US Army Corps of Engineers

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CORNELL-DUBILIER ELECTRONICS SUPERFUND SITE
SOUTH PLAINFIELD, NEW JERSEY

OPERABLE UNIT 4: BOUND BROOK
Remedial Design

Phase 3: Groundwater Hydraulic Containment

CONTRACT SPECIFICATIONS
VOLUME 2 OF 2
FINAL DESIGN

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DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS
08/10

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 201	(2002; R 2011) Fans and Systems
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 300	(2014) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2014) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2012) Laboratory Methods of Testing Dampers for Rating

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2013) Ventilation for Acceptable Indoor Air Quality
ASHRAE 70	(2006; R 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets
ASHRAE 90.1 - IP	(2016; ERTA 1-4 2017; INT 1-2 2017) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and

	Steel Products
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A924/A924M	(2017) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM C1071	(2016) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
ASTM C553	(2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C916	(2014) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D3359	(2017) Standard Test Methods for Rating Adhesion by Tape Test
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E2016	(2015) Standard Specification for Industrial Woven Wire Cloth
ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2015) Standard Methods of Fire Tests for

	Flame Propagation of Textiles and Films
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82	Protection of Stratospheric Ozone
PL 109-58	Energy Policy Act of 2005 (EPAct05)

UNDERWRITERS LABORATORIES (UL)

UL 181	(2013; Reprint Apr 2017) UL Standard for Safety Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint Aug 2016) UL Standard for Safety Fire Dampers
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 705	(2004; Reprint Mar 2016) UL Standard for Safety Power Ventilators
UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL Bld Mat Dir	(updated continuously online) Building Materials Directory
UL Electrical Constructn	(2012) Electrical Construction Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.02 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as

required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

A. Mechanical Equipment Identification

The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart or diagram per space is required, mount these in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1. Charts

Provide chart listing of equipment by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

2. Diagrams

Submit proposed diagrams, at least 2 weeks prior to start of related testing. Provide neat mechanical drawings provided with extruded aluminum frame under 1/8-inch glass or laminated plastic, system diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system. After approval, post these items where directed.

B. Service Labeling

Label equipment, including fans, air handlers, terminal units, etc. with labels made of self-sticking, plastic film designed for permanent installation. Labels shall be in accordance with the typical examples below:

SERVICE	LABEL AND TAG DESIGNATION
Air handling unit Number	AHU - 1
Control and instrument air	CONTROL AND INSTR.
Exhaust Fan Number	EF - 1
VAV Box Number	VAV - 1
Fan Coil Unit Number	FC - 1
Terminal Box Number	TB - 1
Unit Ventilator Number	UV - 1

Identify similar services with different temperatures or

pressures. Where pressures could exceed 125 pounds per square inch, gauge, include the maximum system pressure in the label. Label and arrow piping in accordance with the following:

1. Each point of entry and exit of pipe passing through walls.

2. Each change in direction, i.e., elbows, tees.

3. In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

4. In long straight runs, locate labels at distances within eyesight of each other not to exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes	
for Outside Diameters of	Lettering
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

C. Color Coding

Color coding of all piping systems shall be in accordance with ASME A13.1.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Insulated Nonmetallic Flexible Duct Runouts; G

Duct Connectors; G

Duct Access Doors; G

Fire Dampers; G

Manual Balancing Dampers; G

Sound Attenuation Equipment; G

Acoustical Duct Liner; G

Diffusers; G

Registers and Grilles; G

Louvers; G

Centrifugal Type Power Roof Ventilators; G

Ceiling Exhaust Fans; G

Air Handling Units; G

Room Fan-Coil Units; G

Coil Induction Units; G

Test Procedures; G

Diagrams; G

SD-06 Test Reports

Performance Tests; G

Damper Acceptance Test; G

Ductwork Leak Test; G

SD-07 Certificates

Ozone Depleting Substances

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G

Operation and Maintenance Training; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Fire Dampers; G

Manual Balancing Dampers; G

Centrifugal Type Power Roof Ventilators; G

Ceiling Exhaust Fans; G

Room Fan-Coil Units; G

1.04 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the

standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

d. Where products are specified to meet or exceed the specified energy efficiency requirement of FEMP-designated or Energy Star certified product categories, equipment selected shall have as a minimum the efficiency rating identified under "Energy-Efficient Products" at http://www1.eere.energy.gov/femp/procurement.

These specifications conform to the efficiency requirements as defined in Public Law PL 109-58, "Energy Policy Act of 2005" for federal procurement of energy-efficient products. Equipment having a lower efficiency than Energy Star or FEMP requirements may be specified if the designer determines the equipment to be more life-cycle cost effective using the life-cycle cost analysis methodology and procedure in 10 CFR 436.

A. Prevention of Corrosion

Protect metallic materials against corrosion. Manufacturer shall provide rust-inhibiting treatment and standard finish for the equipment enclosures. Do not use aluminum in contact with earth, and where connected to dissimilar metal. Protect aluminum by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123/A123M for exterior locations and cadmium-plated in conformance with ASTM B766 for interior locations.

B. Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

C. Ozone Depleting Substances Used as Refrigerants

Minimize releases of Ozone Depleting Substances (ODS) during

repair, maintenance, servicing or disposal of appliances containing ODS's by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of equipment containing refrigerants must comply with the following:

1. Do not knowingly vent or otherwise release into the environment, Class I or Class II substances used as a refrigerant.

2. Do not open appliances without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices for evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

3. Only persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification, can conduct work on appliances containing refrigerant.

In addition, provide copies of all applicable certifications to the Contracting Officer at least 14 calendar days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

1. Proof of Technician Certification

2. Proof of Equipment Certification for recovery or recycling equipment.

3. Proof of availability of certified recovery or recycling equipment.

D. Use of Ozone Depleting Substances, Other than Refrigerants

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

1. Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

2. Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays.

3. Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial cabling.

4. Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

Request a waiver if a facility requirement dictates that a

prohibited material is necessary to achieve project goals. Submit the waiver request in writing to the Contracting Officer. The waiver will be evaluated and dispositioned.

E. Detail Drawings

Submit detail drawings showing equipment layout, including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications. Include any information required to demonstrate that the system has been coordinated and functions properly as a unit on the drawings and show equipment relationship to other parts of the work, including clearances required for operation and maintenance. Submit drawings showing bolt-setting information, and foundation bolts prior to concrete foundation construction for all equipment indicated or required to have concrete foundations. Submit function designation of the equipment and any other requirements specified throughout this Section with the shop drawings.

F. Test Procedures

Submit proposed test procedures and test schedules for the ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

1.05 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Provide components and equipment that are "standard products" of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. "Standard products" is defined as being in satisfactory commercial or industrial use for 2 years before bid opening, including applications of components and equipment under similar circumstances and of similar size, satisfactorily completed by a product that is sold on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Provide equipment items that are supported by a service organization.

2.02 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, provide engraved laminated phenolic identification plates for each piece of mechanical equipment. Identification plates are to designate the function of the equipment. Submit designation with the shop drawings. Identification plates shall be three layers, black-white-black,

engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger shall have beveled edges. Install identification plates using a compatible adhesive.

2.03 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard. The requirements for guardrails are specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

2.04 ELECTRICAL WORK

A. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Division 26. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

B. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

C. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system, and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

D. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

E. Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS.

2.05 ANCHOR BOLTS

Provide anchor bolts for equipment placed on concrete equipment pads or on concrete slabs. Bolts to be of the size and number recommended by the equipment manufacturer and located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.06 PAINTING

Paint equipment units in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouch only if approved. Otherwise, return equipment to the factory for refinishing.

2.07 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.08 DUCT SYSTEMS

A. Metal Ductwork

Provide metal ductwork construction, including all fittings and components, that complies with SMACNA 1966, as supplemented and modified by this specification.

a. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

b. Provide ductwork that meets the requirements of Seal Class A. Provide ductwork in VAV systems upstream of the VAV boxes that meets the requirements of Seal Class A.

c. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant.

d. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

1. Insulated Nonmetallic Flexible Duct Runouts

Use flexible duct runouts only where indicated. Runout length is indicated on the drawings, and is not to exceed 5 feet. Provide runouts that are preinsulated, factory fabricated, and that comply with NFPA 90A and UL 181. Provide either field or factory applied vapor barrier. Provide not less than 20 ounce glass fabric duct connectors coated on both sides with neoprene. Where coil induction units or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. Insulated flexible connectors are allowed as runouts. Provide insulated material and vapor barrier that conform to the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Do not expose the insulation material surface to the air stream.

2. General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

B. Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

C. Fire Dampers

Use 1.5 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire

dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies in conformance with UL Fire Resistance. Provide curtain type with damper blades fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and NFPA 90A.

D. Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

E. Air Supply And Exhaust Air Dampers

Where outdoor air supply and exhaust air dampers are required they shall have a maximum leakage rate when tested in accordance with AMCA 500-D as required by ASHRAE 90.1 - IP, including maximum Damper Leakage for:

1. Climate Zones 1,2,6,7,8 the maximum damper leakage at 1.0 inch w.g. for motorized dampers is 4 cfm per square foot of damper area and non-motorized dampers are not allowed.

2. All other Climate Zones the maximum damper leakage at 1.0 inch w.g. is 10 cfm per square foot and for non-motorized dampers is 20 cfm per square foot of damper area.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

F. Air Deflectors (Volume Extractors) and Branch Connections

Provide air deflectors (volume extractors) at all duct mounted supply outlets, at takeoff or extension collars to supply outlets, at duct branch takeoff connections, and at 90 degree

elbows, as well as at locations as indicated on the drawings or otherwise specified. Conical branch connections or 45 degree entry connections are allowed in lieu of deflectors for branch connections. Furnish all air deflectors (volume extractors), except those installed in 90 degree elbows, with an approved means of adjustment. Provide easily accessible means for adjustment inside the duct or from an adjustment with sturdy lock on the face of the duct. When installed on ducts to be thermally insulated, provide external adjustments with stand-off mounting brackets, integral with the adjustment device, to provide clearance between the duct surface and the adjustment device not less than the thickness of the thermal insulation. Provide factory-fabricated air deflectors consisting of curved turning vanes or louver blades designed to provide uniform air distribution and change of direction with minimum turbulence or pressure loss. Provide factory or field assembled air deflectors (volume extractors). Make adjustment from the face of the diffuser or by position adjustment and lock external to the duct. Provide stand-off brackets on insulated ducts as described herein. Provide fixed air deflectors (volume extractors), also called turning vanes, in 90 degree elbows.

G. Sound Attenuation Equipment

1. System with total pressure of 4 Inch Water Gauge and Lower

Use sound attenuators only where indicated. Provide factory fabricated sound attenuators that are constructed of galvanized steel sheets. Provide attenuator with outer casing that is not less than 22 gauge. Provide fibrous glass acoustical fill. Provide net sound reduction indicated. Obtain values on a test unit not less than 24 by 24 inches outside dimensions made by a certified nationally recognized independent acoustical laboratory. Provide air flow capacity as indicated or required. Provide pressure drop through the attenuator that does not exceed the value indicated, or that is not in excess of 15 percent of the total external static pressure of the air handling system, whichever is less. Acoustically test attenuators with metal duct inlet and outlet sections while under the rated air flow conditions. Include with the noise reduction data the effects of flanking paths and vibration transmission. Construct sound attenuators to be airtight when operating at the internal static pressure indicated or specified for the duct system, but in no case less than 2 inch water gauge.

2. Acoustical Duct Liner

Use fibrous glass designed or flexible elastomeric duct liner for lining ductwork and conforming to the requirements of ASTM C1071, Type I and II. Provide uniform density, graduated density, or dual density liner composition, as standard with the manufacturer. Provide not less than 1 inch thick coated lining. Where acoustical duct liner is used, provide the thermal equivalent of the insulation specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS for liner or combination of liner and insulation applied to the exterior of the ductwork. Increase duct sizes shown to compensate for the thickness of the lining used.

H. Diffusers, Registers, and Grilles

Provide factory-fabricated units of steel that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers, except linear slot diffusers. Provide linear slot diffusers with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

1. Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Provide air handling troffers or combination light and ceiling diffusers conforming to the requirements of UL Electrical Constructn for the interchangeable use as cooled or heated air supply diffusers or return air units. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2. Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

I. Louvers

Provide louvers for installation in exterior walls that are associated with the air supply and distribution system as specified in Section 08 91 00 METAL WALL LOUVERS.

J. Bird Screens and Frames

Provide bird screens that conform to ASTM E2016, No. 2 mesh, aluminum or stainless steel. Provide "medium-light" rated aluminum screens. Provide "light" rated stainless steel screens. Provide removable type frames fabricated from either stainless steel or extruded aluminum.

2.09 AIR SYSTEMS EQUIPMENT

A. Fans

Test and rate fans according to AMCA 210. Calculate system effect on air moving devices in accordance with AMCA 201 where installed ductwork differs from that indicated on drawings. Install air moving devices to minimize fan system effect. Where system effect is unavoidable, determine the most effective way to accommodate the inefficiencies caused by system effect on the installed air moving device. The sound power level of the fans shall not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 120 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D (A fixed-pitch sheave is provided on both the fan shaft and the motor shaft. This is a non-adjustable speed drive.). Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

1. Centrifugal Type Power Roof Ventilators

Provide direct or V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, gravity dampers, roof curb. Provide dripproof type motor enclosure. Use only lubricated bearings.

2. Ceiling Exhaust Fans

Provide centrifugal type, direct driven suspended cabinet-type ceiling exhaust fans. Provide fans with acoustically insulated housing. Provide chatter-proof backdraft damper. Provide egg-crate design or louver design integral face grille. Mount fan motors on vibration isolators. Furnish unit with mounting flange for hanging unit from above. Provide U.L. listed fans.

2.10 FACTORY PAINTING

Factory paint new equipment, which are not of galvanized construction. Paint with a corrosion resisting paint finish according to ASTM A123/A123M or ASTM A924/A924M. Clean, phosphatize and coat internal and external ferrous metal surfaces with a paint finish which has been tested according to ASTM B117, ASTM D1654, and ASTM D3359. Submit evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors. Provide rating of failure at the scribe mark that is not less than 6, average creepage not greater than 1/8 inch. Provide rating of the inscribed area that is not less than 10, no failure. On units constructed of galvanized steel that have been welded, provide a final shop docket of zinc-rich protective paint on exterior surfaces of welds or welds that have burned through from the interior according to ASTM D520 Type I.

Factory painting that has been damaged prior to acceptance by the Contracting Officer shall be field painted in compliance with the requirements of paragraph FIELD PAINTING OF MECHANICAL EQUIPMENT.

PART 3 EXECUTION

3.01 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.02 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional 3 feet.

c. Except as otherwise indicated, install emergency switches and

alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

A. Condensate Drain Lines

Provide water seals in the condensate drain from all units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

B. Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated. Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00.00 10 CAST-IN-PLACE CONCRETE.

C. Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced. Provide access panels as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

D. Flexible Duct

Install pre-insulated flexible duct in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Provide hangers, when required to suspend the duct, of the type recommended by the duct manufacturer and set at the intervals recommended.

E. Metal Ductwork

Install according to SMACNA 1966 unless otherwise indicated. Install duct supports for sheet metal ductwork according to

SMACNA 1966, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA 1966. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate metal framing. Where C-clamps are used, provide retainer clips.

