the pipe adequately from injury and movement.
4. Maintain optimum moisture content of bedding material to attain required compaction density.
5. Where so indicated on the drawings or where directed by the Engineer, the pipe shall be supported by compacted granular fill or concrete cradle or encasement according to the applicable detail shown on the Drawings.

    a. Pipe bedded in compacted granular backfill shall not be supported on blocking, wedges, bricks, or anything except the bedding material.
    b. Where concrete cradle or encasement is required, the pipe shall be supported on solid concrete blocks or pre-cast concrete saddles which shall become part of the completed cradle or encasement.
    c. Where no other bedding is indicated, pipe shall be placed on a shaped bed of undisturbed material.

2.6 MIXES

A. Grout: Grout shall be Embeco 167 or approved equal.

B. Mortar: Mortar shall be Embeco 381 or approved equal.

2.7 FINISHES

A. Galvanizing:

1. Hot-dip galvanize after fabrication.
2. Comply with ASTM A123/A123M.

2.8 ACCESSORIES

A. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.

2.9 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of pipe.
C. Include one or both of following Paragraphs to require Owner's inspection or witnessing of test at factory.
D. Owner Inspection:

1. Make completed pipe sections available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

E. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

F. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that trench cut or excavation base is ready to receive Work of this Section.
C. Verify that excavations, dimensions, and elevations are as indicated on Drawings or as directed by the Engineer.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Correct over-excavation with coarse aggregate.
C. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.
D. Protect and support existing sewer lines, utilities, and appurtenances.
E. Utilities:

1. Maintain profiles of utilities.
2. Coordinate with existing utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding and Backfill:

1. Excavation, trenching, and backfilling shall be in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches and compacted to the following requirements:
    a. Backfill under roadways: 98% Standard Proctor Density.
    b. Backfill not under roadways: 95% Standard Proctor Density.
3. Immediately after the pipe has been jointed and inspected, sufficient backfill shall be performed to protect the pipe adequately from injury and movement.
4. Maintain optimum moisture content of bedding material to attain required compaction density.
5. Where so indicated on the drawings or where directed by the Engineer, the pipe shall be supported by compacted granular fill or concrete cradle or encasement according to the applicable detail shown on the Drawings.
    a. Pipe bedded in compacted granular backfill shall not be supported on blocking, wedges, bricks, or anything except the bedding material.
    b. Where concrete cradle or encasement is required, the pipe shall be supported on solid concrete blocks or pre-cast concrete saddles which shall become part of the completed cradle or encasement.
    c. Where no other bedding is indicated, pipe shall be placed on a shaped bed of undisturbed material.

B. Piping:
1. Install pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
2. Lay pipe to slope gradients as indicated on Drawings.
3. Begin at downstream end of system and progress upstream.
4. Bedding: As indicated on Drawings.
5. Lay bell-and-spigot pipe with bells upstream.
6. PE Pipe Encasement: Comply with AWWA C105, Method A.
7. Backfill and compact as specified in Section 02 32 00 - Trenching, bedding, and backfill and 31 23 23 – Fill.
8. Do not displace or damage pipe when compacting.
9. Connect pipe to existing facilities as shown on the Drawings.
10. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.

C. Manholes: As specified in Section 33 05 61 - Concrete Manholes.
D. Connections to Existing Manholes:

1. Drilling:
    a. Core drill existing manhole to clean opening.
    b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.
2. Install watertight neoprene gasket and seal with non-shrink concrete grout.
3. Encasement:
    a. Concrete encase new sewer pipe as shown on the Drawings.
    b. Use epoxy binder between new and existing concrete.
4. Prevent construction debris from entering existing sewer line when making connection.

E. Wye Branches and Tees:

1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.
2. Use standard fittings of same material and joint type as sewer main.
3. Maintain minimum 5-foot separation distance between wye connection and manhole.
4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.
5. Mount saddles with solvent cement or gasket and secure with metal bands.
6. Lay out holes with template, and cut holes with mechanical cutter.

F. Bypassing Sewage:

1. The Contractor, when required, shall provide for the flow of sewage around a section or sections of pipe as required to complete the Work.
2. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow.
3. The Contractor shall submit a detailed bypass plan to the Engineer prior to performing any bypassing activities.

G. Sanitary Laterals:

1. Construct laterals from wye branch to terminal point at right-of-way.
2. Where depth of main pipeline warrants, construct riser-type laterals from wye branch.
3. Minimum Depth of Cover over Piping: 4 feet.
4. Minimum Separation Distance between Laterals: 5 feet.
5. Install watertight plug, braced to withstand pipeline test pressure thrust, at termination of lateral.

6. Install temporary marker stake as shown on the Drawings.

H. Backfilling:

1. Excavation, trenching, and backfilling shall be in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches and compacted to the following requirements:
    a. Backfill under roadways: 98% Standard Proctor Density.
    b. Backfill not under roadways: 95% Standard Proctor Density.
3. Place and compact material immediately adjacent to pipes to avoid damage to pipe and prevent pipe misalignment.
4. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.
B. Maximum Variation from Indicated Slope: 1/8 inch in 10 feet.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Request inspection by Engineer prior to and immediately after placing bedding.
C. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Pipe Testing:
    a. Pressure Testing: As specified in Section 33 05 05.41 - Air Testing.
    b. Infiltration and Exfiltration Testing: As specified in Section 33 05 05.33 - Infiltration and Exfiltration Testing.
    c. Deflection Testing: As specified in Section 33 05 05.43 - Mandrel Testing.
3. Compaction testing shall comply with FDOT Standard Specifications.

1.2 PROTECTION

D. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
E. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
F. Cap open ends of piping during periods of Work stoppage.

END OF SECTION

SECTION 33 31 11.05

INSIDE DROP SYSTEM SPECIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section includes the minimum requirements for installing an inside drop system for a sanitary wet-well structure, which includes the furnishing, installing, laying, jointing, and testing of all piping, fittings and appurtenances as shown on the Drawings and specified herein. The Work shall also include such connections, reconnections, relocations, temporary services, abandonments, and all other provisions in regard to existing sewer operations and modifications as required.

B. Section Includes:

1. Sanitary sewerage piping.
2. Drop Bowl Fitting

C. Related Requirements:

1. Section 33 05 05.33 - Infiltration and Exfiltration Testing.
2. Section 33 05 61 - Concrete Manholes.
3. Section 33 05 97 - Identification and Signage for Utilities.
4. Section 33 31 11 – Public Sanitary Sewerage Gravity Piping

1.2 DEFINITIONS – NOT USED

1.3 REFERENCE STANDARDS

A. ASTM International:

1. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
2. ASTM C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals (Metric).
3. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
4. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
7. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

8. ASTM D2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
9. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
10. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
11. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.4 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with the Owner and all authorities having jurisdiction.