F. Acoustical Duct Lining

Apply lining in cut-to-size pieces attached to the interior of the duct with nonflammable fire resistant adhesive conforming to ASTM C916, Type I, NFPA 90A, UL 723, and ASTM E84. Provide top and bottom pieces that lap the side pieces and are secured with welded pins, adhered clips of metal, nylon, or high impact plastic, and speed washers or welding cup-head pins installed according to SMACNA 1966. Provide welded pins, cup-head pins, or adhered clips that do not distort the duct, burn through, nor mar the finish or the surface of the duct. Make pins and washers flush with the surfaces of the duct liner and seal all breaks and punctures of the duct liner coating with the nonflammable, fire resistant adhesive. Coat exposed edges of the liner at the duct ends and at other joints where the lining is subject to erosion with a heavy brush coat of the nonflammable, fire resistant adhesive, to prevent delamination of glass fibers. Apply duct liner to flat sheet metal prior to forming duct through the sheet metal brake. Additionally secure lining at the top and bottom surfaces of the duct by welded pins or adhered clips as specified for cut-to-size pieces. Other methods indicated in SMACNA 1966 to obtain proper installation of duct liners in sheet metal ducts, including adhesives and fasteners, are acceptable.

G. Dust Control

To prevent the accumulation of dust, debris and foreign material during construction, perform temporary dust control protection. Protect the distribution system (supply and return) with temporary seal-offs at all inlets and outlets at the end of each day's work. Keep temporary protection in place until system is ready for startup.

H. Insulation

Provide thickness and application of insulation materials for ductwork, piping, and equipment according to Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Externally insulate outdoor air intake ducts and plenums up to the point where the outdoor air reaches the conditioning unit.

I. Duct Test Holes

Provide holes with closures or threaded holes with plugs in ducts and plenums as indicated or where necessary for the use of pitot tube in balancing the air system. Plug insulated duct at the duct surface, patched over with insulation and then marked to indicate

location of test hole if needed for future use.

3.03 EQUIPMENT PADS

Provide equipment pads to the dimensions shown or, if not shown, to conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 28 calendar days before being loaded.

3.04 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

3.05 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.06 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

A. Sleeves

Fabricate sleeves, except as otherwise specified or indicated, from 20 gauge thick mill galvanized sheet metal. Where sleeves are installed in bearing walls or partitions, provide black steel pipe conforming with ASTM A53/A53M, Schedule 20.

B. Framed Prepared Openings

Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

C. Insulation

Provide duct insulation in accordance with Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS continuous through sleeves and prepared openings except firewall penetrations. Terminate duct insulation at fire dampers and flexible connections. For duct handling air at or below 60 degrees F, provide insulation continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air.

D. Firestopping

Where ducts pass through fire-rated walls, fire partitions, and fire rated chase walls, seal the penetration with fire stopping materials as specified in Section 07 84 13 PENETRATIONFIRESTOPPING.

3.07 IDENTIFICATION SYSTEMS

Provide identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and item number on all valves and dampers. Provide tags that are 1-3/8 inch minimum diameter with stamped or engraved markings. Make indentations black for reading clarity. Attach tags to valves with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire, copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.08 DUCTWORK LEAK TEST

Perform ductwork leak test for the entire air distribution and exhaust system, including fans, coils, filters, etc. Provide test procedure, apparatus, and report that conform to SMACNA 1972 CD. The maximum allowable leakage rate is 5 percent. Complete ductwork leak test with satisfactory results prior to applying insulation to ductwork exterior.

3.09 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.10 TESTING, ADJUSTING, AND BALANCING

The requirements for testing, adjusting, and balancing are specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC. Begin testing, adjusting, and balancing only when the air supply and distribution, including controls, has been completed, with the exception of performance tests.

3.11 PERFORMANCE TESTS

After testing, adjusting, and balancing is complete as specified, test

each system as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Record the testing during the applicable season. Make corrections and adjustments as necessary to produce the conditions indicated or specified. Conduct capacity tests and general operating tests by an experienced engineer. Provide tests that cover a period of not less than 1 days for each system and demonstrate that the entire system is functioning according to the specifications. Make coincidental chart recordings at points indicated on the drawings for the duration of the time period and record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors and the ambient temperature and humidity in a shaded and weather protected area.

Submit test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Document phases of tests performed including initial test summary, repairs/adjustments made, and final test results in the reports.

3.12 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of room fan-coil units thoroughly clean ducts, plenums, and casing of debris and blow free of small particles of rubbish and dust and then vacuum clean before installing outlet faces. Wipe equipment clean, with no traces of oil, dust, dirt, or paint spots. Provide temporary filters prior to startup of all fans that are operated during construction, and install new filters after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. Maintain system in this clean condition until final acceptance. Properly lubricate bearings with oil or grease as recommended by the manufacturer. Tighten belts to proper tension. Adjust control valves and other miscellaneous equipment requiring adjustment to setting indicated or directed. Adjust fans to the speed indicated by the manufacturer to meet specified conditions. Maintain all equipment installed under the contract until close out documentation is received, the project is completed and the building has been documented as beneficially occupied.

3.13 OPERATION AND MAINTENANCE

A. Operation and Maintenance Manuals

Submit six manuals at least 2 weeks prior to field training. Submit data complying with the requirements specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data.

B. Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer. Make the training period consist of a total of 8 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of

routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section --

SECTION 23 03 00.00

BASIC MECHANICAL MATERIALS AND METHODS
08/10

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017; Errata 1 2017) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

1.02 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 22, PLUMBING; and 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

1.03 QUALITY ASSURANCE

A. Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through

advertisements, manufacturers' catalogs, or brochures during the 2 year period.

B. Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

C. Service Support

The equipment items must be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations must be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Nameplate

For each item of equipment, provide a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

E. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions must be considered mandatory, the word "should" is interpreted as "must." Reference to the "code official" must be interpreted to mean the "Contracting Officer."

2. Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, must be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.04 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.05 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Motors, controllers, disconnects and contactors must conform to and have electrical connections provided under Division 26. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and must have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work must be included under the section that specified that motor or equipment. Power wiring and conduit for field installed equipment must be provided under and conform to the requirements of Division 26.

1.06 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations must conform to IEEE C2, NFPA 70, and requirements specified herein.

A. New Work

Provide electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not to be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits must be provided under Division 26, except internal wiring for components of package equipment must be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

B. High Efficiency Motors

1. High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors must be high efficiency types corresponding to the applications listed in NEMA MG 11.

2. High Efficiency Polyphase Motors

Unless otherwise specified, polyphase motors must be

selected based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, polyphase squirrel-cage medium induction motors with continuous ratings must meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

C. Three-Phase Motor Protection

Provide controllers for motors rated one 1 horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.07 INSTRUCTION TO GOVERNMENT PERSONNEL

When specified in other sections, furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the specified equipment or system. Instructors must be thoroughly familiar with all parts of the installation and must be trained in operating theory as well as practical operation and maintenance work.

Instruction must be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished must be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with the equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

1.08 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 PAINTING OF NEW EQUIPMENT

New equipment painting must be factory applied or shop applied, and must be as specified herein, and provided under each individual section.

A. Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system must be designed for the temperature service.

B. Shop Painting Systems for Metal Surfaces

Clean, pretreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F must be cleaned to bare metal.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat must be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F must receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of 1 mil; and two coats of enamel applied to a minimum dry film thickness of 1 mil per coat.

-- End of Section --

SECTION 23 05 15

COMMON PIPING FOR HVAC
02/14

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding
AWS WHB-2.9	(2004) Welding Handbook; Volume 2, Welding Processes, Part 1

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1	(2012) Plumbing Supply Fittings
ASME A112.19.2/CSA B45.1	(2013) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME B1.20.7	(1991; R 2013) Standard for Hose Coupling Screw Threads (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.22	(2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2014) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2016) Process Piping

ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2010) BPVC Section IX-Welding and Brazing Qualifications
ASME BPVC SEC VIII D1	(2015) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197/A197M	(2000; R 2015) Standard Specification for Cupola Malleable Iron
ASTM A234/A234M	(2016) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A480/A480M	(2016) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A6/A6M	(2016a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A74	(2016) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B370	(2012) Standard Specification for Copper Sheet and Strip for Building Construction

ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B749	(2014) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B88	(2016) Standard Specification for Seamless Copper Water Tube
ASTM C109/C109M	(2016a) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C404	(2011) Standard Specification for Aggregates for Masonry Grout
ASTM C476	(2016) Standard Specification for Grout for Masonry
ASTM C553	(2013) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C564	(2014) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C67	(2016) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM E1	(2014) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM F104	(2011) Standard Classification System for Nonmetallic Gasket Materials

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017; Errata 1 2017) National Electrical Safety Code

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-125	(2010) Gray Iron and Ductile Iron In-Line,

	Spring-Loaded, Center-Guided Check Valves
MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(Rev A; Notice 2) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 2) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 2) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 2) Shield Expansion (Nail Anchors)
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(Basic; Notice 2) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2015) Fire Tests of Through-Penetration Firestops

1.02 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section

Section 23 05 48.00 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT applies to work specified in this section.

Include with Equipment Foundation Data for piping systems all plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit Fabrication Drawings for pipes, valves and specialties consisting of fabrication and assembly details to be performed in the factory.

Submit Material, Equipment, and Fixture Lists for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Provide a complete list of construction equipment to be used.

Submit Manufacturer's Standard Color Charts for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

Include with Listing of Product Installations for piping systems identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include in the list purchaser, address of installation, service organization, and date of installation.

Submit Record Drawings for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

Submit Connection Diagrams for pipes, valves and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit Coordination Drawings for pipes, valves and specialties showing coordination of work between different trades and with the structural and architectural elements of work. Detail all drawings sufficiently to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate on drawings where conflicts or clearance problems exist between various trades.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists; G

SD-02 Shop Drawings

Record Drawings; G

Connection Diagrams; G

Coordination Drawings; G

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Pipe and Fittings; G

Piping Specialties; G

Valves; G

Miscellaneous Materials; G

Supporting Elements; G

Equipment Foundation Data; G

SD-04 Samples

Manufacturer's Standard Color Charts; G

SD-05 Design Data

Pipe and Fittings; G

Piping Specialties; G

Valves; G

SD-06 Test Reports

Hydrostatic Tests; G

Air Tests; G

Valve-Operating Tests; G

Drainage Tests; G

Pneumatic Tests; G

Non-Destructive Electric Tests; G

System Operation Tests; G

SD-07 Certificates

Record of Satisfactory Field Operation

List of Qualified Permanent Service Organizations

Listing of Product Installations

Surface Resistance; G

Shear and Tensile Strengths; G

Temperature Ratings; G

Bending Tests; G

Flattening Tests; G

Transverse Guided Weld Bend Tests; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.04 QUALITY ASSURANCE

A. Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Provide standard products in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use includes applications of equipment and materials under similar circumstances and of similar size. Ensure the product has been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

B. Alternative Qualifications

Products having less than a two-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

C. Service Support

Ensure the equipment items are supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. Select service organizations that are reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Nameplate

Provide a nameplate on each item of equipment bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent is not acceptable.

E. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer.

1. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions are considered mandatory, the word "should" is interpreted as "shall". Reference to the "code official" is interpreted to mean the "Contracting Officer".

2. Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, are applied as appropriate by the Contracting Officer and as authorized by his administrative cognizance and the FAR.

1.05 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.06 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Ensure motors, controllers, disconnects and contactors conform to and have electrical connections provided under Division 26. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors is not permitted. Provide controllers and contactors with a maximum of 120 volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conform to the

requirements of Division 26.

1.07 ELECTRICAL INSTALLATION REQUIREMENTS

Ensure electrical installations conform to IEEE C2, NFPA 70, and requirements specified herein.

A. New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors are not permitted. Provide under Division 26, the interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits, except internal wiring for components of package equipment is provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

B. Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

C. High Efficiency Motors

1. High Efficiency Single-Phase Motors

Unless otherwise specified, provide high efficiency single-phase fractional-horsepower alternating-current motors corresponding to the applications listed in NEMA MG 11.

2. High Efficiency Polyphase Motors

Unless otherwise specified, select polyphase motors based on high efficiency characteristics relative to the applications as listed in NEMA MG 10. Additionally, ensure polyphase squirrel-cage medium induction motors with continuous ratings meet or exceed energy efficient ratings in accordance with Table 12-6C of NEMA MG 1.

D. Three-Phase Motor Protection

Provide controllers for motors rated one one horsepower and larger with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

1.08 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

Submit equipment and performance data for pipe and fittings consisting of corrosion resistance, life expectancy, gauge tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Type BCS, Black Carbon Steel

Ensure pipe 1/8 through 12 inches is Schedule 40 black carbon steel, conforming to ASTM A53/A53M.

Ensure fittings 2 inches and under are 150-pounds per square inch, gauge (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A197/A197M and ASME B16.3.

Ensure unions 2 inches and under are 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Ensure fittings 2-1/2 inches and over are Steel butt weld, conforming to ASTM A234/A234M and ASME B16.9 to match pipe wall thickness.

Ensure flanges 2-1/2 inches and over are 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

B. Type BCS-125, 125-psi Service

Ensure pipe 1/8 through 1-1/2 inches is Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A53/A53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Ensure pipe 2 through 10 inches is Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M Type S (seamless) and ASME B36.10M.

Ensure fittings 2 inches and under are 125-psig wsp, cast iron, screwed end, conforming to ASTM A126 Class A and ASME B16.4.

C. Type CISP-DWV, Cast-Iron Drain, Waste and Vent

Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A74. Caulk and lead all joints in lines where necessary to provide proper leaktight support and alignment; other-wise joints may be two-gasket system type chloroprene, conforming to ASTM C564. Select the extra heavy (CISP-DWV-XH) pipe class.

D. Type CPR, Copper

1. Type CPR-A, Copper Above Ground

Ensure tubing 2 inches and under is seamless copper tubing, conforming to ASTM B88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for vertical lines).

Ensure fittings 2 inches and under are 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22.

Ensure unions 2 inches and under are 150-psig wsp wrought-copper solder joint, conforming to ASME B16.22.

Provide brazing rod with Classification BCuP-5, conforming to AWS A5.8/A5.8M.

Use solder, alloy Sb-5, conforming to ASTM B32.

2. Type CPR-U, Copper Under Ground

Provide Type K seamless copper tube piping, conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Ensure fittings for connection to corporation cocks are cast bronze, flared-type, conforming to ASME B16.26. Braze the joints.

3. Type CPR-INS, Copper Under Ground Insulated

Provide insulated Type K seamless copper tube piping conforming to ASTM B88. Use wrought copper socket-joint fittings, conforming to ASME B16.22. Braze the joints.

Provide insulation not less than 2 inches thick, suitable for continuous service temperatures of not less than 250 degrees F. Use factory-molded, closed-cell polyurethane foam insulation of not less than 2.5 pounds per cubic foot density. Waterproof insulation with an extruded rigid Type II virgin polyvinylchloride, with minimum wall thickness of 60 mils through 4 inches outside diameter, 85 mils through 6.625 inches and 110 mils through 12.750 inches. Provide fitting covers fabricated from the same materials and thickness as adjacent pipe covering according to the manufacturer's directions.

2.02 PIPING SPECIALTIES

Submit equipment and performance data for piping specialties

consisting of corrosion resistance, life expectancy, gauge tolerances, and grade line analysis. Submit design analysis and calculations consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Air Separator

Provide a commercially constructed separator, designed and certified to separate not less than 80 percent of entrained air on the first passage of water and not less than 80 percent of residual on each successive pass. Provide shop drawings detailing all piping connections proposed for this work.

Ensure the air separator is carbon steel, designed, fabricated, tested, and stamped in conformance with ASME BPVC SEC VIII D1 for service pressures not less than 125 psi.

B. Air Vents

Provide manual air vents using 3/8-inch globe valves.

Provide automatic air vents on pumps, mains, and where indicated using ball-float construction. Ensure the vent inlet is not less than 3/4-inch ips and the outlet not less than 1/4-inch ips. Orifice size is 1/8 inch. Provide corrosion-resistant steel trim conforming to ASTM A480/A480M. Fit vent with try-cock. Ensure vent discharges air at any pressure up to 150 psi. Ensure outlet is copper tube routed.

C. Dielectric Connections

Electrically insulate dissimlar pipe metals from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

D. Expansion Vibration Isolation Joints

Construct single or multiple arch-flanged expansion vibration isolation joints of steel-ring reinforced chloroprene-impregnated cloth materials. Design joint to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Back flanges with ferrous-metal backing rings. Provide control rod assemblies to restrict joint movement. Coat all nonmetallic exterior surfaces of the joint with chlorosulphinated polyethylene. Provide grommets in limit bolt hole to absorb noise transmitted through the bolts.

Ensure joints are suitable for continuous-duty working temperature of at least 250 degrees F.

Fill arches with soft chloroprene.

Ensure joint, single-arch, movement limitations and size-related, pressure characteristics conform to FSA-0017.

E. Flexible Pipe

Construct flexible pipe vibration and pipe-noise eliminators of wire-reinforced, rubber-impregnated cloth and cord materials and be flanged. Back the flanges with ferrous-metal backing rings. Ensure service pressure-rating is a minimum 1.5 times actual service, with surge pressure at 180 degrees F.

Construct flexible pipe vibration and pipe noise eliminators of wire-reinforced chloroprene-impregnated cloth and cord materials. Ensure the pipe is flanged. Provide all flanges backed with ferrous-metal backing rings. Coat nonmetallic exterior surfaces of the flexible pipe with an acid- and oxidation-resistant chlorosulphinated polyethylene. Rate the flexible pipe for continuous duty at 130 psi and 250 degrees F.

Ensure unit pipe lengths, face-to-face, are not less than the following:

INSIDE DIAMETER	UNIT PIPE LENGTH
To 2-1/2 inches, inclusive	12 inches
3 to 4 inches, inclusive	18 inches

F. Flexible Metallic Pipe

Ensure flexible pipe is the bellows-type with wire braid cover and designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Ensure minimum burst pressure is four times working pressure at 300 degrees F. Bellows material is AISI Type 316L corrosion-resistant steel. Ensure braid is AISI 300 series corrosion-resistant steel wire.

Provide threaded end connections; hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A312/A312M.

Ensure flanged end connection rating and materials conform to specifications for system primary-pressure rating.

G. Metallic Expansion Joints

Design and construct joints to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.

Rate, design, and construct joints for pressures to 125 psig and temperatures to 500 degrees F.

Ensure joints have a designed bursting strength in excess of four times their rated pressure.

Ensure joints are capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.

Ensure life expectancy is not less than 10,000 cycles.

Ensure movement capability of each joint exceeds calculated movement of piping by 100 percent.

Provide bellows and internal sleeve material of AISI Type 304, 304L, or 321 corrosion-resistant steel.

End connections require no field preparation other than cleaning.

Flanges of flanged-end expansion joints conforms to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.

Provide joints, 2-1/2 inches and smaller, with internal guides and limit stops.

Provide joints, 3 inches and larger, with removable external covers, internal sleeves, and purging connection. Size sleeves to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, provide the gasket used by the manufacturer. Joints without purging connection may be provided; however, remove these from the line prior to, or not installed until, cleaning operations are complete.

Ensure each expansion joint has adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length is set by the manufacturer to maintain joints in manufacturer's recommended position during installation.

Permanently and legibly mark each joint with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

H. Hose Faucets (Hose Bibs)

Construct hose faucets with 1/2 inch male inlet threads, hexagon shoulder, and 3/4 inch hose connection, conforming to ASME A112.18.1/CSA B125.1. Ensure hose-coupling screw threads conform to ASME B1.20.7.

Provide vandal proof, atmospheric-type vacuum breaker on the discharge of all potable water lines.

I. Pressure Gauges

Ensure pressure gauges conform to ASME B40.100 and to requirements specified herein. Pressure-gauge size is 3-1/2 inches nominal diameter. Ensure case is corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A6/A6M, with an ASM No. 4 standard commercial polish or better. Equip gauges with adjustable red marking pointer and damper-screw adjustment in inlet connection. Align service-pressure reading at midpoint of gauge range. Ensure all gauges are Grade B or better and be equipped with gauge isolators.

J. Sleeve Couplings

Sleeve couplings for plain-end pipe consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

K. Thermometers

Ensure thermometers conform to ASTM E1, except for being filled with a red organic liquid. Provide an industrial pattern armored glass thermometer, (well-threaded and seal-welded). Ensure thermometers installed 6 feet or higher above the floor have an adjustable angle body. Ensure scale is not less than 7 inches long and the case face is manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Provide thermometers with nonferrous separable wells. Provide lagging extension to accommodate insulation thickness.

L. Pump Suction Strainers

Provide a cast iron strainer body, rated for not less than 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction is such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Ensure minimum ratio of open area of each basket to pipe area is 3 to 1. Provide a basket with AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Ensure mesh is capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Provide reducing fittings from strainer-flange size to pipe size.

Provide a differential-pressure gauge fitted with a two-way brass cock across the strainer.

Provide manual air vent cocks in cap of each strainer.

M. Line Strainers, Water Service

Install Y-type strainers with removable basket. Ensure strainers in sizes 2-inch ips and smaller have screwed ends; in sizes 2-1/2-inch ipsand larger, strainers have flanged ends. Ensure body working-pressure rating exceeds maximum service pressure of installed system by at least 50 percent. Ensure body has cast-in arrows to indicate direction of flow. Ensure all strainer bodies fitted with screwed screen retainers have straight threads and gasketed with nonferrous metal. For strainer bodies 2-1/2-inches and larger, fitted with bolted-on screen retainers, provide offset blowdown holes. Fit all strainers larger than 2-1/2-inches with manufacturer's standard ball-type blowdown valve. Ensure body material is cast bronze conforming to ASTM B62. Where system material is nonferrous, use nonferrous metal for the metal strainer body material.

Ensure minimum free-hole area of strainer element is equal to not less than 3.4 times the internal area of connecting piping. Strainer screens perforation size is not to exceed 0.045-inch. Ensure strainer screens have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material is AISI Type 304 corrosion-resistant steel.

2.03 VALVES

Submit equipment and performance data for valves consisting of corrosion resistance and life expectancy. Submit design analysis and calculations consisting of rates of flow, head losses, inlet and outlet design, and pressure calculations. Also include in data, pipe dimensions, as well as temperature ratings, vibration and thrust limitations, minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

A. Ball and Butterfly Valves

Ensure ball valves conform to MSS SP-72 for Figure 1A, 1 piece bod 1By, vertically split body 1C, top entry 1D, three piece body and are rated for service at not less than 175 psig at 200 degrees F. For valve bodies in sizes 2 inches and smaller, use screwed-end connection-type constructed of Class A copper alloy. For valve bodies in sizes 2-1/2 inches and larger, use flanged-end connection type, constructed of Class D material. Balls and stems of valves 2 inches and smaller are manufacturer's standard with hard chrome plating finish. Balls and stems of valves 2-1/2 inches and larger are manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Ensure valves are suitable for flow from either direction and seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. Ensure all valves have adjustable packing glands. Seats and seals are fabricated from tetrafluoroethylene.

Ensure butterfly valves conform to MSS SP-67and are the wafer type for mounting between specified flanges. Ensure valves are rated for 150-psig shutoff and nonshock working pressure. Select bodies of cast ferrous metal conforming to ASTM A126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals are fabricated from resilient elastomer designed for field removal and replacement.

B. Drain, Vent, and Gauge Cocks

Provide lever handle drain, vent, and gauge cocks, ground key type, with washer and screw, constructed of polished ASTM B62 bronze, and rated 125-psi wsp. Ensure end connections are rated for specified service pressure.

Ensure pump vent cocks, and where spray control is required, are UL umbrella-hood type, constructed of manufacturer's standard polished brass. Ensure cocks are 1/2-inch ips male, end threaded, and rated at not less than 125 psi at 225 degrees F.

C. Gate Valves (GAV)

Ensure gate valves 2 inches and smaller conform to MSS SP-80. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated use union-ring bonnet, screwed-end type. Make packing of non-asbestos type materials. Use rising stem type valves.

Ensure gate valves 2-1/2 inches and larger, are Type I, (solid wedge disc, tapered seats, steam rated); Class 125 (125-psig steam-working pressure at 353 degrees F saturation); and 200-psig, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Select flanged valves, with bronze trim and outside screw and yoke (OS&Y) construction. Make packing of non-asbestos type materials.

D. Globe and Angle Valves (GLV-ANV)

Ensure globe and angle valves 2 inches and smaller, are 125-pound, 125-psi conforming to MSS SP-80 and to requirements specified herein. For valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated, use union-ring bonnet, screwed-end type. Ensure disc is free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Make packing of non-asbestos type materials. Ensure disk and packing are suitable for pipe service installed.

Ensure globe and angle valves, 2-1/2 inches and larger, are cast iron with bronze trim. Ensure valve bodies are cast iron conforming to ASTM A126, Class A, as specified for Class 1 valves under MSS SP-80. Select flanged valves in conformance with ASME B16.1. Valve construction is outside screw and yoke (OS&Y) type. Make packing of non-asbestos type materials.

E. Standard Check Valves (SCV)

Ensure standard check valves in sizes 2 inches and smaller are 125-psi swing check valves except as otherwise specified. Provide lift checks where indicated. Ensure swing-check pins are nonferrous and suitably hard for the service. Select composition type discs. Ensure the swing-check angle of closure is manufacturer's standard unless a specific angle is needed.

Use cast iron, bronze trim, swing type check valves in sizes 2-1/2 inches and larger. Ensure valve bodies are cast iron, conforming to ASTM A126, Class A and valve ends are flanged in conformance with ASME B16.1. Swing-check pin is AISI Type or approved equal corrosion-resistant steel. Angle of closure is manufacturer's standard unless a specific angle is needed. Ensure valves have bolted and gasketed covers.

Provide check valves with lever-weighted, positive-closure devices and valve ends are flanged.

F. Nonslam Check Valves (NSV)

Provide check valves at pump discharges in sizes 2 inches and

larger with nonslam or silent-check operation conforming to MSS SP-125. Select a valve disc or plate that closes before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Ensure valve is Class 125 rated for 200-psi maximum, nonshock pressure at 150 degrees F in sizes to 12 inches. Use valves that are fitted with flanges conforming to ASME B16.1. Valve body may be cast iron, or equivalent strength ductile iron. Select disks using manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Ensure pins, springs, and miscellaneous trim are manufacturer's standard corrosion-resistant steel. Disk and shaft seals are Buna-N elastomer tetrafluoroethylene.

2.04 MISCELLANEOUS MATERIALS

Submit equipment and performance data for miscellaneous materials consisting of corrosion resistance, life expectancy, gauge tolerances, and grade line analysis.

A. Bolting

Ensure flange and general purpose bolting is hex-head and conforms to ASTM A307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts conform to ASTM A563. Square-head bolts and nuts are not acceptable. Ensure threads are coarse-thread series.

B. Elastomer Caulk

Use two-component polysulfide- or polyurethane-base elastomer caulking material, conforming to ASTM C920.

C. Escutcheons

Manufacture escutcheons from nonferrous metals and chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Ensure metals and finish conforms to ASME A112.19.2/CSA B45.1.

Use one-piece escutcheons where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. Ensure all escutcheons have provisions consisting of setscrews for maintaining a fixed position against a surface.

D. Flashing

Ensure sheetlead conforms to ASTM B749, UNS Alloy Number L50049 (intended for use in laboratories and shops in general application).

Ensure sheet copper conforms to ASTM B370 and be not less than 16 ounces per square foot weight.

E. Flange Gaskets

Provide compressed non-asbestos sheets, conforming to ASTM F104, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 750 degrees F.

F. Grout

Provide shrink-resistant grout as a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C404 and ASTM C476.

Ensure shrink-resistant grout is a combination of pre-measured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C109/C109M	14,000 psi, minimum
Shrinkage, linear maximum		0.00012 inch per inch,
Water absorption	ASTM C67	0.1 percent, maximum
Bond strength to in shear		1,000 psi, minimum steel minimum

G. Pipe Thread Compounds

Use polytetrafluoroethylene tape not less than 2 to 3 mils thick in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Use polytetrafluoroethylene dispersions and other suitable compounds for all other applications upon approval by the Contracting Officer; however, do not use lead-containing compounds in potable water systems.

2.05 SUPPORTING ELEMENTS

Submit equipment and performance data for the supporting elements consisting of corrosion resistance, life expectancy, gauge tolerances, and grade line analysis.

Provide all necessary piping systems and equipment supporting elements, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. Ensure supporting elements are suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Ensure supporting elements conform to requirements of ASME B31.3, and MSS SP-58, except as noted.

Ensure attachments welded to pipe are made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Ensure supporting elements exposed to weather are hot-dip galvanized or stainless steel. Select materials of such a nature that their apparent and latent-strength characteristics are not reduced due to

galvanizing process. Electroplate supporting elements in contact with copper tubing with copper.

Type designations specified herein are based on MSS SP-58. Ensure masonry anchor group-, type-, and style-combination designations are in accordance with CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925, CID A-A-55614, and CID A-A-55615. Provide support elements, except for supplementary steel, that are cataloged, load rated, commercially manufactured products.

A. Building Structure Attachments

1. Anchor Devices, Concrete and Masonry

Ensure anchor devices conform to CID A-A-1922, CID A-A-1923, CID A-A-1924, CID A-A-1925, CID A-A-55614, and CID A-A-55615

For cast-in, floor mounted, equipment anchor devices, provide adjustable positions.

Provide built-in masonry anchor devices.

Do not use powder-actuated anchoring devices to support any mechanical systems components.

2. Beam Clamps

Ensure beam clamps are center-loading MSS SP-58 Type 28.

When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type 25 may be used for piping sizes 2 inches and less and for piping sizes 2 through 10 inches provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, determine rod diameter in accordance with referenced standards.

3. C-Clamps

Do not use C-clamps.

4. Inserts, Concrete

Use concrete MSS SP-58 Type 18 inserts When applied to piping in sizes 2 inches ips and larger and where otherwise required by imposed loads, insert and wire a 1-foot length of 1/2-inch reinforcing rod through wing slots. Submit proprietary-type continuous inserts for approval.

B. Horizontal Pipe Attachments

1. Single Pipes

Support piping in sizes to and including 2-inch ips by MSS SP-58 Type 6 solid malleable iron pipe rings, except that, use split-band-type rings in sizes up to 1-inch ips.

Support piping in sizes through 8-inch ips inclusive by MSS SP-58 Type 1 attachments.

Use MSS SP-58 Type 1 and Type 6 assemblies on vapor-sealed insulated piping and have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Use MSS SP-58 Type 40 shields on all insulated piping. Ensure area of the supporting surface is such that compression deformation of insulated surfaces does not occur. Roll away longitudinal and transverse shield edges from the insulation.

Provide insulated piping without vapor barrier on roll supports with MSS SP-58 Type 39 saddles.

Provide spring supports as indicated.

C. Vertical Pipe Attachments

Ensure vertical pipe attachments are MSS SP-58 Type 8.

Include complete fabrication and attachment details of any spring supports in shop drawings.

D. Hanger Rods and Fixtures

Use only circular cross section rod hangers to connect building structure attachments to pipe support devices. Use pipe, straps, or bars of equivalent strength for hangers only where approved by the Contracting Officer.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

Submit certificates for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Provide certificates verifying Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.