1.5 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.
C. Permits: Submit three (3) copies of all permits required for completion of the Work shown and specified.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.
F. The pipe or fitting manufacturer shall supply a "Certificate of Application" that the lining applicator has met the specified requirements.
G. Manufacturer Instructions:

    1. Indicate special procedures required to install specified products.
    2. Submit detailed description of procedures for connecting new sewer line.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
J. Qualifications Statement:

    1. Submit qualifications for manufacturer(s) and installer(s).

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record invert elevations and all other pertinent features associated with the Work.

1.7 QUALITY ASSURANCE

A. Perform Work according to applicable Federal, State, and Local standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing product specified in this Section with minimum five (5) years of documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum five (5) years of documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

1. Pipe, fittings, and drop bowl with cracked or chipped linings or defects will be rejected.

C. Storage:

1. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 INSIDE DROP SYSTEM

1. Drop Bowl

a. Shall be manufactured by Reliner ®/Duran or approved equal.

b. Shall be fabricated from fiberglass

c. Shall be sized in accordance with design indicated on plans.

d. Shall have protective liner applied resistant to corrosive effects of hydrogen sulfide.

2. Clamping Pipe Support

a. Shall be 304 SS or 316 SS with 18-8 Stainless nuts and bolts

2.2 SANITARY SEWERAGE PIPING

1. High Density Polyethylene Pipe (HDPE):

a. Comply with AWWA C901 and C906, PE 3408.

b. HDPE pipe shall DR-9 or DR-11.

c. HDPE pipe shall have a pressure rating of not less than 160 psi.

d. Pipe Outside Diameter: Iron Pipe Sizes (IPS).

e. Comply with AWWA C901 and C906.

f. Type: Molded or fabricated.

g. Joints: Butt fusion.

2. Polyvinyl Chloride (PVC) Pipe:

a. Gravity sewer PVC pipe shall conform to ASTM 3034, SDR-26.

b. Color: Green.

c. Pipe manufacturer shall supply a Certificate of Application that the pipe has met requirements of ASTM 3034, SDR-26.

d. PVC fittings shall conform to ASTM 1336, SDR-26.

e. Fittings shall be gasketed bell joint type and green in color.

f. Joints:

1) Push-On Joints:

a) Comply with AWWA/ANSI C111/A21.11.

b) Furnish complete with all accessories required.

2) Restrained Joint:

a) Restrained joints shall be restrained using grip gaskets of locking rings.

b) All restraints shall comply with applicable AWWA standards.

3) Manufacturers:

a) American, Fast-Grip Restrained Gaskets, Lok-Ring Restrained Rings,

b) McWane, Sure Stop Restrained Gaskets, Super Lok Restrained Rings,

c) Griffin, Talon Restrained Gaskets, Snap-Lok Restrained Rings,

d) U.S. Pipe, Field-Lok Restrained Gaskets, TR Flex Gripper Restrained Rings,

e) EBAA Iron, Mega-Lug Restraint Harness, Series 1700,

f) Sigma, Bell Joint Restraint Series PVP (16-inch and smaller), Series SLDH (18-inch and larger),

g) Tyler Union, Tuff Grip MJ Fitting Restraints,

h) or approved equal.

2.3 MANHOLES

A. As specified in Section 33 05 61 - Concrete Manholes.

2.4 FLEXIBLE PIPE BOOTS FOR MANHOLE PIPE ENTRANCES

A. Description:

1. Material: Heavy duty rubber.
2. Comply with ASTM C923.
3. Attachment: Series-300 stainless-steel clamp and hardware.

2.5 ACCESSORIES

A. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.

2.6 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for testing, inspection, and analysis.
B. Provide shop inspection and testing of all products pertaining to installation of drop bowl system.
C. Include one or both of following Paragraphs to require Owner's inspection or witnessing of test at factory.
D. Owner Inspection:

1. Make completed pipe sections available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

E. Owner Witnessing:

1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

F. Certificate of Compliance:

1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Verify that dimensions and elevations are as indicated on Drawings or as directed by the Engineer.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
B. Protect and support existing sewer lines, utilities, and appurtenances.
C. Utilities:

1. Maintain profiles of utilities.

2. Coordinate with existing utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Drop Bowl

1. Install per manufacturer guidelines.

B. Piping:

1. Install pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
2. Lay pipe to slope gradients as indicated on Drawings.
3. Begin at downstream end of system and progress upstream.
4. Bedding: As indicated on Drawings.
5. Lay bell-and-spigot pipe with bells upstream.
6. PE Pipe Encasement: Comply with AWWA C105, Method A.
7. Backfill and compact as specified in Section 31 23 16.13 - Trenching.
8. Do not displace or damage pipe when compacting.
9. Connect pipe to existing facilities as shown on the Drawings.
10. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.

C. Manholes: As specified in Section 33 05 61 - Concrete Manholes.
D. Bypassing Sewage:

1. The Contractor, when required, shall provide for the flow of sewage around a section or sections of pipe as required to complete the Work.
2. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow.
3. The Contractor shall submit a detailed bypass plan to the Engineer prior to performing any bypassing activities.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.
B. Maximum Variation from Indicated Slope: 1/8 inch in 10 feet.

3.5 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Request inspection by Engineer prior to and immediately after placing bedding.
C. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Pipe Testing:
    a. Pressure Testing: As specified in Section 33 05 05.41 - Air Testing.
    b. Infiltration and Exfiltration Testing: As specified in Section 33 05 05.33 - Infiltration and Exfiltration Testing.
    c. Deflection Testing: As specified in Section 33 31 11.00 – Public Sanitary Sewerage Gravity Piping

END OF SECTION

SECTION 33 31 23

SANITARY SEWERAGE FORCE MAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. General: This section includes the minimum requirements for installing sanitary sewer force mains, which includes the furnishing, installing, laying, jointing, and testing of all force mains, fittings, air release valves, plug valves, and appurtenances required for a complete system as shown on the Drawings and specified herein. The Work shall also include such connections, reconnections, relocations, temporary force mains, temporary pumping, abandonments, and all other provisions in regard to existing force main operations and modifications required to perform the Work.

B. Section Includes:

1. Force mains.
2. Valves.
3. Valve Boxes and Lids.
4. Couplings and Adaptors.
5. Tapping Saddles.
6. Bedding and cover materials.
7. Accessories.

C. Related Requirements:

1. Section 33 05 05.31 - Hydrostatic Testing.
2. Section 33 05 61 - Concrete Manholes
3. Section 33 05 97 - Identification and Signage for Utilities.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:

1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Water Works Association:

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
3. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
4. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In., for Water Transmission and Distribution.
5. AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In.

Through 48 In., for Water Transmission and Distribution.

C. ASTM International:

1. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
2. ASTM F 714-05 Standard Specification for Polyethylene (PE) Pipe (SDR-PR) Based on Outside Diameter.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
4. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
5. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
6. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
8. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Coordinate Work of this Section with connection to existing sanitary sewer system.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit manufacturer information indicating pipe material used, pipe accessories, valves, and restrained joint details and materials.
C. Shop Drawings:

1. Indicate piping piece numbers and locations.
2. Indicate restrained joint locations.

D. The Contractor shall submit certificates of inspection in triplicate from the manufacturer that the pipe, valves, and fittings to be supplied have been inspected at the plant and meet the requirements of the Contract Documents. These certificates shall be submitted prior to beginning Work.
E. Manufacturer Instructions: Submit special procedures required to install specified products.
F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
G. Qualifications Statement:

1. Submit qualifications for manufacturer, installer, and licensed professional.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record invert elevations and actual locations of pipe runs and connections.
C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work according to Florida Department of Environmental Protection and Florida Department of Transportation standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five (5) years of documented experience.
B. Installer: Company specializing in performing Work of this Section with minimum five (5) years of documented experience.
C. Licensed Professional: Professional engineer, if required, experienced in design of specified Work and licensed in State of Florida.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
C. Storage:

1. Store materials according to manufacturer instructions.
2. Do not place materials on private property without written permission of property owner.
3. Do not stack pipe higher than recommended by pipe manufacturer.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Store gaskets for mechanical and push-on joints in cool and dry location, out of direct sunlight, and not in contact with petroleum products.
3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 FORCE MAIN

A. Ductile Iron Pipe:

1. Flanged ductile iron pipe shall comply with AWWA C115.
2. Bell and spigot ductile iron pipe shall comply with AWWA C150 and AWWA C151.
3. Pipe shall be rated for a minimum working pressure of 200 psi or specified project requirements, whichever is greater, plus a two to one (2:1) factor of safety, using a Type II laying condition and a depth of cover of 4 feet.
    a. Pipe diameters 4-inch through 12-inch shall be Class 350, minimum.
    b. Pipe diameters 14-inch through 20-inch shall be Class 250, minimum.
    c. Pipe diameters 24-inches and larger shall be Class 200, minimum.
4. End Connections: Bell and spigot.
5. Ductile iron pipe shall be manufactured in the U.S.A. and each piece shall be subjected to a hydrostatic pressure test of at least 500 psi at the point of manufacture.
6. The class or nominal thickness, new weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, country where cast, year in which the pipe was produced, and the letters "DI" or "Ductile" shall be cast or stamped on each length of pipe.
7. Pipe shall have an exterior bituminous coating applied by airless spray method.
8. Pipe shall have an interior Amine Cured Epoxy Lining.
9. PE Encasement: Comply with AWWA C105 for installation of PE Encasement when pipe is installed in corrosive soils.
10. Fittings:
    a. Material: Ductile iron with a pressure rating that meets, but does not exceed the specified pressure rating of connected pipe.
    b. Comply with AWWA C153 or AWWA C110.
    c. Lining: Factory applied amine cured epoxy.
    d. Coating: Exterior of fittings shall be epoxy coated as specified in Section 09 90 00 - Painting and Coating.
11. Joints:
    a. Push-On Joints:
        1) Comply with AWWA/ANSI C111/A21.11.

2) Furnish complete with all accessories required.

b. Restrained Joint:

1) Restrained joints shall be restrained using grip gaskets or locking rings.
2) All restraints shall comply with applicable AWWA standards.
3) Manufacturers:

a) American, Fast-Grip Restrained Gaskets, Lok-Ring Restrained Rings,
b) McWane, Sure Stop Restrained Gaskets, Super Lok Restrained Rings,
c) Griffin, Talon Restrained Gaskets, Snap-Lok Restrained Rings,
d) U.S. Pipe, Field-Lok Restrained Gaskets, TR Flex Gripper Restrained Rings,
e) EBAA Iron, Mega-Lug Restraint Harness, Series 1700,
f) Sigma, Bell Joint Restraint Series PVP (16-inch and smaller), Series SLDH (18-inch and larger),
g) Tyler Union, Tuff Grip MJ Fitting Restraints,
h) or approved equal.

c. Restrained Mechanical Joints:

1) Restraint shall be ductile iron conforming to ANSI/AWWA C151/A21.51.
2) All restrained mechanical joints shall be furnished with accessories and have a minimum pressure resistance of 200 psi.
3) Manufacturers:

a) EBAA Iron Works, Megalug,
b) Tyler Union, Tuflock,
c) Sigma, SLD Series,
d) or approved equal.

d. Flanged Joints:

1) Comply with AWWA/ANSI 115/A21.51.
2) Pipe shall be furnished complete with all accessories.
3) Gaskets: Unless otherwise shown or specified, gaskets shall be minimum 1/8-inch thick, full-face type. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.

B. PVC Pipe (Push on Joint, 4” and Larger):

1. Comply with AWWA C900 and C905.

2. PVC pipe shall be DR-18, minimum, and have a pressure rating of no less than 200 psi.
3. PVC pipe shall be green in color.
4. Fittings: Mechanical joint ductile iron, complying with AWWA C111.
    a. Restraint system shall be non-penetrating type specifically designed for PVC pipe.
5. Push-On Joints:
    a. Comply with ASTM D3139 and ASTM F477.
    b. Seals: PVC flexible elastomeric.
    c. Solvent-cement couplings are not permitted.
6. Restrained Joints:
    a. Where required, joints shall be restrained using restrained joint PVC piping system or bell restraint harnesses complying with all applicable AWWA specifications.
    b. Manufacturers:
        1) Certain Teed: Certa-Lok C900/RJ Restrained Joint, Mechanical Gland Adapters for DR 14 and DR 18 pipe;
        2) EBAA Iron Works: Bell Restraint Harness for C900 PVC Pipe, Series 1600 for DR 14 and DR 18 pipe;
        3) Sigma: PVP-LOK Restraint;
        4) S&B Technical Products: Bull Dog Joint Restraints;
        5) Tyler Union: Tuff Grip MJ Fitting Restraint.