Provide test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests, in compliance with referenced standards contained within this section.

Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-58, and AWS WHB-2.9.

Submit Installation Drawings for pipes, valves and specialties. Drawings include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide

requirements for equipment, and equipment room layout and design. Ensure drawings specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

Ensure connections between steel piping and copper piping are electrically isolated from each other with dielectric couplings (or unions) rated for the service.

Make final connections to equipment with unions provided every 100 feet of straight run. Provide unions in the line downstream of screwed- and welded-end valves.

Ream all pipe ends before joint connections are made.

Make screwed joints with specified joint compound with not more than three threads showing after joint is made up.

Apply joint compounds to the male thread only and exercise care to prevent compound from reaching the unthreaded interior of the pipe.

Provide screwed unions, or bolted flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Securely support piping systems with due allowance for thrust forces, thermal expansion and contraction. Do not subject the system to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Ensure field welded joints conform to the requirements of the AWS WHB-2.9, ASME B31.3, and ASME BPVC SEC IX.

Take all necessary precautions during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Ensure installation conforms to manufacturer's instructions.

3.02 VALVES

Provide valves in piping mains and all branches and at equipment where indicated and as specified.

Provide valves to permit isolation of branch piping and each equipment item from the balance of the system.

Provide riser and downcomer drains above piping shutoff valves in piping 2-1/2 inches and larger. Tap and fit shutoff valve body with a 1/2-inch plugged globe valve.

Provide valves unavoidably located in furred or other normally inaccessible places with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.03 SUPPORTING ELEMENTS INSTALLATION

Provide supporting elements in accordance with the referenced codes

and standards.

Support piping from building structure. Do not support piping from roof deck or from other pipe.

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there is no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangars on different adjacent service lines running parallel with each other in line with each other and parallel to the lines of the building.

Install piping support elements at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout, and not over 1 foot from each change in direction of piping.

Base load rating for all pipe-hanger supports on insulated weight of lines filled with water and forces imposed. Deflection per span is not exceed slope gradient of pipe. Ensure supports are in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, reduce the allowable span proportionately:

PIPE SIZE INCHES	ROD SIZE INCHES	STEEL PIPE FEET	COPPER PIPE FEET
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12

Provide vibration isolation supports where needed. Refer to Section 23 05 48.00 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT where A/C equipment and piping is installed.

Support vertical risers independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Ensure risers have guides for lateral stability. For risers subject to expansion, provide only one rigid support at a point approximately one-third down from the top. Place clamps under fittings unless otherwise specified. Support carbon-steel pipe at each floor and at not more than 15-foot intervals for pipe 2 inches and smaller and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

3.04 PENETRATIONS

Provide effective sound stopping and adequate operating clearance to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceilings where no special acoustic treatment of ceiling is provided. Finish penetrations to be compatible with surface being penetrated.

3.05 SLEEVES

Provide sleeves where piping passes through roofs, masonry, concrete walls and floors.

Continuously braze sleeves passing through steel decks to the deck.

Ensure sleeves that extend through floors, roofs, load bearing walls, and fire barriers are continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. Form all other sleeves by molded linear polyethylene liners or similar materials that are removable. Ensure diameter of sleeves is large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and provides a minimum 3/8-inch clearance. Install a sleeve size to accommodate mechanical and thermal motion of pipe precluding transmission of vibration to walls and the generation of noise.

Pack the space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration solid with a mineral fiber conforming to ASTM C553 Type V (flexible blanket), (to 1,000 degrees F). Provide this packing wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration with an elastomer caulk to a depth of 1/2 inch. Ensure all caulked surfaces are oil- and grease-free.

Ensure through-penetration fire stop materials and methods are in accordance with ASTM E814 and UL 1479.

Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.

3.06 ESCUTCHEONS

Provide escutcheons at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. For insulated pipes, select plates large enough to fit around the insulation. Use chrome-plated escutcheons in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Firmly attach escutcheons with setscrews.

3.07 FLASHINGS

Provide flashings at penetrations of building boundaries by mechanical systems and related work.

3.08 DISINFECTION

Flush piping with potable water until visible grease, dirt and other contaminants are removed (visual inspection).

3.09 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Submit test data that is clear and readily legible.

-- End of Section --

SECTION 23 05 48.00

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT
08/15

PART 1 GENERAL

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section to the extent applicable.

Section 23 05 15 COMMON PIPING FOR HVAC applies to work specified in this section to the extent applicable.

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.71	(1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK	(2016) HVAC Applications Handbook, I-P Edition

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

1.02 ADMINISTRATIVE REQUIREMENTS

Within ten working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure the data includes information on the following:

a. Mountings

b. Bases

c. Isolators

d. Floor-Mounted Piping

e. Vertical Piping

Five working days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights of equipment.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

Outline Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

Isolators; G

SD-06 Test Reports

Type of Isolator; G

Type of Base; G

Allowable Deflection; G

Measured Deflection; G

1.04 QUALITY CONTROL

Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in paragraph EQUIPMENT, means longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

A. Design Requirements

Design for vibration isolation using ASHRAE HVAC APP IP HDBK, Chapter 48, as applicable to the following sections.

1. Mountings

Provide the following mountings:

Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.

Type B: Double elastomer-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50-inch are allowed.

Type C: Free-standing laterally stable open-spring type for deflections over 0.50-inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 0.50-inch clearance maintained around springs, with adjustable limit stops, 0.25-inch thick Type A base elastomer pads, and accessories.

Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow maximum movements of 0.25-inch in each direction, 0.25-inch thick Type A base elastomer pads.

Type F: Combination elastomer-in-shear steel framed for hanger-rod mounting, with minimum total static deflection of 1-inch.

2. Bases

Provide the following bases:

Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.

Type R: Rails, connected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.

Type S: Structural-steel bases common to a supported

assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height is 5-inches.

Type CIB: Provide concrete inertia blocks common to the entire assembly, with welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8-inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts. Fill with 3,000 psi cured-strength concrete.

Configure rectangular inertia bases to accommodate equipment supported.

Ensure minimum thickness of inertia base, in addition to providing suitable mass, is sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components, and is sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Verify minimum thickness, the preceding requirements not withstanding, is 8 percent of the longest base dimension.

Ensure pumps with flexible couplings do not have inertia base less than 8-inches thick, and the minimum mass of concrete inertia block is equal in weight to supported equipment.

2.02 EQUIPMENT

Vibration isolation design per ASHRAE HVAC APP IP HDBK, Chapter 37.

A. Centrifugal Pump Locations

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON/ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Close-couple through 5 hp	None	-R-0.35	C-S-1.0	C-S-1.0
Bedplate-mounted through 5 hp	None	C-CIB-1.0	C-CIB-1.5	C-CIB-1.75

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON/ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON/ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
7-1/2 hp	None	C-CIB-1.0	C-CIB-1.75	C-CIB-2.5
*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES				

B. Air-Cooled Condensing Unit Locations

TYPE EQUIPMENT	20-FOOT ROOF-SPAN PROVISIONS*	30-FOOT ROOF-SPAN PROVISIONS*	40-FOOT ROOF-SPAN PROVISIONS*
Through 5 hp over 900 rpm	B-U-0.5	D-U-1.0	D-U-1.75
Over 5 hp to 500 rpm	B-U-0.5	D-U-1.75	D-U-2.5
500 rpm and over	B-U-0.5	D-U-1.0	D-U-1.75
*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES			

C. Low-Pressure Suspended Air-Handling Unit (AHU) Locations

Vibration-isolation provisions apply to ceiling-suspended Air Moving and Conditioning Association Class A packaged central-station units.

TYPE EQUIPMENT	20-FOOT ROOF-SPAN PROVISIONS*	30-FOOT ROOF-SPAN PROVISIONS*	40-FOOT ROOF-SPAN PROVISIONS*
Through 5 hp	F-U-1.0	F-U-1.0	F-U-1.0
7-1/2 hp and over 250 to 500 rpm	F-U-1.75	F-U-1.75	F-U-1.75
500 rpm and over	F-U-1.0	F-U-1.25	F-U-1.55
*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES			

D. Pipe And Duct Vibration Isolation

Type G: Provide isolators with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 1-inch and 3/8-inch, respectively.

Type H: Provide isolators with contained chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8-inch.

Type J: Provide isolators with elastomers mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 3/8-inch.

1. Vertical Piping

Type L: Provide isolators which are pipe base-support devices with one or more contained steel springs. Load devices by supported system during operating conditions to produce a minimum static deflection of 1-inch. Equip devices with precompression and vertical-limit features, as well as a minimum 1/4-inch thick elastomer sound pad and isolation washers, for mounting to floor.

Type M: Provide isolators which are elastomer mounted baseplate and riser pipe-guide devices, with contained double acting elastomer elements which under rated load have a minimum static deflection of 3/8-inch. Size isolator to accommodate thermal insulation within the stationary guide ring.

2.03 MATERIALS

Ensure rubber is natural rubber and elastomer is chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

2.04 TESTS, INSPECTIONS, AND VERIFICATIONS

Submit test reports for testing vibration isolation for each type of isolator and each type of base. Meet referenced standards contained within this section. Include in test reports allowable deflection and measured deflection also meeting referenced standards within this section.

PART 3 EXECUTION

3.01 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than 1-inch above the floor and are level when equipment supported is under operating load.

Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

3.02 FIELD QUALITY CONTROL

A. Tests and Reports

Ensure vibration-isolation devices are deflection tested. Submit test reports substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Contracting Officer.

-- End of Section --

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC
11/15

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S1.11 PART 1	(2014) American National Standard Electroacoustics - Octave-Band and Fractional-Octave-Band Filters - Part 1: Specifications
ASA S1.4	(1983; Amendment 1985; R 2006) Specification for Sound Level Meters (ASA 47)

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 203	(1990; R 2011) Field Performance Measurements of Fan Systems

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2013) Ventilation for Acceptable Indoor Air Quality
ASHRAE HVAC APP IP HDBK	(2016) HVAC Applications Handbook, I-P Edition

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002; 6th ed) National Standards for Total System Balance
AABC MN-4	(1996) Test and Balance Procedures

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB MASV	(2006) Procedural Standards for Measurements and Assessment of Sound and Vibration
NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1780	(2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition
SMACNA 1858	(2004) HVAC Sound And Vibration Manual - First Edition
SMACNA 1972 CD	(2012) HVAC Air Duct Leakage Test Manual - 2nd Edition

1.02 DEFINITIONS AND RELATED TERMS

A. Definitions

1. AABC: Associated Air Balance Council

2. COTR: Contracting Officer's Technical Representative

3. DALT: Duct air leakage test

4. DALT'd: Duct air leakage tested

5. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling

6. NEBB: National Environmental Balancing Bureau

7. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means "a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction and sealant class". When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

8. Season of maximum heating load: The time of year when the outdoor temperature at the project site remains within plus or minus 30 degrees Fahrenheit of the project site's winter outdoor design temperature, throughout the period of TAB data recording.

9. Season of maximum cooling load: The time of year when the outdoor temperature at the project site remains within plus or minus 5 degrees Fahrenheit of the project site's summer outdoor design temperature, throughout the period of TAB data recording.

10. Season 1, Season 2: Depending upon when the project HVAC is completed and ready for TAB, Season 1 is defined, thereby defining Season 2. Season 1 could be the season of maximum heating load, or the season of maximum cooling load.

11. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

12. TAB: Testing, adjusting, and balancing (of HVAC systems)

13. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed

14. TAB Agency: TAB Firm

15. TAB team leader: TAB team field leader

16. TAB team supervisor: TAB team engineer

17. TAB team technique: TAB team assistants

18. TABB: Testing Adjusting and Balancing Bureau

B. Similar Terms

In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS			
Contract Term	AABC Term	NEBB Term	TABB Term
TAB Standard	National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems	Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems	International Standards for Environmental Systems Balance
TAB Specialist	TAB Engineer	TAB Supervisor	TAB Supervisor
Systems Readiness Check	Construction Phase Inspection	Field Readiness Check & Preliminary Field Procedures	Field Readiness Check & Preliminary Field Procedures

1.03 WORK DESCRIPTION

The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings.

Perform TAB in accordance with the requirements of the TAB procedural

standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1972 CD, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

A. Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

B. Water Distribution Systems

TAB systems in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

C. TAB SCHEMATIC DRAWINGS

Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Air quantities and temperatures in air handling unit schedules.

4. Water quantities and temperatures in thermal energy transfer equipment schedules.

5. Water quantities and heads in pump schedules.

6. Water flow measurement fittings and balancing fittings.

7. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications: http://www.wbdg.org/FFC/NAVGRAPH/graphtoc.pdf

The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

Submit three copies of the TAB Schematic Drawings and Report Forms and proposed TAB procedures to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are forinformation only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions; G

TAB Firm; G

TAB Specialist; G

SD-02 Shop Drawings

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SD-11 Closeout Submittals

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1.05 QUALITY ASSURANCE

A. Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

1. Independent AABC or NEBB or TABB TAB agency:

a. TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

b. TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

c. TAB team field leader: Name and documented evidence that

the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

d. TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

e. Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

2. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

3. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

B. TAB Standard

Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

C. Qualifications

1. TAB Firm

The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems building systems commissioning.

Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

2. TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

3. TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process.

4. TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB, no later than 7 days after the approval of the TAB team engineer and assistant. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Government. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

D. Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in the paragraph TAB SUBMITTAL AND WORK SCHEDULE.

1. Contractor

a. AB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirementsspecified in the paragraph TAB PERSONNEL QUALIFICATION REQUIREMENTS.

b. Pre-DALT/TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

1) Contract drawings and specifications
2) Approved submittal data for equipment
3) Construction work schedule
4) Up-to-date revisions and change orders for the previously listed items

d. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in the paragraph TAB SUBMITTAL AND WORK SCHEDULE is met.

e. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated

test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

f. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting Officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

g. Prerequisite HVAC work: Complete check out anddebugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, andverifying all adjustable devices are functioning asdesigned. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

h. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

    1) HVAC system installations are fully complete.

    2) HVAC prerequisite checkout work lists specified in the paragraph PRE-FIELD TAB ENGINEERING REPORT are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

    3) DALT field checks for all systems are completed.

    4) HVAC system filters are clean for both Season 1 and Season 2 TAB field work.

i. Advance notice: Furnish to the Contracting Officer with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

j. Insulation work: For required DALT work, ensure that insulation is not installed on ducts to be DALT'd until DALT work on the subject ducts is complete. Later, ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

2. TAB Agency

Provide the services of a TAB team which complies with the requirements of the paragraph INDEPENDENT TAB AGENCY PERSONNEL QUALIFICATIONS. The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air and water systems to satisfy the requirements of this specification section.

3. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Pre-DALT/TAB meeting: Attend meeting with Contractor.

c. Design review report: Review project specifications and accompanying drawings to verify that the air systems and water systems are designed in such a way that the TAB engineer can accomplish the work in compliance with the requirements of this section. Verify the presence and location of permanently installed test ports and other devices needed, including gauge cocks, thermometer wells, flow control devices, circuit setters, balancing valves, and manual volume dampers.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency, such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, during the DALT or the TAB field work.

e. Pre-field DALT preliminary notification: Monitor the completion of the duct installation of each system and provide the necessary written notification to the Contracting Officer.

f. Pre-field engineering report: Utilizing the following HVAC-related documentation; contract drawings and specifications, approved submittal data for equipment, up-to-date revisions and change orders; prepare this report.

g. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

h. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

(2) DALT field visit: Near the end of the DALT field work effort, visit the contract site to inspect the HVAC installation and the progress of the DALT field work. Conduct a site visit to the extent necessary to verify correct procedures are being implemented and to confirm the accuracy of the Pre-final DALT Report data which has been reported. Also, perform sufficient evaluation to allow the TAB supervisor to issue certification of the final report. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

i. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Review: Review the Pre-final DALT report data. .From these field reports, prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

j. Technical Assistance for TAB Work: Provide immediate technical assistance to the TAB field team for the TAB work.

(1) TAB field visit: At the midpoint of the Season 1 and Season 2 TAB field work effort, visit the contract site to inspect the HVAC installation and the progress of the TAB field work. Conduct the site visit full-time for a minimum of one 8 hour workday duration.

k. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

l. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies.

Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

m. TAB Field Check: The TAB team supervisor must attend and supervise Season 1 and Season 2 TAB field check.

4. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, EXECUTION.

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

E. Test Reports

1. Data from DALT Field Work

Report the data for the Pre-final DALT Report and Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1972 CD. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition,provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

2. Certified TAB Reports

Submit: TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Measure and compile data on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season I and Season 2 TAB Report.

c. Duct Traverses: Report duct traverses for main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

d. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration

date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

e. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

f. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

g. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

1.06 SEQUENCING AND SCHEDULING

A. DALT and TAB Submittal and Work Schedule

Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer for review and approval. Include with the submittal the planned calendar dates for each submittal or work item. Resubmit an updated version for Contracting Officer approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

1. Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

2. Pre-DALT/TAB Meeting: Within 30 calendar days after the date of approval of the TAB agency and personnel, meet with the COTR.

3. Design Review Report: Within 60 calendar days after the date of the TAB agency personnel qualifications approval, submit design review report.

4. Pre-Field DALT Preliminary Notification: On completion of the duct installation for each system, notify the Contracting Officer in writing within 5 days after completion.

5. Ductwork Selected for DALT: Within 7 calendar days of Pre-Field DALT Preliminary Notification, the COTR will select which of the project ductwork must be DALT'd.

6. DALT Field Work: Within 48 hours of COTR's selection, complete DALT field work on selected.

7. Submit Pre-final DALT Report: Within one working day after completion of DALT field work, submit Pre-final DALT Report. Separate Pre-final DALT reports may be submitted to allow

phased testing from system to system.

8. DALT Work Field Check: Upon approval of the Pre-final DALT Report, schedule the COTR's DALT field check work with the Contracting Officer.

9. Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

10. Pre-Field TAB Engineering Report: Within 15 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

11. Prerequisite HVAC Work Check Out List For Season 1 and Advanced Notice For Season 1 TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit Season 1 prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of Season 1 TAB field work.

12. Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work.

13. Submit Season 1 TAB Report: Within 15 calendar days after completion of Season 1 TAB field work, submit Season 1 TAB report.

14. Season 1 TAB Field Check: 30 calendar days after Season 1 TAB report is approved by the Contracting Officer, conduct Season 1 field check.

15. Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

16. Season 1 TAB Field Work: At a minimum of 90 calendar days prior to CCD, and when the ambient temperature is within Season 1 limits, accomplish Season 1 TAB field work; submit Season 1 TAB report; and conduct Season 1 field check.

17. Complete Season 1 TAB Work: Prior to CCD, complete all TAB work except Season 2 TAB work.

18. Prerequisite HVAC Work Check Out List For Season 2 and Advanced Notice For Season 2 TAB Field Work: Within 150 calendar days after date of the commencement of the Season 1 TAB field work, submit the Season 2 prerequisite HVAC work check out list certified as complete and submit advance notice of commencement of Season 2 TAB field work.

19. Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work.

20. Submit Season 2 TAB Report: Within 15 calendar days after completion of Season 2 TAB field work, submit Season 2 TAB report.

21. Season 2 TAB Field Check: 30 calendar days after the Season 2 TAB report is approved by the Contracting Officer, conduct Season 2 field check.

22. Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 TAB field data check, complete all TAB work.

23. Season 2 TAB Field Work: Within 180 calendar days after date of commencement of the Season 1 TAB field work and when the ambient temperature is within Season 2 limits, accomplish Season 2 TAB field work; submit Season 2 TAB report; and conduct Season 2 field check.

24. Complete Season 2 TAB Work: Within 15 calendar days after the completion of Season 2 field data check, complete TAB work.

B. TAB Design Review Report

Submit typed report describing omissions and deficiencies in the HVAC system's design that would preclude the TAB team from accomplishing the duct leakage testing work and the TAB work requirements of this section. Provide a complete explanation including supporting documentation detailing the design deficiency. State that no deficiencies are evident if that is the case.

C. Pre-Field DALT Preliminary Notification

Notification: On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing within 7 calendar days after completion.

D. TAB Pre-Field Engineering Report

Submit report containing the following information:

a. Step-by-step TAB procedure:

(1) Strategy: Describe the method of approach to the TAB field work from start to finish. Include in this description a complete methodology for accomplishing each seasonal TAB field work session.

(2) Air System Diagrams: Use the contract drawings and duct fabrication drawings if available to provide air system diagrams in the report showing the location of all terminal outlet supply, return, exhaust and transfer registers, grilles and diffusers. Use a key numbering system on the diagrams which identifies each outlet contained in the outlet airflow report sheets. Show intended locations of all traverses and static pressure readings.

(3) Procedural steps: Delineate fully the intended procedural steps to be taken by the TAB field team to accomplish the required TAB work of each air distribution system and each water distribution system. Include intended procedural steps for TAB

work for subsystems and system components.

b. Pre-field data: Submit AABC or NEBB or SMACNA 1780 data report forms with the following pre-field information filled in:

(1) Design data obtained from system drawings, specifications, and approved submittals.

(2) Notations detailing additional data to be obtained from the contract site by the TAB field team.

(3) Designate the actual data to be measured in the TAB field work.

(4) Provide a list of the types of instruments, and the measuring range of each, which are anticipated to be used for measuring in the TAB field work. By means of a keying scheme, specify on each TAB data report form submitted, which instruments will be used for measuring each item of TAB data. If the selection of which instrument to use, is to be made in the field, specify from which instruments the choice will be made. Place the instrument key number in the blank space where the measured data would be entered.

c. Prerequisite HVAC work checkout list: Provide a list of inspections and work items which are to be completed by the Contractor. This list must be acted upon and completed by the Contractor and then submitted and approved by the Contracting Officer prior to the TAB team coming to the contract site.

At a minimum, a list of the applicable inspections and work items listed in the NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" must be provided for each separate system to be TAB'd.

1.07 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 2 years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 5 year contractor installation warranty.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section.

3.02 PRE-DALT/TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the DALT work and TAB work requirements. Ensure that the TAB supervisor is present at this meeting. Requirements to be discussed include required submittals, work schedule, and field quality control.

3.03 DALT PROCEDURES

A. Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

B. Advance Notice of Pre-Final DALT Field Work

On completion of the installation of each duct system indicated to be DALT'd, notify the Contracting Officer in writing prior to the COTR's duct selection field visit.

C. Ductwork To Be DALT'd

From each duct system indicated as subject to DALT, the COTR will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

D. DALT Testing

Perform DALT on the HVAC duct sections of each system as selected by the COTR. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1972 CD.

In spite of specifications of SMACNA 1972 CD to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the COTR selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

E. Completed Pre-Final DALT Report

After completion of the DALT work, prepare a Pre-final DALT Report using the reporting forms specified. TAB team to furnish data required by those data report forms. Prepare the report neatly and legibly; the Pre-final DALT report is the basis for the Final DALT Report. TAB supervisor must review and certify the Pre-final DALT Report and submit this report within one day of completion of DALT field work. Verbally notify the COTR that the field check of the Pre-final DALT Report data can commence.

F. Quality Assurance - COTR DALT Field Acceptance Testing

In the presence of the COTR and TAB team field leader, verify for accuracy Pre-final DALT Report data selected by the COTR. For each duct system, this acceptance testing shall be conducted on a maximum of 50 percent of the duct sections DALT'd.

Further, if any data on the Pre-final DALT report form for a given duct section is out-of-tolerance, then field acceptance testing shall be conducted on data for one additional duct section, preferably in the same duct system, in the presence of the COTR.

G. Additional COTR Field Acceptance Testing

If any of the duct sections checked for a given system are determined to have a leakage rate measured that exceeds the leakage rate allowed by SMACNA Leak Test Manual for an indicated duct construction class and sealant class, terminate data checking for that section. The associated Pre-final DALT Report data for the given duct system will be disapproved. Make the necessary corrections and prepare a revised Pre-final DALT Report. Reschedule a field check of the revised report data with the COTR.

H. Certified Final DALT Report

On successful completion of all field checks of the Pre-final DALT Report data for all systems, the TAB Supervisor is to assemble, review, certify and submit the Final DALT Report to the Contracting Officer for approval.

I. Prerequisite for TAB Field Work

Do not commence TAB field work prior to the completion and approval, for all systems, of the Final DALT Report.

3.04 TAB PROCEDURES

A. TAB Field Work

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

That is, comply with the the requirements of AABC MN-1 or SMACNA 1780 (TABB) and SMACNA 1858 (TABB),except as supplemented and modified by this section.

Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

Test, adjust, and balance the HVAC systems until measured flow rates (air and water flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB PROCEDURAL STANDARDS and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

B. Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

C. TAB Air Distribution Systems

1. Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX and steam coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of

verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

2. Heat Pump

Heat pump unit systems including fans, coils, ducts, plenums, roof vents, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

3. Exhaust Fans

Exhaust fan systems including fans, ducts, plenums, grilles, and hoods for exhaust air.

D. TAB Water Distribution Systems

1. Condenser

Condenser systems including condensers, pumps, coils, heat exchangers, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

E. Sound Measurement Work

1. Areas To Be Sound Measured

In the following spaces, measure and record the sound power level for each octave band listed in ASHRAE HVAC APP IP HDBK Noise Criteria:

a. All HVAC mechanical rooms, including machinery spaces and other spaces containing HVAC power drivers and power driven equipment.

b. All spaces sharing a common barrier with each mechanical room, including rooms overhead, rooms on the other side of side walls, and rooms beneath the mechanical room floor.

2. Procedure

Measure sound levels in each room, when unoccupied except for the TAB team, with all HVAC systems that would cause sound readings in the room operating in their noisiest mode. Record the sound level in each octave band. Attempt to mitigate the sound level and bring the level to within the specified ASHRAE HVAC APP IP HDBK noise criteria goals, if such mitigation is within the TAB team's control. State in the report the ASHRAE HVAC APP IP HDBK noise criteria goals. If sound level cannot be brought into compliance, provide written notice of the deficiency to the Contractor for resolution or correction.

3. Timing

Measure sound levels at times prescribed by AABC or NEBB or TABB.

4. Meters

Measure sound levels with a sound meter complying with ASA S1.4, Type 1 or 2, and an octave band filter set complying with ASA S1.11 PART 1. Use measurement methods for overall sound levels and for octave band sound levels as prescribed by NEBB.

5. Calibration

Calibrate sound levels as prescribed by AABC or NEBB or TABB, except that calibrators emitting a sound pressure level tone of 94 dB at 1000 hertz (Hz) are also acceptable.

F. TAB Work on Performance Tests Without Seasonal Limitations

1. Performance Tests

In addition to the TAB proportionate balancing work on the air distribution systems and the water distribution systems, accomplish TAB work on the HVAC systems which directly transfer thermal energy. TAB the operational performance of the heating systems and cooling systems.

2. Ambient Temperatures

On each tab report form used for recording data, record the outdoor and indoor ambient dry bulb temperature range and the outdoor and indoor ambient wet bulb temperature range within which the report form's data was recorded. Record these temperatures at beginning and at the end of data taking.

3. Refrigeration Units

Refrigeration units or refrigeration compressors/condensers/condensing units, report data as required by NEBB Form TAB 15-83, NEBB PROCEDURAL STANDARDS, including refrigeration operational data.

4. Coils

Report heating and cooling performance capacity tests for hot water, chilled water, DX for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

b. Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

G. Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

H. Deficiencies

Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph WORKMANSHIP, provide written notice as soon as possible to the Contractor and the Contracting Officer describing the deficiency and recommended correction.

Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

I. TAB Reports

After completion of the TAB work, prepare a pre-final TAB report using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph WORKMANSHIP of this section.

Prepare the report neatly and legibly; the pre-final TAB report is the final TAB report minus the TAB supervisor's review and

certification. Obtain, at the contract site, the TAB supervisor's review and certification of the TAB report.

Verbally notify the COTR that the field check of the TAB report data can commence; give this verbal notice 48 hours in advance of field check commencement. Do not schedule field check of the TAB report until the specified workmanship requirements have been met or written approval of the deviations from the requirements have been received from the Contracting Officer.

J. Quality Assurance - COTR TAB Field Acceptance Testing

1. TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the COTR. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: All chillers, boilers, return fans, computer room units, and air handling units (rooftop and central stations).

Group 2: 25 percent of the VAV terminal boxes and associated diffusers and registers.

Group 3: 25 percent of the supply diffusers, registers, grilles associated with constant volume air handling units.

Group 4: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 5: 25 percent of the supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the COTR. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

2. Additional COTR TAB Field Acceptance Testing

If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the COTR.

Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to to be found. This additional field testing is up and above the original 25 percent of the reported data entries to be field tested.

If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3. Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

3.05 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

3.06 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

-- End of Section --

SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS
02/13

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2016; ERTA 1-4 2017; INT 1-2 2017) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A580/A580M	(2016) Standard Specification for Stainless Steel Wire
ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1710	(2011) Standard Guide for Installation of Flexible Closed Cell Preformed Insulation in Tube and Sheet Form
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C450	(2008) Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging
ASTM C795	(2008; R 2013) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(2014) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2014a) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

ASTM E2231	(2015) Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1999) National Commercial & Industrial Insulation Standards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2015) Standard for the Installation of Warm Air Heating and Air Conditioning Systems

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-A-24179	(1969; Rev A; Am 2 1980; Notice 1 1987) Adhesive, Flexible Unicellular-Plastic Thermal Insulation

UNDERWRITERS LABORATORIES (UL)

UL 723	(2008; Reprint Aug 2013) Test for Surface Burning Characteristics of Building Materials
UL 94	(2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.02 SYSTEM DESCRIPTION

A. General

Provide field-applied insulation and accessories on mechanical systems as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

For each system, submit SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time.

SD-02 Shop Drawings

MICA National Insulation Standards Plates; G

Pipe Insulation Systems and Associated Accessories; G

Duct Insulation Systems and Associated Accessories; G

SD-03 Product Data

Pipe Insulation Systems; G

Duct Insulation; G

SD-04 Samples

Display Samples; G

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G

Duct Insulation; G

1.04 QUALITY ASSURANCE

A. Installer Qualification

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.05 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. The Contracting Officer may reject insulation material and supplies that become dirty, dusty, wet, or contaminated by some other means. Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material, date codes, and approximate shelf life (if applicable). Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Provide materials which are the standard products of manufacturers regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit a complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories including adhesives, sealants and jackets for each mechanical system requiring insulation shall be included. The product data must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. Materials furnished under this section shall be submitted together in a booklet.

A. Insulation System

Provide insulation systems in accordance with the approved MICA National Insulation Standards plates as supplemented by this specification. Provide field-applied insulation for heating, ventilating, and cooling (HVAC) air distribution systems and piping systems that are located within, on, under, and adjacent to buildings; and for plumbing systems. Provide CFC and HCFC free insulation.

B. Surface Burning Characteristics

Unless otherwise specified, insulation must have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Test insulation in the same density and installed thickness as the material to be used in the actual construction. Prepare and mount test specimens according to ASTM E2231.