C. PVC Pipe (Thermal Butt-Fusion Joint):

1. Thermal Butt-Fusion Joint PVC Pipe shall be utilized for horizontal directional drills 4" diameter and larger, and shall conform to AWWA C900 and C905 standards.
2. PVC pipe shall be DR-18 and have a pressure rating of no less than 200 psi.
3. PVC pipe shall be green in color.

D. PVC Pipe (Solvent Weld):

1. Solvent Weld PVC Pipe shall conform to ASTM D1785, Schedule 80.
2. Pipe shall be green in color and shall be labeled in accordance with FDEP requirements.
3. Pipe shall have a pressure rating of no less than 200 psi.
4. Solvent Weld PVC Fittings shall conform to ASTM D2467.
5. Fittings:
    a. Solvent Weld PVC Fittings shall conform to ASTM D2466, ASTM D2467, and applicable

AWWA standards.

b. Fittings shall have a pressure rating of no less than 200 psi.

E. High Density Polyethylene Pipe (HDPE):

1. Comply with AWWA C906, PE 3408.
2. HDPE pipe shall DR-9 or DR-11.
3. HDPE pipe shall have a pressure rating of not less than 160 psi.
4. Pipe Outside Diameter: Iron Pipe Sizes (IPS).
5. HDPE pipe shall include green striping.
6. Fittings:

   a. Comply with AWWA C901 and C906.

   b. Type: Molded or fabricated.

7. Joints: Butt fusion.

F. Mechanical Joint Restraints:

1. Mechanical joint restraints shall include a restraining mechanism, which when activated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases.
2. Flexibility of the joint shall be maintained after burial.
3. Glands shall be manufactured of ductile iron conforming to ASTM A 536-80.
4. Restraining devices shall be of ductile iron, heat treated to a minimum hardness of 370 BHN.
5. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-headed bolts conforming to ANSI/AWWA A21.11 and ANSI/AWWA C153/A21.53.
6. Twist off nuts shall be used to insure proper actuating of the restraining devices.
7. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2:1.
8. Manufacturers:

   a. EBAA Iron Works, Megalug,

   b. Sigma, SLD Series,

   c. Tyler Union, Tuflock

   d. or approved equal.

2.2 VALVES

A. Eccentric Plug Valves:

1. Resilient plug valve shall be permanently lubricated eccentric type with resilient faced plugs.
2. The resilient plug shall be Buna- N or neoprene coated.
3. Plug valves up to 12-inch diameter shall have a minimum pressure rating of 175 psi and plug valves 14-inch and larger shall have a minimum pressure rating of 150 psi.
4. Plug valves shall conform to ANSI/AWWA C517 and be able to shut off flow from both directions.
5. Plug valves shall have a port opening not be less than 81% on valves up to 24-inch diameter.
6. Valve bodies shall be constructed of ASTM A-126 Class B semi-steel.
7. Valve Stem: Type 304 or 431 Stainless Steel.
8. All valves shall be equipped with two (2) inch square operating nut on all sizes through 24-inch diameter and shall be equipped with gear actuators.
9. Eccentric plug valves shall be mechanical joint or flanged joint as shown on the Drawings.
10. All bolts and nuts shall be stainless steel for non-buried service valves.
11. Shall be epoxy coated inside and out.
12. Manufacturers:
    a. Clow, F-5413,
    b. Val-Matic, Series 5000,
    c. DeZurik, Series 100,
    d. Pratt, Ballcentric,
    e. Milliken Camcentric,
    f. or approved equal.

B. Insertion Valves:

1. Insertion valves shall meet or exceed the testing requirements of AWWA C509 or C515.
2. Valve body may be cast iron, ductile iron, or Type 304 stainless steel.
3. Valve shall be pressure rated for 175 psi.
4. Valve Stem: Type 304 or 431 Stainless Steel.
5. Operating nut shall be 2” square and turn counterclockwise to open the valve with an operating rate of three (3) turns per inch of nominal pipe size.
6. Interior Lining: Epoxy.
7. Exterior Coating: Tar.
8. Manufacturers:
    a. Advanced Valve Technologies, EZ Valve,
    b. Rangeline, Hydro Stop Valve,

c. Team Industrial Services, Insert Valve,

d. or approved equal.

C. Air Release Valves (Stainless Steel Body):

1. Stainless Steel Body Air Release Valves shall be of the type designed for use in sanitary sewage force mains to exhaust entrapped air and shall conform to all applicable AWWA standards.
2. Valve shall be simple lever type and be constructed and tested to 175 psi working pressure.
3. Air release valves shall be furnished with backwash accessories.
4. Materials:

   a. Body and Cover: Stainless Steel

   b. Interior Working Parts: Stainless Steel

5. Air release valve inlets and outlets shall be threaded to NPT standards.
6. Manufacturers:

   a. Val-Matic, Model 48ASV,

   b. or approved equal.

D. Air/Vacuum Valves (Stainless Steel Body):

1. Stainless Steel Body Air/Vacuum Valves shall be of the type designed for use in sanitary sewage force mains to exhaust entrapped air while the pipe is being filled and allow air to reenter during draining to prevent vacuum conditions within the pipe.
2. Valve shall be spherical float operated and shall close drop tight against replaceable rubber seat.
3. Minimum working pressure: 175 psi.
4. Air/vacuum valves shall be furnished with backwash accessories.
5. Materials:

   a. Body and Cover: Stainless Steel

   b. Interior Working Parts: Stainless Steel

6. Air/vacuum valve inlets and outlets shall be threaded to NPT standards.
7. Manufacturers:

   a. Empire / GA Industries, Figure 935-F (1-inch), Figure 935-A (2-inch),

   b. or approved equal.

E. Combination Air Valves (Plastic Body):

1. Plastic Body Combination Air Valves shall be of the type designed for use in sanitary sewage

force mains to exhaust entrapped air while the pipe is being filled, allow air to reenter during draining to prevent vacuum conditions within the pipe, and release air from the system while operating under pressure.

2. Valve shall be tested to 175 psi working pressure.
3. Air release valves shall be furnished with required backwash accessories.
4. Materials:
    a. Body and Cover: PVC
    b. Interior Working Parts: PVC and stainless steel.
5. Air release valve inlets and outlets shall be threaded to NPT standards.
6. Manufacturers:
    a. A.R.I. Flow Control Accessories, Ltd., D-025-PN10,
    b. or approved equal.

F. Check Valves (Lever and Spring Type)

1. Lever and spring type check valves shall conform to AWWA C508.
2. Flanges shall conform to ANSI B16.1, Class 125.
3. Materials:
    a. Disc: Bronze.
    b. Valve Body: Ductile iron, bronze mounted.
4. Valve shall be pressure rated for 175 psi.
5. Stuffing box shall be o-ring sealed.
6. Lever and spring with adjustable tension shall be included to control opening and closing of the clapper.
    a. Lever and spring shall be capable of being installed on either side of valve.
7. Interior Lining: Factory applied amine cured epoxy.
8. Exterior Coating: Exterior of fittings shall be epoxy coated as specified in Section 09 90 00 - Painting and Coating.
9. Manufacturers:
    a. Clow, F-5382,
    b. Mueller, A-2600-6-02,
    c. M & H, Style 259-02,
    d. AMI, Series 504,

e. or approved equal.

G. Check Valves (Flanged Swing-Flex Type)

1. Flanged swing-flex type check valves shall conform to AWWA C508.
2. Flanges shall conform to ANSI B16.1, Class 125.
3. Materials:

a. The flexible disc shall be one piece and precision molded with alloy steel and Nylon reinforcement and an integral O-ring style seat for drop tight seating at low pressure.
b. Valve Body: Ductile iron, bronze mounted.

4. Valve shall be pressure rated for 175 psi and include a mechanical position indicator.
5. Interior Lining: Factory applied amine cured epoxy.
6. Exterior Coating: Exterior of fittings shall be epoxy coated as specified in Section 09 90 00 - Painting and Coating.
7. Manufacturers:

a. Val-Matic, 500A Swing-Flex,
b. Clow, Ken-Flex,
c. Pratt, Flex Check,
d. Mueller, Flex Check,
e. or approved equal.

2.3 VALVE BOXES AND LIDS

A. Valve Box:

1. Valve boxes shall not deeper than five (5) feet without Owner approval.
2. Bottom Section:

a. Cast iron, ASTM A48, heavy duty screw type.
b. Cast iron screw valve box will be only type allowed in asphalt pavement.
c. Cast iron screw or sliding type valve box may be used in right of way as specified per project.

3. Valve Box Extension:

a. Cast iron, ASTM A48, heavy duty screw type extension.
b. For deep valves use six (6) inch ductile or cast iron pipe cut to proper length so only one valve box extension is used.

4. Valve Box Tops shall be cast iron, screw type and conform to ASTM A48.

5. Valve Box Tops shall be rated for H-20 traffic in conformance with AASHTO M-306.
6. Manufacturers:
    a. Tyler, #6850-5625-24B (Bottom), #6050-5625-585C (Extension), #6850-5625-16T (Top),
    b. Opelika Foundry, #4908-5562-S-625 (Bottom), #4906X-64E (Extension), #4905-5562-S-55S (Top),
    c. Sigma, VB 2622 (Bottom), VB302-18 (Extension), VB2621X (Top),
    d. Star Pipe Products, VBB24SHD (Bottom), VBEX14S (Extension), VBT16SHD (Top),
    e. or approved equal.

B. Valve Box Lid:

1. Provide cast iron, ASTM A48, heavy duty, screw type, valve box, 5 ¼" shaft for non-pavement installations.
2. Valve Box Lids shall be rated for H-20 traffic in conformance with AASHTO M-306.
3. Cover shall be marked "SEWER".
4. Manufacturers:
    a. Sigma, VB2600X,
    b. Tyler, 5 1/4" Drop Lid,
    c. Opelika Foundry, #4908-562 Lid,
    d. Star Pipe Products, VBLIOHD,
    e. or approved equal.

C. Lockable Valve Box Lid:

1. Provide cast iron, ASTM A48, heavy duty, screw type, lockable type, valve box, 5 ¼" shaft
2. Lockable Valve Box Lids shall be for installation in low traffic pavement areas.
3. Valve Box Lids shall be rated for H-20 traffic in conformance with AASHTO M-306.
4. Cover shall be marked "SEWER".
5. Manufacturers:
    a. Sigma, VB2600X,
    b. Tyler, 5 1/4" Drop Lid,
    c. Opelika Foundry, #4908-562 Lid,
    d. Star Pipe Products, VBLIOHD,
    e. or approved equal.

D. Non-Pop Valve Box Lid:

1. Provide high tech molded polymer lid, ASTM A48, heavy duty, screw type, valve box, 5 ¼"

shaft cast iron valve box top.

2. Non-Pop Valve Box Lids shall be installed in heavy traffic pavement areas.
3. Valve Box Lids shall be rated for H-20 traffic in conformance with AASHTO M-306.
4. All boxes shall conform to applicable AWWA standards.
5. Cover shall be marked "SEWER".
6. Manufacturers:

    a. SW Services, 5 1/4" Non-Pop Lid,
    b. or approved equal.

2.4 FLOW METERS

A. Electromagnetic Flow Meter:

1. Electromagnetic Flow Meters shall meet or exceed requirements of AWWA C703 standards.
2. Materials:

    a. Body: Stainless Steel.
    b. Electrodes: Hastelloy C, platinum, stainless steel, titanium, tantalum, or low noise (with low noise coating).

3. Electromagnetic Flow Meters shall be rated for 200 psi working pressure.
4. Connection: Flanged.

    a. Flanged connections shall include companion flanges, gaskets, bolts, and nuts.

5. Electronic Display

    a. Electronic display shall be included with Electromagnetic Flow Meter.
    b. Display shall include three (3) outputs for pulses and alarm shall display usage and total.
    c. Electronic display shall be mounted in a secure location.
    d. Manufacturers:

        1) Krohne
        2) pre-approved equal.

2.5 METER VAULT AND ACCESS HATCH

a. Access Hatches:

    1) Provide access hatches as shown on the Drawings.
    2) Access hatches shall be constructed of one-quarter inch (1/4"), minimum, Floor Diamond Plate Aluminum with one-quarter inch (1/4"), minimum, extruded aluminum angle frame with concrete anchors and integral neoprene gasket strip.

3) Aluminum shall be mill finished with coal tar epoxy applied to surfaces to be in contact with concrete.
4) Hinges, bolts, and fasteners shall be stainless steel.
5) All stainless steel is to be 316 grade stainless steel.
6) Minimum design loading: H-20 Load Rating.
7) Hatch shall include hold-open arm mechanism and cast aluminum drop handle and safety hasp.
8) Single Door Access Hatch:
    a) Manufacturers:
        (1) U.S. Foundry, AHS,
        (2) Halliday, H1R,
        (3) or approved equal.
9) Double Door Access Hatch:
    a) Manufacturers:
        (1) U.S. Foundry, AHD,
        (2) Halliday, H2R,
        (3) or approved equal.