2.02 MATERIALS

Provide insulation that meets or exceed the requirements of ASHRAE 90.1 - IP. Insulation exterior shall be cleanable, grease resistant, non-flaking and non-peeling. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C795 requirements. Calcium silicate shall not be used on chilled or cold water systems. Materials shall be asbestos free. Provide product recognized under UL 94 (if containing plastic) and listed in FM APP GUIDE.

A. Adhesives

1. Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2. Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

3. Contact Adhesive

Adhesives may be any of, but not limited to, the neoprene based, rubber based, or elastomeric type that have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The dried adhesive shall be nonflammable and fire resistant. Flexible Elastomeric Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product listed in FM APP GUIDE.

B. Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

C. Corner Angles

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

D. Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems in accordance with ASTM C1710. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor). For satisfactory performance, properly installed protective vapor retarder/barriers and vapor stops shall be used on high relative humidity and below ambient temperature applications to reduce movement of moisture through or around the insulation to the colder interior surface.

E. Finishing Cement

ASTM C450: Mineral fiber hydraulic-setting thermal insulating and finishing cement. All cements that may come in contact with Austenitic stainless steel must comply with ASTM C795.

F. Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth, with 20X20 maximum mesh size, and glass tape shall have maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Tape shall be 4 inch wide rolls. Class 3 tape shall be 4.5 ounces/square yard. Elastomeric Foam Tape: Black vapor-retarder foam tape with acrylic adhesive containing an anti-microbial

additive.

G. Staples

Outward clinching type ASTM A167, Type 304 or 316 stainless steel.

H. Jackets

1. Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket circumferential seam bands shall be 2 by 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 by 0.020 inch thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2. Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, ultraviolet (UV) resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

3. Vapor Barrier/Weatherproofing Jacket

Vapor barrier/weatherproofing jacket shall be laminated self-adhesive, greater than 3 plies standard grade, silver, white, black and embossed or greater than 8 ply (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M, using the water transmission rate test method; heavy duty, white or natural; and UV resistant. Flexible Elastomeric exterior foam with factory applied, UV Jacket made with a cold weather acrylic adhesive. Construction of laminate designed to provide UV resistance, high puncture, tear resistance and excellent Water Vapor Transmission (WVT) rate.

4. Vapor Barrier/Vapor Retarder

Apply the following criteria to determine which system is required.

a. On ducts, piping and equipment operating below 60 degrees F or located outside shall be equipped with a vapor barrier.

I. Vapor Retarder Not Required

ASTM C921, Type II, Class D, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance

of 25 Beach units is acceptable. Jacket shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

J. Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

K. Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

L. Sealants

Sealants shall be chosen from the butyl polymer type, the styrene-butadiene rubber type, or the butyl type of sealants. Sealants shall have a maximum permeance of 0.02 perms based on Procedure B for ASTM E96/E96M, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.01 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. Flexible elastomeric cellular insulation shall not be compressed at joists, studs, columns, ducts, hangers, etc. The insulation shall not pull apart after a one hour period; any insulation found to pull apart after one hour, shall be replaced.

A. Display Samples

Submit and display, after approval of materials, actual sections of installed systems, properly insulated in accordance with the specification requirements. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. The Contracting Officer will inspect display sample sections at the jobsite. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

1. Pipe Insulation Display Sections

Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric waterways and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for

hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

2. Duct Insulation Display Sections

Display sample sections for rigid and flexible duct insulation used on the job. Use a temporary covering to enclose and protect display sections for duct insulation exposed to weather

B. Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds plates except where modified herein or on the drawings.

C. Firestopping

Where ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07 84 13 PENETRATION FIRESTOPPING. The protection of ducts at point of passage through firewalls must be in accordance with NFPA 90A and/or NFPA 90B. All other penetrations, such as piping, conduit, and wiring, through firewalls must be protected with a material or system of the same hourly rating that is listed by UL, FM, or a NRTL.

D. Painting and Finishing

Painting shall be as specified in Section 09 90 00 PAINTING AND COATING.

E. Installation of Flexible Elastomeric Cellular Insulation

Install flexible elastomeric cellular insulation with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Stagger seams when applying multiple layers of insulation. Protect insulation exposed to weather and not shown to have vapor barrier weatherproof jacketing with two coats of UV resistant finish or PVC or metal jacketing as

recommended by the manufacturer after the adhesive is dry and cured.

1. Adhesive Application

Apply a brush coating of adhesive to both butt ends to be joined and to both slit surfaces to be sealed. Allow the adhesive to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

2. Adhesive Safety Precautions

Use natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices.

F. Welding

No welding shall be done without written approval of the Contracting Officer.

-- End of Section --

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC
11/15

PART 1 GENERAL

1.01 SUMMARY

Provide a complete Direct Digital Control (DDC) system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as indicated and shown and in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and other referenced Sections.

A. System Requirements

Provide systems meeting the requirements this Section and other Sections referenced by this Section, and which have the following characteristics:

1. The system implements the control sequences of operation shown in the Contract Drawings using DDC hardware to control mechanical and electrical equipment

2. The system meet the requirements of this specification as a stand-alone system and does not require connection to any other system.

3. Control sequences reside in DDC hardware in the building. The building control network is not dependent upon connection to a Utility Monitoring and Control System (UMCS) Front End or to any other system for performance of control sequences. To the greatest extent practical, the hardware performs control sequences without reliance on the building network.

4. The hardware is installed such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

5. All necessary documentation, configuration information, programming tools, programs, drivers, and other software are licensed to and otherwise remain with the Government such that the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

6. Sufficient documentation and data, including rights to documentation and data, are provided such that the Government or their agents can execute work to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer.

7. Hardware is installed and configured such that the Government

or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the Contractor, Vendor or Manufacturer.

B. End to End Accuracy

Select products, install and configure the system such that the maximum error of a measured value as read from the DDC Hardware over the network is less than the maximum allowable error specified for the sensor or instrumentation.

C. Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

D. Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 511	(2010) Certified Ratings Program for Air Control Devices

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135	(2016; INT 1 2016; ERTA 1 2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks
ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

TRIDIUM, INC (TRIDIUM)

Niagara Framework	(2012) NiagaraAX User's Guide

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.03 DEFINITIONS

The following list of definitions includes terms used in Sections referenced by this Section and are included here for completeness.

The definitions contained in this Section may disagree with how terms are defined or used in other documents, including documents referenced by this Section. The definitions included here are the authoritative definitions for this Section and all Sections referenced by this Section.

A. Alarm Generation

Alarm Generation is the monitoring of a value, comparison of the value to alarm conditions and the creation of an alarm when the conditions set for the alarm are met. Note that this does NOT include delivery of the alarm to the final destination (such as a user interface).

In BACnet, Alarm Generation is the creation of alarm events using Event Reporting as defined in ASHRAE 135 in one of three ways:

1. Intrinsic Alarm Generation using Intrinsic Reporting

2. Local Algorithmic Alarm Generation using Algorithmic Reporting where the referenced property is in the same device as the Event Enrollment Object

3. Remote Algorithmic Alarm Generation using Algorithmic Alarming where the referenced property is in a different device than the Event Enrollment Object.

B. Building Automation and Control Network (BACnet)

The term BACnet is used in two ways. First, meaning the BACnet Protocol Standard - the communication requirements as defined by ASHRAE 135 including all annexes and addenda. Second, to refer to the overall technology related to the ASHRAE 135 protocol.

C. BACnet Advanced Application Controller (B-AAC)

A hardware device BTL Listed as a B-AAC, which is required to support BACnet Interoperability Building Blocks (BIBBs) for scheduling and alarming, but is not required to support as many BIBBs as a B-BC.

D. BACnet Application Specific Controller (B-ASC)

A hardware device BTL Listed as a B-ASC, with fewer BIBB requirements than a B-AAC. It is intended for use in a specific application.

E. BACnet Building Controller (B-BC)

A hardware device BTL Listed as a B-BC. A general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks including control and monitoring via direct digital control (DDC) of specific systems and data storage for trend information, time schedules, and alarm data. Like the other BTL Listed controller types (B-AAC, B-ASC etc.) a B-BC device is required to support the server ("B") side of the ReadProperty and WriteProperty services, but unlike the other controller types it is also required to support the client ("A") side of these services. Communication between controllers requires that one of them support the client side and the other support the server side, so a B-BC is often used when communication between controllers is needed.

F. BACnet Broadcast Management Device (BBMD)

A communications device, typically combined with a BACnet router. A BBMD forwards BACnet broadcast messages to BACnet/IP devices and other BBMDs connected to the same BACnet/IP network. Each IP subnet that is part of a BACnet/IP network must have at least one BBMD. Note there are additional restrictions when multiple BBMDs share an IP subnet.

G. BACnet/IP

An extension of BACnet, Annex J, defines the use of a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnets that share the same BACnet network number. See also paragraph BACNET BROADCAST MANAGEMENT DEVICE.

H. BACnet Internetwork

Two or more BACnet networks, connected with BACnet routers. In a BACnet internetwork, there exists only one message path between devices.

I. BACnet Interoperability Building Blocks (BIBBs)

A BIBB is a collection of one or more ASHRAE 135 Services intended to define a higher level of interoperability. BIBBs are combined to build the BACnet functional requirements for a device in a specification. Some BIBBs define additional requirements (beyond requiring support for specific services) in order to

achieve a level of interoperability. For example, the BIBB DS-V-A (Data Sharing-View-A), which would typically be used by a front-end, not only requires the client to support the ReadProperty Service, but also provides a list of data types (Object / Properties) which the client must be able to interpret and display for the user.

In the BIBB shorthand notation, -A is the client side and -B is the server side.

In the BIBB shorthand notation, -A is the client side and -B is the server side.	
DS-COV-A	Data Sharing-Change of Value (A side)
DS-COV-B	Data Sharing-Change of Value (B side)
NM-RC-B	Network Management-Router Configuration (B side)
DS-RP-A	Data Sharing-Read Property (A side)
DS-RP-B	Data Sharing-Read Property (B side)
DS-RPM-A	Data Sharing-Read Property Multiple (A Side)
DS-RPM-B	Data Sharing-Read Property Multiple (B Side)
DS-WP-A	Data Sharing-Write Property (A Side)
DM-TS-B	Device Management-Time Synchronization (B Side)
DM-UTC-B	Device Management-UTC Time Synchronization (B Side)
DS-WP-B	Data Sharing-Write Property (B side)
SCHED-E-B	Scheduling-External (B side)
DM-OCD-B	Device Management-Object Creation and Deletion (B side)
AE-N-I-B	Alarm and Event-Notification Internal (B Side)
AE-N-E-B	Alarm and Event-Notification External (B Side)
T-VMT-I-B	Trending-Viewing and Modifying Trends Internal (B Side)
T-VMT-E-B	Trending-Viewing and Modifying Trends External (B Side)

J. BACnet Network

In BACnet, a portion of the control internetwork consisting of one or more segments connected by repeaters. Networks are separated by routers.

K. BACnet Operator Display (B-OD)

A basic operator interface with limited capabilities relative to a B-OWS. It is not intended to perform direct digital control. A B-OD profile could be used for LCD devices, displays affixed to BACnet devices, handheld terminals or other very simple user interfaces.

L. BACnet Segment

One or more physical segments interconnected by repeaters (ASHRAE 135).

M. BACnet Smart Actuator (B-SA)

A simple actuator device with limited resources intended for specific applications.

N. BACnet Smart Sensor (B-SS)

A simple sensing device with limited resources.

O. BACnet Testing Laboratories (BTL)

Established by BACnet International to support compliance testing and interoperability testing activities and consists of BTL Manager and the BTL Working Group (BTL-WG). BTL also publishes Implementation Guidelines.

P. BACnet Testing Laboratories (BTL) Listed

A device that has been listed by BACnet Testing Laboratory. Devices may be certified to a specific device profile, in which case the listing indicates that the device supports the required capabilities for that profile, or may be listed as "other".

Q. Binary

A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level. 'Digital' is sometimes used interchangeably with 'binary'.

R. Broadcast

Unlike most messages, which are intended for a specific recipient device, a broadcast message is intended for all devices on the network.

S. Building Control Network (BCN)

The network connecting all DDC Hardware within a building (or specific group of buildings).

T. Building Point of Connection (BPOC)

A FPOC for a Building Control System. (This term is being phased out of use in preference for FPOC but is still used in some

specifications and criteria. When it was used, it typically referred to a piece of control hardware. The current FPOC definition typically refers instead to IT hardware.)

U. Commandable

See Overridable.

V. Commandable Objects

Commandable Objects have a Commandable Property, Priority_Array, and Relinquish_Default Property as defined in ASHRAE 135, Clause 19.2, Command Prioritization.

W. Configurable

A property, setting, or value is configurable if it can be changed via hardware settings on the device, via the use of engineering software or over the control network from the front end, and is retained through (after) loss of power.

In a BACnet system, a property, setting, or value is configurable if it can be changed via one or more of:

1. via BACnet services (including proprietary BACnet services)

2. via hardware settings on the device

Note this is more stringent than the ASHRAE 135 definition.

X. Control Logic Diagram

A graphical representation of control logic for multiple processes that make up a system.

Y. Device

A Digital Controller that contains a BACnet Device Object and uses BACnet to communicate with other devices.

Z. Device Object

Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance or device ID.

AA. Device Profile

A collection of BIBBs determining minimum BACnet capabilities of a device, defined in ASHRAE 135. Standard device profiles include BACnet Advanced Workstations (B-AWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS).

AB. Digital Controller

An electronic controller, usually with internal programming logic and digital and analog input/output capability, which performs control functions.

AC. Direct Digital Control (DDC)

Digital controllers performing control logic. Usually the controller directly senses physical values, makes control decisions with internal programs, and outputs control signals to directly operate switches, valves, dampers, and motor controllers.

AD. Field Point of Connection (FPOC)

The FPOC is the point of connection between the UMCS IP Network and the field control network (either an IP network, a non-IP network, or a combination of both). The hardware at this location which provides the connection is generally an IT device such as a switch, IP router, or firewall.

In general, the term "FPOC Location" means the place where this connection occurs, and "FPOC Hardware" means the device that provides the connection. Sometimes the term "FPOC" is used to mean either and its actual meaning (i.e., location or hardware) is determined by the context in which it is used.

AE. Gateway

A device that translates from one protocol application data format to another. Devices that change only the transport mechanism of the protocol - "translating" from TP/FT-10 to Ethernet/IP or from BACnet MS/TP to BACnet over IP for example - are not gateways as the underlying data format does not change. Gateways are also called Communications Bridges or Protocol Translators.

AF. IEEE 802.3 Ethernet

A family of local-area-network technologies providing high-speed networking features over various media, typically Cat 5, 5e or Cat 6 twisted pair copper or fiber optic cable.

AG. Internet Protocol (IP, TCP/IP, UDP/IP)

A communication method, the most common use is the World Wide Web. At the lowest level, it is based on Internet Protocol (IP), a method for conveying and routing packets of information over various LAN media. Two common protocols using IP are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP). UDP conveys information to well-known "sockets" without confirmation of receipt. TCP establishes connections, also known as "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

AH. Input/Output (I/O)

Physical inputs and outputs to and from a device, although the

term sometimes describes network or "virtual" inputs or outputs. See also "Points".

AI. I/O Expansion Unit

An I/O expansion unit provides additional point capacity to a digital controller

AJ. IP subnet

A group of devices which share a defined range IP addresses. Devices on a common IP subnet can share data (including broadcasts) directly without the need for the traffic to traverse an IP router.

AK. Local-Area Network (LAN)

A communication network that spans a limited geographic area and uses the same basic communication technology throughout.

AL. Local Display Panels (LDPs)

A DDC Hardware with a display and navigation buttons, and must provide display and adjustment of points as shown on the Points Schedule and as indicated.

AM. MAC Address

Media Access Control address. The physical device address that identifies a device on a Local Area Network.

AN. Master-Slave/Token-Passing (MS/TP)

Data link protocol as defined by the BACnet standard. Multiple speeds (data rates) are permitted by the BACnet MS/TP standard.

AO. Monitoring and Control (M&C) Software

The UMCS 'front end' software which performs supervisory functions such as alarm handling, scheduling and data logging and provides a user interface for monitoring the system and configuring these functions.

AP. Network Number

A site-specific number assigned to each network. This network number must be unique throughout the BACnet internetwork.

AQ. Object

An ASHRAE 135 Object. The concept of organizing BACnet information into standard components with various associated Properties. Examples include Analog Input objects and Binary Output objects.

AR. Object Identifier

A grouping of two Object properties: Object Type (e.g. Analog Value, Schedule, etc.) and Object Instance (in this case, a

number). Object Identifiers must be unique within a device.

AS. Object Instance

See paragraph OBJECT IDENTIFIER.

AT. Object Properties

Attributes of an Object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

AU. Operator Configurable

For BACnet systems, a property, setting, or value in a device is Operator Configurable when it is Configurable and is either:

1. a Writeable Property of a Standard BACnet Object; or

2. a Property of a Standard BACnet Object that is Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable.

AV. Override

Changing the value of a point outside of the normal sequence of operation where the change has priority over the sequence and where there is a mechanism for releasing the change such that the point returns to the normal value. Overrides persist until released or overridden at the same or higher priority but are not required to persist through a loss of power.

AW. Performance Verification Test (PVT)

The procedure for determining if the installed BAS meets design criteria prior to final acceptance. The PVT is performed after installation, testing, and balancing of mechanical systems. Typically the PVT is performed by the Contractor in the presence of the Government.

AX. Physical Segment

A single contiguous medium to which BACnet devices are attached (ASHRAE 135).

AY. Polling

A device periodically requesting data from another device.

AZ. Points

Physical and virtual inputs and outputs. See also paragraph INPUT/OUTPUT (I/O).

BA. Proportional, Integral, and Derivative (PID) Control Loop

Three parameters used to control modulating equipment to maintain a setpoint. Derivative control is often not required for HVAC

systems (leaving "PI" control).

BB. Proprietary

Within the context of BACnet, any extension of or addition to object types, properties, Private Transfer services, or enumerations specified in ASHRAE 135. Objects with Object_Type values of 128 and above are Proprietary Objects. Properties with Property_Identifier of 512 and above are proprietary Properties.

BC. Protocol Implementation Conformance Statement (PICS)

A document, created by the manufacturer of a device, which describes which portions of the BACnet standard may be implemented by a given device. ASHRAE 135 requires that all ASHRAE 135 devices have a PICS, and also defines a minimum set of information that must be in it. A device as installed for a specific project may not implement everything in its PICS.

BD. Repeater

A device that connects two control network segments and retransmits all information received on one side onto the other.

BE. Router

A device that connects two netwoks and controls traffic between the two by retransmitting signals received from one side onto the other based on the signal destination. Routers are used to subdivide a control internetwork and to control bandwidth usage.

BF. Segment

A 'single' section of a control network that contains no repeaters or routers. There is generally a limit on the number of devices on a segment, and this limit is dependent on the topology/media and device type.

BG. Standard BACnet Objects

Objects with Object_Type values below 128 and specifically enumerated in Clause 21 of ASHRAE 135. Objects which are not proprietary. See paragraph PROPRIETARY.

BH. Standard BACnet Properties

Properties with Property_Identifier values below 512 and specifically enumerated in Clause 21 of ASHRAE 135. Properties which are not proprietary. See Proprietary.

BI. Standard BACnet Services

ASHRAE 135 services other than ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer. See paragraph PROPRIETARY.

BJ. UMCS

UMCS stands for Utility Monitoring and Control System. The term refers to all components by which a project site monitors,

manages, and controls real-time operation of HVAC and other building systems. These components include the UMCS "front-end" and all field building control systems connected to the front-end. The front-end consists of Monitoring and Montrol Software (user interface software), browser-based user interfaces and network infrastructure.

The network infrastructure (the "UMCS Network"), is an IP network connecting multiple building or facility control networks to the Monitoring and Control Software.

BK. UMCS NETWORK

The UMCS Network connects multiple building or facility control networks to the Monitoring and Control Software.

BL. Writeable Property

A Property is Writeable when it can be changed through the use of one or more of the WriteProperty services defined in ASHRAE 135, Clause 15 regardless of the value of any other Property. Note that in the ASHRAE 135 standard, some Properties may be writeable when the Out of Service Property is TRUE; for purposes of this Section, Properties that are only writeable when the Out of Service Property is TRUE are not considered to be Writeable.

1.04 PROJECT SEQUENCING

TABLE I: PROJECT SEQUENCING lists the sequencing of submittals as specified in paragraph SUBMITTALS (denoted by an 'S' in the 'TYPE' column) and activities as specified in PART 3 EXECUTION (denoted by an 'E' in the 'TYPE' column). TABLE I does not specify overall project milestone and completion dates; these dates are specified in the contract documents.

A. Sequencing for Submittals: The sequencing specified for submittals is the deadline by which the submittal must be initially submitted to the Government. Following submission there will be a Government review period as specified in Section 01 33 00 SUBMITTAL PROCEDURES. If the submittal is not accepted by the Government, revise the submittal and resubmit it to the Government within 14 days of notification that the submittal has been rejected. Upon resubmittal there will be an additional Government review period. If the submittal is not accepted the process repeats until the submittal is accepted by the Government.

B. Sequencing for Activities: The sequencing specified for activities indicates the earliest the activity may begin.

C. Abbreviations: In TABLE I the abbreviation AAO is used for 'after approval of' and 'ACO' is used for 'after completion of'.

TABLE I. PROJECT SEQUENCING			
ITEM #	TYPE	DESCRIPTION	SEQUENCING (START OF ACTIVITY OR DEADLINE FOR SUBMITTAL)
1	S	Existing Conditions Report	-
2	S	DDC Contractor Design Drawings	-
3	S	Manufacturer's Product Data	-
4	S	Pre-construction QC Checklist	-
5	E	Install Building Control System	AAO #1 thru #4
6	E	Start-Up and Start-Up Testing	ACO #5
7	S	Post-Construction QC Checklist	ACO #6
8	S	Programming Software Configuration Software	ACO #6
9	S	Draft As-Built Drawings Draft LNS Database	ACO #6
10	S	Start-Up Testing Report	ACO #6
11	S	PVT Procedures	before schedule start of #12 and AAO #10
12	E	Execute PVT	AAO #9 and #11
13	S	PVT Report	ACO #12
14	S	Controller Application Programs Controller Configuration Settings	AAO #13
15	S	Final As-Built Drawings	AAO #13
16	S	O&M Instructions	AAO #15
17	S	Training Documentation	AAO #10 and before scheduled start of #18
18	E	Training	AAO #16 and #17
19	S	Closeout QC Checklist	ACO #18

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

DDC Contractor Design Drawings; G

Draft As-Built Drawings; G

Final As-Built Drawings; G

SD-03 Product Data

Certificate of Networthiness Documentation; G

Programming Software; G

Controller Application Programs; G

Configuration Software; G

Controller Configuration Settings; G

Manufacturer's Product Data; G

SD-06 Test Reports

Start-Up Testing Report; G

PVT Procedures; G

PVT Report; G

Pre-Construction Quality Control (QC) Checklist; G

Post-Construction Quality Control (QC) Checklist; G

SD-10 Operation and Maintenance Data

Operation and Maintenance (O&M) Instructions; G

Training Documentation; G

SD-11 Closeout Submittals

Enclosure Keys; G

Password Summary Report; G

Closeout Quality Control (QC) Checklist; G

1.06 DATA PACKAGE AND SUBMITTAL REQUIREMENTS

Technical data packages consisting of technical data and computer software (meaning technical data which relates to computer software)

which are specifically identified in this project and which may be defined/required in other specifications must be delivered strictly in accordance with the CONTRACT CLAUSES and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered must be identified by reference to the particular specification paragraph against which it is furnished. All submittals not specified as technical data packages are considered 'shop drawings' under the Federal Acquisition Regulation Supplement (FARS) and must contain no proprietary information and be delivered with unrestricted rights.

1.07 SOFTWARE FOR DDC HARDWARE AND GATEWAYS

Provide all software related to the programing and configuration of DDC Hardware and Gateways as indicated. License all Software to the project site. The term "controller" as used in these requirements means both DDC Hardware and Gateways.

A. Configuration Software

For type of controller, provide the configuration tool software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of the software user manuals for each software with the software submittal.

B. Controller Configuration Settings

For each controller, provide copies of the installed configuration settings as source code compatible with the configuration tool software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

C. Programming Software

For each type of programmable controller, provide the programming software in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. Submit hard copies of software user manuals for each software with the software submittal.

D. Controller Application Programs

For each programmable controller, provide copies of the application program as source code compatible with the programming software for that controller in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

E. Certificate of Networthiness Documentation

For all software provided, provide documentation that an Enterprise Certificate of Networthiness exists, that a Limited Certificate of Networthiness for the project site exists, or provide a completed Certificate of Networthiness "Application Checklist".

1.08 QUALITY CONTROL CHECKLISTS

The QC Checklist for Niagara Framework Based BACnet Systems in APPENDIX A of this Section must be completed by the Contractor's Chief Quality Control (QC) Representative and submitted as indicated. The QC Representative must verify each item indicated and initial in the space provided to indicate that the requirement has been met. The QC Representative must sign and date the Checklist prior to submission to the Government.

A. Pre-Construction Quality Control (QC) Checklist

Complete items indicated as Pre-Construction QC Checklist items in the QC Checklist.

B. Post-Construction Quality Control (QC) Checklist

Complete items indicated as Post-Construction QC Checklist items in the QC Checklist.

C. Closeout Quality Control (QC) Checklist

Complete items indicated as Closeout QC Checklist items in the QC Checklist. Four copies of the Closeout QC Checklist.

PART 2 PRODUCTS

Provide products meeting the requirements of Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, and this Section.

2.01 GENERAL PRODUCT REQUIREMENTS

Units of the same type of equipment must be products of a single manufacturer. Each major component of equipment must have the manufacturer's name and address, and the model and serial number in a conspicuous place. Materials and equipment must be standard products of a manufacturer regularly engaged in the manufacturing of these and similar products. The standard products must have been in a upsatisfactory commercial or industrial use for two years prior to use on this project. The two year use must include applications of equipment and materials under similar circumstances and of similar size. DDC Hardware not meeting the two-year field service requirement is acceptable provided it has been successfully used by the Contractor in a minimum of two previous projects. The equipment items must be supported by a service organization. Items of the same type and purpose must be identical, including equipment, assemblies, parts and components.

2.02 PRODUCT DATA

Provide manufacturer's product data sheets documenting compliance with product specifications for each product provided under Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, or this Section. Provide product data for all products in a single indexed compendium, organized by product type. For each

manufacturer, model and version (revision) of DDC Hardware provide the Protocol Implementation Conformance Statement (PICS) in accordance with Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1. Submit Certificate of Networthiness Documentation in PDF format on CD-ROM.

2. Submit Programming Software on CD-ROM as a Technical Data Package. Submit 3 hard copies of the software user manual for each piece of software.

3. Submit Controller Application Programs on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which application program is associated with each device. Submit 2 copies of the Controller Application Programs CD-ROM.

4. Submit Configuration Software on CD-ROM as a Technical Data Package. Submit 3 hard copies of the software user manual for each piece of software.

5. Submit Controller Configuration Settings on CD-ROM as a Technical Data Package. Include on the CD-ROM a list or table of contents clearly indicating which files are associated with each device. Submit 2 copies of the Controller Configuration Settings CD-ROM.

6. Submit Manufacturer's Product Data on CD-ROM.

2.03 OPERATION ENVIRONMENT

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

A. Pressure: Pressure conditions normally encountered in the installed location.

B. Vibration: Vibration conditions normally encountered in the installed location.

C. Temperature:

   1. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

   2. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

D. Humidity: 10 to 95 percent relative humidity, noncondensing and humidity conditions outside this range normally encountered at the installed location.

2.04 Wireless Capability

For products incorporating any wireless capability (including but not limited to radio frequency (RF), infrared and optical), provide

products for which wireless capability can be permanently disabled at the device. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate.

2.05 ENCLOSURES

Enclosures supplied as an integral (pre-packaged) part of another product are acceptable. Provide two Enclosure Keys for each lockable enclosure on a single ring per enclosure with a tag identifying the enclosure the keys operate. Provide enclosures meeting the following minimum requirements:

A. Outdoors

For enclosures located outdoors, provide enclosures meeting NEMA 250 Type 4 requirements.

B. Mechanical and Electrical Rooms

For enclosures located in mechanical or electrical rooms, provide enclosures meeting NEMA 250 Type 4 requirements.

C. Other Locations

For enclosures in other locations including but not limited to occupied spaces, above ceilings, and in plenum returns, provide enclosures meeting NEMA 250 Type 1 requirements.

2.06 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

A. Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

B. Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or thicker wire rated for 300-volt service.

C. Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

1. minimum 2 inch lay of twist

2. 100 percent shielded pairs

3. at least 300-volt insulation

4. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

5. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

D. Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

E. Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

PART 3 EXECUTION

3.01 INSTALLATION

Fully install and test the control system in accordance Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and this Section.

A. Dielectric Isolation

Provide dielectric isolation where dissimilar metals are used for connection and support. Install control system in a matter that provides clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Install control system such that it does not interfere with the clearance requirements for mechanical and electrical system maintenance.

B. Penetrations in Building Exterior

Make all penetrations through and mounting holes in the building exterior watertight.

C. Device Mounting Criteria

Install devices in accordance with the manufacturer's recommendations and as indicated and shown. Provide a weathershield for all devices installed outdoors. Provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. Provide clearance for mechanical and electrical system maintenance; do not interfere with the clearance requirements for mechanical and electrical system maintenance.

D. Labels and Tags

Key all labels and tags to the unique identifiers shown on the

As-Built drawings. For labels exterior to protective enclosures provide engraved plastic labels mechanically attached to the enclosure or DDC Hardware. Labels inside protective enclosures may be attached using adhesive, but must not be hand written. For tags, provide plastic or metal tags mechanically attached directly to each device or attached by a metal chain or wire.

1. Label all Enclosures and DDC Hardware.

2. Tag Airflow measurement arrays (AFMA) with flow rate range for signal output range, duct size, and pitot tube AFMA flow coefficient.

3. Tag duct static pressure taps at the location of the pressure tap

E. SURGE PROTECTION

1. Power-Line Surge Protection

Protect equipment connected to AC circuits to withstand power-line surges in accordance with IEEE C62.41. Do not use fuses for surge protection.

2. Surge Protection for Transmitter and Control Wiring

Protect DDC hardware against or provided DDC hardware capable of withstanding surges induced on control and transmitter wiring installed outdoors and as shown. Protect equipment againnst the following two waveforms:

a. A waveform with a 10-microsecond rise time, a 1000-microsecond decay time and a peak current of 60 amps.

b. A waveform with an 8-microsecond rise time, a 20-microsecond decay time and a peak current of 500 amperes.

F. Basic Cybersecurity Requirements

1. Passwords

For all devices with a password, change the password from the default password. Do not use the same password for more than one device. Coordinate selection of passwords with Contracting Officer. Provide a Password Summary Report documenting the password for each device and describing the procedure to change the password for each device.