B. Box, Utility, Precast Concrete Vault:

1. Precast Concrete Utility Box shall meet the requirements of ASTM C478, with the exclusion of Section 10 (a), except as modified herein.
2. Cement shall meet the requirements of ASTM C150, Specification for Portland Cement, Type I/II.
3. Concrete for utility boxes shall be 4,000 PSI and meet the minimum requirements for Class III.
4. Minimum wall thickness shall be six inches.
5. The required minimum strength of concrete and conformance to the design parameters shall be confirmed by testing in accordance with Section 345 of the FDOT Standard Specifications except that the CONTRACTOR shall be responsible for all testing.
6. Reinforcing steel shall be #4 GR60 rebar 12” O.C. both ways.
7. Utility box shall be constructed with open bottom.
8. Where a top slab is required, it shall be six inches (6”) thick, 4,000 PSI concrete with #4 GR60 rebar 12” O.C. both ways.

2.6 COUPLINGS AND ADAPTORS

A. Flange Adaptors:

1. Flange adaptors shall be cast iron with iron pipe threads.
2. Flange adaptors shall conform to applicable AWWA standards and shall receive the same interior and exterior coating as the pipe receiving the flange.
3. Lining: Factory applied amine cured epoxy.
4. Coating: Exterior of fittings shall be epoxy coated as specified in Section 09 90 00 - Painting and Coating.

B. Sleeve-Type Couplings:

1. Sleeve-type couplings shall be stainless steel couplings for plain-end cast iron and ductile iron pipe.
2. The couplings shall be furnished with the pipe stop removed.
3. Couplings shall be provided with plain, Grade 27, rubber gaskets and with stainless steel, track-head bolts with nuts.
4. To ensure correct fitting of pipe and couplings, all sleeve-type couplings, and accessories shall be furnished by the supplier of the pipe.

2.7 TAPPING SADDLES

A. Stainless Steel Tapping Saddles:

1. Tapping saddle shall be all Type 304 stainless steel, per ASTM A-240.
2. All welds and metal surfaces shall be chemically passivated to meet ASTM A-380.
3. Saddles to be two-piece construction with two (2) inch outlet with IPS thread.
4. Saddles to have double bolt and received bars. Bolts and nuts shall be 18-8 stainless steel.
5. Saddle shall be rated for 150 psi.
6. Manufacturers:

    a. Ford, FRS202,
    b. Cascade, CS22,
    c. or approved equal.

2.8 MATERIALS

A. Select bedding and cover material type based on Project conditions. If more than one type is required, edit following Paragraph. Consider using material "Type" coding from Section 310516 in this Section for uniformity of reference.

B. Bedding and Cover:

1. Excavation, trenching, and backfilling shall be in accordance with Section 125 of the Florida

Department of Transportation Standard Specifications for Road and Bridge Construction.

2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches, tamp in place, and compact to 95 percent of maximum density.
3. Immediately after the pipe has been jointed and inspected, sufficient backfill shall be performed to protect the pipe adequately from injury and movement.
4. Maintain optimum moisture content of bedding material to attain required compaction density.
5. Where so indicated on the drawings or where directed by the Engineer, the pipe shall be supported by compacted granular fill or concrete cradle or encasement according to the applicable detail shown on the Drawings.

    a. Pipe bedded in compacted granular backfill shall not be supported on blocking, wedges, bricks, or anything except the bedding material.
    b. Where concrete cradle or encasement is required, the pipe shall be supported on solid concrete blocks or pre-cast concrete saddles which shall become part of the completed cradle or encasement.
    c. Where no other bedding is indicated, pipe shall be placed on a shaped bed of undisturbed material.

2.9 MIXES

A. Concrete: As specified in the FDOT Standard Specifications for Road and Bridge Construction.

2.10 ACCESSORIES

A. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
B. Contractor shall contact Sunshine 811 for location of existing utilities at 811 or 1-800-432-4770 a minimum of 48 hours prior beginning Work.
C. The Contractor shall field verify vertical and horizontal locations of all underground facilities in advance of construction to verify that no conflicts exist with the proposed pipe alignment and depth.

    1. Should a conflict be discovered, the Contractor shall contact the Engineer immediately and provide all pertinent information for preparation of a remedial design.

D. Verify that excavation base is ready to receive Work.
E. Verify that excavations, dimensions, and elevations are as indicated on the Drawings.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Preconstruction Site Photos:

1. As specified in Section 01 70 00 - Execution and Closeout Requirements.
2. Take photographs along centerline of proposed pipe trench; minimum one photograph for each 50 feet of pipe trench.
3. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.
4. Include Project description, date taken, and sequential number on back of each photograph.

C. Pipe Cutting and Lining Repair:

1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.
2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.
3. Grind edges smooth with beveled end for push-on connections.
4. Remove all traces of oil, grease, asphalt, dust, dirt, etc.
5. Remove damaged lining and clean any exposed metal by sanding or scraping. Sandblasting and power tool cleaning is also acceptable.
    a. Remove any loose lining by chiseling, cutting, or scraping to well adhered lined area before patching.
    b. Lining patch shall overlap remaining lining at least one (1) inch.
6. With the area to be sealed or repaired absolutely cleaned and thoroughly roughened, apply a coat of repair compound specified in the applicator's "Certificate of Application" as furnished and approved with the pipe submittal. The Contractor shall apply the repair compound in strict accordance with the manufacturer's written instructions.
7. The Contractor shall repair damaged coating and lining immediately, using the repair compound recommended by the manufacturer.
8. The cost of repair to cut pipe ends or damaged linings shall be incidental to construction and the Contractor shall absorb the cost thereof in the unit price specified for related items.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Bedding and installation shall be Class B as shown on the Drawings unless otherwise specified or directed by the Engineer.

B. Handling and Cutting Pipe:

1. The Contractor shall exercise extreme care in handling and laying pipe and fittings to avoid damaging, scratching or marring machined surfaces, and abrasion of the pipe or fitting coating.
2. Any fitting showing a crack and any fitting or pipe that has received a severe blow that may have resulted in an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and immediately removed from the Work.
3. Any pipe showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved by the Engineer, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used may be perfectly sound. The cut shall be made in the sound barrel at a point at least twelve (12) inches from the visible limits of the crack.
4. Except as otherwise approved, all cuttings shall be done with a machine having rolling wheel cutters, or pipe saw adapted for that purpose. All cut ends shall be examined for possible cracks caused by cutting.

C. Abandoning Sewer Force Mains:

1. Sewer Force Mains Abandoned in Place: The Contractor shall cut the sewer force main as required to make connections or install plugs. That portion of the pipe to be abandoned and left in place shall be plugged at locations where the pipe was cut or punctured. Plugging shall be accomplished by grouting the end or punctured area to the satisfaction of the Engineer.
2. Sewer Force Mains Abandoned in Place with Grout Fill: The Contractor shall cut the sewer force main as required, install plugs, and fill the pipe with grout as shown on the Drawings.
3. Sewer force mains to be abandoned and removed shall be cut or disconnected as required.

D. Pipe Installation:

1. Comply with AWWA C600 and C605 as applicable.
2. Handle and assemble pipe according to pipe and gasket manufacturer instructions and as indicated on Drawings.
3. Steel Rods, Bolts, Lugs, and Brackets: Coat buried steel before backfilling.
4. No sanitary sewer force main shall be installed within six (6) feet of a potable water line, unless the crown of the sewer main is at least six (6) inches lower than the bottom of the water line, or unless special permission is obtained from the Engineer and the Florida Department of Environmental Protection. In no case shall a sanitary sewer main be placed in the same trench with a water main.
5. Sanitary Sewer Force Main Location:

    a. Sanitary sewer force mains shall be installed as shown on the Drawings.

b. Every effort shall be made to avoid creation of low or high points in the force main other than those shown on the Drawings.
c. Minimum depth of installation shall be three (3) feet, measured from the top of the pipe to the finished grade or centerline of roadway directly above the pipe.
d. Minimum depth of installation at air release valve locations shall be four (4) feet.

6. Route pipe in straight line, and re-lay pipe that is out of alignment or grade.
7. Ductile-Iron Piping and Fittings: Comply with AWWA C600.
8. PVC Pipe Piping and Fittings: Comply with AWWA C605.
9. Field Welding Materials: Comply with AWWA C206.
10. Flanged Joints: Do not use in underground installations except within structures.
11. To ensure correct fitting of pipe and couplings, all sleeve-type couplings and accessories shall be furnished by the supplier of the pipe.
12. High Points:
    a. Install pipe with no high points other than shown on the Drawings.
    b. If approved by the Engineer, minor changes in alignment may be permitted to avoid underground facilities.
    c. If unforeseen field conditions arise that necessitate high points, install air-release valves as specified or as directed by the Engineer.
13. Bearing:
    a. The pipe shall be laid on an unyielding foundation with uniform bearing under the full length of the barrel of the pipe.
    b. Excavate bell holes to permit proper joint installation.
    c. The spigot end of the pipe shall abut the base of the socket of the adjacent pipe in such a manner that there will be no gaps along the perimeter of the mating halves.
14. Do not lay pipe in wet or frozen trench.
15. The Contractor shall take all necessary precautions to prevent flotation of the pipe from flooding of the trench.
16. The pipe shall not be driven down to grade by striking it with a shovel handle, timber, rammer, or other unyielding object.
17. Immediately before jointing the pipe, the mating ends shall be thoroughly cleaned of all dirt, debris, and foreign material.
18. Prevent mud, sand, or other foreign material from entering pipe during placement.

19. At all times when pipe laying is not actually in progress, the open ends of the pipe shall be closed by temporary watertight plugs or by other approved means. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe has passed.
20. Allow for expansion and contraction without stressing pipe or joints.
21. Close pipe openings with watertight plugs during Work stoppages.
22. Cover:
    a. Establish elevations of buried piping with not less than four (4) feet of cover.
    b. Measure depth of cover from final surface grade to top of pipe barrel.
23. Pipe Markers: As specified in Section 33 05 97 - Identification and Signage for Utilities.
24. Any defective pipe that may have been installed shall be removed and replaced with sound pipe at no additional cost to the Owner.

E. Pipe Joint Assembly:

1. Assemble all joints in accordance with recommendations of the manufacturer.
2. If a lubricant is required to facilitate assembly, it shall have no detrimental effect on the gasket or on the pipe when subjected to prolonged exposure.
3. Proper jointing may be verified by rotation of the spigot by hand or with a strap wrench.
4. If unusual jointing resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint, inspect for damage, re-clean the joint components, and repeat the assembly steps.
5. Note that fitting bells may permit less insertion depth than pipe bells.
6. When mechanical equipment is used to assemble joints, care should be taken to prevent over-insertion.

F. Valves

1. Valves shall be installed as indicated on Drawings and according to manufacturer instructions.
2. Valves shall be set vertically so that stems form a vertical line. Care shall be taken to keep out dirt and sand, and no valve shall be operated until it has been cleaned of sand, grit, or other foreign material.
3. No valve operating nut shall be deeper than five (5) feet without Owner approval.
4. Valve Boxes:
    a. All valves shall be fitted with heavy duty traffic rated valve box and cover as specified herein.

b. Valve boxes shall be long enough to reach from the valve to finished ground level and shall be installed as recommended by the manufacturer.

c. Valve boxes shall have suitable barrel and shaft extension sections to cover and protect the valve bonnet section.

d. Extension sections fabricated by one piece of ductile iron are allowed. No more than one (1) shaft extension shall be used in any one (1) valve installation.

e. Valve box extensions shall be by same manufacturer as valve box or ductile iron pipe.

f. Valve boxes shall be installed in vertical alignment and positioned to facilitate the operation of the valve with a standard valve wrench. The box shall be installed as shown on the drawings and shall be set on firmly packed soil or bricks to prevent settlement and to prevent bearing on the valve or the main at any point.

g. Adjustment of valve boxes shall be subject to the approval of the Engineer. The Contractor shall maintain vertical alignment and position to permit operation of the valve with a standard valve wrench.

h. All valve boxes located in heavy traffic pavement areas shall include non-pop covers as specified.

i. Terminate locating wire for all sizes of PVC and HDPE water mains in the valve boxes in accordance with the Drawings.

j. Valve Box Adjustment:

1) All valve boxes within the area of finished construction shall be adjusted to finish grade as shown and specified.

2) Valve boxes damaged during construction shall be replaced by the Contractor at no additional cost to the Owner. Removal and replacement of valve boxes during construction may be authorized, provided the Contractor insures that sufficient valve ties are available and on site in order to quickly locate the valve.

3) Adjustment of valve boxes shall be subject to approval of the Engineer.

G. Tapping Sleeves and Valves: As indicated on Drawings and according to manufacturer instructions.

H. Double continuous tracing wires shall be installed on all non-metallic pipes per Specification Section 33 05 97 – Identification and Signage for Utilities.

I. Early warning tape, as specified in Section 33 05 97 – Identification and Signage for Utilities, shall be installed 12-inches to 18-inches above all sanitary sewer force mains.