2. Wireless Capability

Unless otherwise indicated, disable wireless capability (including but not limited to radio frequency (RF), infrared and optical) for all devices with wireless capability. Optical and infrared capabilities may be disabled via a permanently affixed opaque cover plate. Password protecting a wireless connections does not meet this requirement; the wireless capability must be disabled.

3. IP Network Physical Security

Install all IP Network media in conduit. Install all IP devices including but not limited to IP-enabled DDC hardware and IP Network Hardware in lockable enclosures.

4. Project Closeout

Provide Two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.02 DRAWINGS AND CALCULATIONS

Provide drawings in the form and arrangement indicated and shown. Use the same abbreviations, symbols, nomenclature and identifiers shown. Assign a unique identifier as shown to each control system element on a drawing. When packaging drawings, group schedules by system. When space allows, it is permissible to include multiple schedules for the same system on a single sheet. Except for drawings covering all systems, do not put information for different systems on the same sheet.

a. Submit DDC Contractor Design Drawings consisting of each drawing indicated with pre-construction information depicting the intended control system design and plans. Submit DDC Contractor Design Drawings as a single complete package: 5 hard copies and 3 copies on CDROM. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

b. Submit Draft As-Built Drawings consisting of each drawing indicated updated with as-built data for the system prior to PVT. Submit draft As-Built Drawings as a single complete package: 5 hard copies and 3 copies on CDROM. Submit hardcopy drawings on A3 17 by 11 inches sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

c. Submit Final As-Built Drawings consisting of each drawing indicated updated with all final as-built data. Submit final As-Built Drawings as a single complete package: 5 hard copies and 3 copies on CDROM. Submit hardcopy drawings on ISO A1 34 by 22 inches sheets, and electronic drawings in PDF and in AutoCAD format. In addition, submit electronic drawings in editable Excel format for all drawings that are tabular, including but not limited to the Point Schedule and Equipment Schedule.

Sample drawings in electronic format are available via a link in the "Graphical Table of Contents" online at: http://www.wbdg.org/FFC/NAVGRAPH/graphtoc.pdf. These drawings may prove useful in demonstrating expected drawing formatting and example content and are provided for illustrative purposes only. These drawings do not meet the content requirements of this Section.

A. Drawing Index and Legend

Provide an HVAC Control System Drawing Index showing the name and number of the building, military site, State or other similar designation, and Country. In the Drawing Index, list all Contractor Design Drawings, including the drawing number, sheet number, drawing title, and computer filename when used. In the Design Drawing Legend, show and describe all symbols, abbreviations and acronyms used on the Design Drawings. Provide a single Index and Legend for the entire drawing package.

B. Thermostat and Occupancy Sensor Schedule

Provide a thermostat and occupancy sensor schedule containing each thermostat's unique identifier, room identifier and control features and functions as shown. Provide a single thermostat and occupancy sensor schedule for the entire project.

C. Valve Schedule

Provide a valve schedule containing each valve's unique identifier, size, flow coefficient Kv (Cv), pressure drop at specified flow rate, spring range, positive positioner range, actuator size, close-off pressure to torque data, dimensions, and access and clearance requirements data. In the valve schedule include actuator selection data supported by calculations of the force required to move and seal the valve, access and clearance requirements. Provide a single valve schedule for the entire project.

D. Damper Schedule

Provide a damper schedule containing each damper's unique identifier, type (opposed or parallel blade), nominal and actual sizes, orientation of axis and frame, direction of blade rotation, actuator size and spring ranges, operation rate, positive positioner range, location of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. Include the AMCA 511 maximum leakage rate at the operating static-pressure differential for each damper in the Damper Schedule. Provide a single damper schedule for the entire project.

E. Project Summary Equipment Schedule

Provide a project summary equipment schedule containing the manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a single project equipment schedule for the entire project.

F. Equipment Schedule

Provide system equipment schedules containing the unique identifier, manufacturer, model number, part number and descriptive name for each control device, hardware and component provided under this specification. Provide a separate equipment schedule for each HVAC system.

G. Occupancy Schedule

Provide an occupancy schedule drawing containing the same fields as the occupancy schedule Contract Drawing with Contractor updated information. Provide a single occupancy schedule for the entire project.

H. DDC Hardware Schedule

Provide a single DDC Hardware Schedule for the entire project and including following information for each device.

1. DDC Hardware Identifier

The Unique DDC Hardware Identifier for the device.

2. HVAC System

The system "name" used to identify a specific system (the name used on the system schematic drawing for that system).

3. Device Object Identifier

The Device Object Identifier: The Object_Identifier of the Device Object

4. Network Number

The Network Number for the device.

5. MAC Address

The MAC Address for the device.

6. BTL Listing

The BTL Listing of the device. If the device is listed under multiple BTL Profiles, indicate the profile that matches the use and configuration of the device as installed.

7. Proprietary Services Information

If the device uses non-standard ASHRAE 135 services as defined and permitted in Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS, indicate that the device uses non-standard services and include a description of all non-standard services used. Describe usage and content such that a device from another vendor can interoperate with the device using the non-standard service. Provide descriptions with sufficient detail to allow a device from a different manufacturer to be programmed to both read and write the non-standard service request:

a. Read: interpret the data contained in the non-standard service and;

b. Write: given similar data, generate the appropriate non-standard service request.

8. Alarming Information

   Indicate whether the device is used for alarm generation, and which types of alarm generation the device implements: intrinsic, local algorithmic, remote algorithmic.

9. Scheduling Information

   Indicate whether the device is used for scheduling.

10. Trending Information

    Indicate whether the device is used for trending, and indicate if the device is used to trend local values, remote values, or both.

I. Points Schedule

Provide a Points Schedule in tabular form for each HVAC system, with the indicated columns and with each row representing a hardware point, network point or configuration point in the system.

a. When a Points Schedule was included in the Contract Drawing package, use the same fields as the Contract Drawing with updated information in addition to the indicated fields.

b. When Point Schedules are included in the contract package, items requiring contractor verification or input have been shown in angle brackets ("<" and ">"), such as <___> for a required entry or <value> for a value requiring confirmation. Complete all items in brackets as well as any blank cells. Do not modify values which are not in brackets without approval.

Points Schedule Columns must include:

1. Point Name

   The abbreviated name for the point using the indicated naming convention.

2. Description

   A brief functional description of the point such as "Supply Air Temperature".

3. DDC Hardware Identifier

   The Unique DDC Hardware Identifier shown on the DDC Hardware Schedule and used across all drawings for the DDC Hardware containing the point.

4. Settings

   The value and units of any setpoints, configured setpoints, configuration parameters, and settings related to each point.

5. Range

The range of values, including units, associated with the point, including but not limited to a zone temperature setpoint adjustment range, a sensor measurement range, occupancy values for an occupancy input, or the status of a safety.

6. Input or Output (I/O) Type

The type of input or output signal associated with the point. Use the following abbreviations for entries in this column:

a. AI: The value comes from a hardware (physical) Analog Input

b. AO: The value is output as a hardware (physical) Analog Output

c. BI: The value comes from a hardware (physical) Binary Input

d. BO: The value is output as a hardware (physical) Binary Output

e. PULSE: The value comes from a hardware (physical) Pulse Accumulator Input

f. NET-IN: The value is provided from the network (generally from another device). Use this entry only when the value is received from another device as part of scheduling or as part of a sequence of operation, not when the value is received on the network for supervisory functions such as trending, alarming, override or display at a user interface.

g. NET-OUT: The value is provided to another controller over the network. Use this entry only when the value is transmitted to another device as part of scheduling or as part of a sequence of operation, not when the value is transmitted on the network for supervisory functions such as trending, alarming, override or display at a user interface.

7. Object and Property Information

The Object Type and Instance Number for the Object associated with the point. If the value of the point is not in the Present_Value Property, then also provide the Property ID for the Property containing the value of the point. Any point that is displayed at the front end or on an LDP, is trended, is used by another device on the network, or has an alarm condition must be documented here.

8. Network Data Exchange Information (Gets Data From, Sends Data To)

Provide the DDC Hardware Identifier of other DDC Hardware

the point is shared with.

9. Override Information (Object Type and Instance Number)

For each point requiring an Override, indicate if the Object for the point is Commandable or, if the use of a separate Object was specifically approved by the Contracting Officer, provide the Object Type and Instance Number of the Object to be used in overriding the point.

10. Trend Object Information

For each point requiring a trend, indicate if the trend is Local or Remote, the trend Object type and the trend Object instance number. For remote trends provide the DDC Hardware Identifier for the device containing the trend Object in the Points Schedule notes.

11. Alarm Information

Indicate the Alarm Generation Type, Event Enrollment Object Instance Number, and Notification Class Object Instance Number for each point requiring an alarm. (Note that not all alarms will have Event Enrollment Objects.

12. Configuration Information

Indicate the means of configuration associated with each point.

a. For Operator Configurable Points indicate BACnet Object and Property information (Name, Type, Identifiers) containing the configurable value. Indicate whether the property is writable always, or only when Out_Of_Service is TRUE.

b. For Configurable Points indicate the BACnet Object and Property information as for Operator Configurable points, or identification of the configurable settings from within the engineering software for the device or identification of the hardware settings on the device.

J. Riser Diagram

The Riser Diagram of the Building Control Network may be in tabular form, and must show all DDC Hardware and all Network Hardware, including network terminators. For each item, provide the unique identifier, common descriptive name, physical sequential order (previous and next device on the network), room identifier and location within room. A single riser diagram must be submitted for the entire system.

K. Control System Schematics

Provide control system schematics in the same form as the control system schematic Contract Drawing with Contractor updated information. Provide a control system schematic for each HVAC system.

L. Sequences of Operation

Provide HVAC control system sequence of operation in the same format as the Contract Drawings. Within these drawings, refer to devices by their unique identifiers. Submit sequences of operation and control logic diagrams for each HVAC system.

M. Controller, Motor Starter and Relay Wiring Diagram

Provide controller wiring diagrams as functional wiring diagrams which show the interconnection of conductors and cables to each controller and to the identified terminals of input and output devices, starters and package equipment. Show necessary jumpers and ground connections and the labels of all conductors. Identify sources of power required for control systems and for packaged equipment control systems back to the panel board circuit breaker number, controller enclosures, magnetic starter, or packaged equipment control circuit. Show each power supply and transformer not integral to a controller, starter, or packaged equipment. Show the connected volt-ampere load and the power supply volt-ampere rating. Provide wiring diagrams for each HVAC system.

3.03 CONTROLLER TUNING

Tune each controller in a manner consistent with that descrbed in the ASHRAE FUN IP and in the manufacturer's instruction manual. Tuning must consist of adjustment of the proportional, integral, and where applicable, the derivative (PID) settings to provide stable closed-loop control. Each loop must be tuned while the system or plant is operating at a high gain (worst case) condition, where high gain can generally be defined as a low-flow or low-load condition. Upon final adjustment of the PID settings, in response to a change in controller setpoint, the controlled variable must settle out at the new setpoint with no more than two (2) oscillations above and below setpoint. Upon settling out at the new setpoint the controller output must be steady. With the exception of naturally slow processes such as zone temperature control, the controller must settle out at the new setpoint within five (5) minutes. Set the controller to its correct setpoint and record and submit the final PID configuration settings with the O&M Instructions and on the associated Points Schedule.

3.04 START-UP

A. Test Results

1. Four copies of the PVT Report. The PVT Report may be submitted as a Technical Data Package.

2. Four copies of the Pre-Construction QC Checklist.

3. Four copies of the Post-Construction QC Checklist.

B. Start-Up Test

Perform the following startup tests for each control system to ensure that the described control system components are installed and functioning per this specification.

Adjust, calibrate, measure, program, configure, set the time schedules, and otherwise perform all necessary actions to ensure that the systems function as indicated and shown in the sequence of operation and other contract documents.

1. Systems Check

An item-by-item check must be performed for each HVAC system

a. Step 1 - System Inspection

With the system in unoccupied mode and with fan hand-off-auto switches in the OFF position, verify that power and main air are available where required and that all output devices are in their failsafe and normal positions. Inspect each local display panel and each M&C Client to verify that all displays indicate shutdown conditions.

b. Step 2 - Calibration Accuracy Check

Perform a two-point accuracy check of the calibration of each HVAC control system sensing element and transmitter by comparing the value from the test instrument to the network value provided by the DDC Hardware. Use digital indicating test instruments, such as digital thermometers, motor-driven psychrometers, and tachometers. Use test instruments with accuracy at least twice as accurate as the specified sensor accuracy and with calibration traceable to National Institute of Standards and Technology standards. Check one the first check point in the bottom one-third of the sensor range, and the second in the top one-third of the sensor range. Verify that the sensing element-to-DDC readout accuracies at two points are within the specified product accuracy tolerances, and if not recalibrate or replace the device and repeat the calibration check.

c. Step 3 - Actuator Range Check

With the system running, apply a signal to each actuator through the DDC Hardware controller. Verify proper operation of the actuators and positioners for all actuated devices and record the signal levels for the extreme positions of each device. Vary the signal over its full range, and verify that the actuators travel from zero stroke to full stroke within the signal range. Where applicable, verify that all sequenced actuators move from zero stroke to full stroke in the proper direction, and move the connected device in the proper direction from one extreme position to the other. For valve actuators and damper actuators, perform the actuator range check under normal system pressures.

2. Weather Dependent Test

Perform weather dependent test procedures in the appropriate climatic season.

C. Start-Up Testing Report

Submit 4 copies of the Start-Up Testing Report. The report may be submitted as a Technical Data Package documenting the results of the tests performed and certifying that the system is installed and functioning per this specification, and is ready for the Performance Verification Test (PVT).

3.05 PERFORMANCE VERIFICATION TEST (PVT)

A. PVT Procedures

Prepare PVT Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system performs in accordance with the sequences of operation, and other contract documents. Submit 4 copies of the PVT Procedures. The PVT Procedures may be submitted as a Technical Data Package.

1. Sensor Accuracy Checks

Include a one-point accuracy check of each sensor in the PVT procedures.

2. Endurance Test

Include a one-week endurance test as part of the PVT during which the system is operated continuously. Use the building control system BACnet Trend Log or Trend Log Multiple Objects to trend all points shown as requiring a trend on the Point Schedule for the entire endurance test. If insufficient buffer capacity exists to trend the entire endurance test, upload trend logs during the course of the endurance test to ensure that no trend data is lost.

3. PVT Equipment List

Include in the PVT procedures a control system performance verification test equipment list that lists the equipment to be used during performance verification testing. For each piece of equipment, include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration

B. PVT Execution

Demonstrate compliance of the control system with the contract documents. Using test plans and procedures approved by the Government, software capable of reading and writing COV Notification Subscriptions, Notification Class Recipient List Properties, event enrollments, demonstrate all physical and functional requirements of the project. Show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. Do not start the performance verification test until after receipt of

written permission by the Government, based on Government approval of the PVT Plan and Draft As-Builts and completion of balancing. Do not conduct tests during scheduled seasonal off periods of base heating and cooling systems. If the system experiences any failures during the endurance test portion of the PVT, repair the system repeat the endurance test portion of the PVT until the system operates continuously and without failure for the specified endurance test period.

C. PVT Report

Prepare and submit a PVT report documenting all tests performed during the PVT and their results. Include all tests in the PVT procedures and any additional tests performed during PVT. Document test failures and repairs conducted with the test results.

3.06 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. Provide HVAC control System Operation and Maintenance Instructions which include:

a. "Data Package 3" as indicated in Section 01 78 23 OPERATION AND MAINTENANCE DATA for each piece of control equipment.

b. "Data Package 4" as described in Section 01 78 