J. PE Encasement:

1. Encase ductile iron piping in PE to prevent contact with surrounding backfill material when pipe is installed in corrosive soils as shown on the Drawings.

2. Comply with AWWA C105.
3. Terminate encasement 3 to 6 inches above ground where pipe is exposed.

K. Bedding and Backfilling:

1. Excavation, trenching, and backfilling shall be in accordance with Section 125 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.
2. Backfill around sides and to top of pipe with cover fill in minimum lifts of six (6) inches and compacted to the following requirements:
    a. Backfill under roadways: 98% Standard Proctor Density.
    b. Backfill not under roadways: 95% Standard Proctor Density.
3. Immediately after the pipe has been jointed and inspected, sufficient backfill shall be performed to protect the pipe adequately from injury and movement.
4. Maintain optimum moisture content of bedding material to attain required compaction density.
5. Where so indicated on the drawings or where directed by the Engineer, the pipe shall be supported by compacted granular fill or concrete cradle or encasement according to the applicable detail shown on the Drawings.
    a. Pipe bedded in compacted granular backfill shall not be supported on blocking, wedges, bricks, or anything except the bedding material.
    b. Where concrete cradle or encasement is required, the pipe shall be supported on solid concrete blocks or pre-cast concrete saddles which shall become part of the completed cradle or encasement.
    c. Where no other bedding is indicated, pipe shall be placed on a shaped bed of undisturbed material.

L. Cleaning and Flushing:

1. As the Work progresses, the interior of the piping shall be cleaned of all dirt, jointing material, and superfluous materials of every description.
2. Prior to the pressure and leakage tests, all piping shall be thoroughly cleaned of all dirt, dust, oil, grease, and other foreign matter. This work shall be done with care to avoid damage to any inside coating.
3. All lines shall be thoroughly flushed with clean water to clear the lines of all foreign matter.

3.4 PIPE SUPPORT AND THRUST RESTRAINT

A. The Contractor shall furnish and install all supports necessary to hold the piping and appurtenances in a firm, substantial manner at the lines and grades indicated on the Drawings or specified.

B. Where buried piping contains fittings, which raise or lower the centerline of the pipe, suitable socket clamps, tie rods, or other approved restraining devices shall be used to prevent movement of the fittings. The restraining devices shall be coated thoroughly and heavily with an approved bituminous paint.
C. All bends, tees, and other fittings in pipelines, and sleeve-coupled pipelines buried in the ground shall be backed with Class 1 concrete placed against undisturbed earth where firm support can be obtained or by the use of restrained joints. If the soil does not provide firm support, then suitable clamps, and accessories or restrained joints shall be provided to brace the fitting properly. Such items shall be coated thoroughly and heavily with an approved bituminous paint after assembly or, if necessary, before assembly.
D. Thrust blocks and joint restraints shall be provided as shown on the Drawings.

3.5 CONNECTION TO EXISTING SANITARY SEWER FORCE MAINS

A. Connections to existing force mains shall be performed as shown on the Drawings or as directed by the Engineer.
B. Connection of new force mains to existing shall be performed in the normal accepted method for connecting mains and shall be done without unduly disrupting service. All connections are subject to the approval of the Engineer as to method, time, and location.
C. Where existing lines are connected to proposed lines, the Contractor shall take appropriate action to ensure that the existing lines do not interfere with the pressure testing portions of the work. Failure to do so will not relieve the Contractor of the responsibility of properly pressure testing the entire system installed. The Contractor shall bear full responsibility for the action or inaction on this matter and shall not claim damages, injuries, or additional compensation for said action or inaction.
D. At least 48 hours prior to excavating for the actual connection operation, the Contractor shall excavate and expose the main to be cut at the proposed location and shall advise the Engineer, so that the exposed area may be inspected by the Engineer to verify that no conditions are present that would hamper the connection operation.
E. Damage caused by sewage from an accidentally cut force main or gravity sewer shall be mitigated by either pumping the sewage back into the gravity sewer system or cleaned by flushing with either fire hoses or tank trucks. Where practical, the affected area shall be treated with a disinfectant, such as Calcium Hypochlorite (HTH). Disinfectant shall be approved by the Engineer.
F. The Contractor shall notify the City of Ocala Water Resources Department, Lift Station Division at least 48 hours prior to making connections to existing force mains.

3.6 CONNECTION TO SANITARY SEWER MANHOLES

A. Where force mains are to be connected to manholes, the complete interior of the manhole shall be protected.
B. The Contractor shall take upstream measurements necessary to properly install boots, grout pipe openings, and thoroughly clean the walls.
C. Apply lining as shown and specified in accordance with Section 33 05 61 - Concrete Manholes. The application shall be installed in strict accordance with the manufacturer's written instructions.

3.7 PAVEMENT CROSSINGS

A. Bases, Sidewalk, Curb, and Driveway Repairs – The Contractor shall replace any and all bases, sidewalks, curbs and gutter, and driveways with materials and workmanship sufficient to give an equal and similar surface to the disturbed areas as existed before construction.
B. Pavement removal and replacement shall be in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction and as shown on the Drawings.

3.8 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Requirements for tolerances.
B. Install pipe to indicated elevation within tolerance of 5/8 inch.

3.9 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
B. Testing:

1. All testing shall be performed in the presence of the Engineer or a designated representative thereof.
2. All parts of the Work including, but not being limited to, pipe, fittings, joints, valves, and any other appurtenances shall be subjected to testing as described herein. To achieve this, all methods of testing shall be approved by the Engineer and FDEP.
3. Except as otherwise directed, all pipelines shall be tested. Pipelines installed in excavation or bedded in concrete shall be tested prior to the backfilling of the excavation or placing of the concrete and exposed piping shall be tested prior to field painting.
4. All piping to operate under liquid pressure shall be tested in sections of approved length. The section of pipe being tested shall be limited to a maximum length of 2000 feet. For these tests the Contractor shall furnish clean water, suitable temporary testing plugs or caps, and other necessary equipment and all labor required, without additional compensation. The Contractor shall furnish suitable pressure gauges, pumps, and measuring tank.
5. The Contractor shall be responsible for the cost of all water used for testing and flushing. The Contractor shall make suitable arrangements with the Owner for the monitoring of water consumption and locations to which water may be made available. Water charges shall be in accordance with City of Winter Springs Fees and Rate Schedule.
6. Pressure test piping system as specified in Section 33 05 05.31 – Hydrostatic Testing.

C. Compaction Testing:

1. Comply with Florida Department of Transportation requirements for compaction testing.
2. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
3. The Owner shall provide density testing. The Contractor shall be responsible for the cost of any retesting required.

3.10 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION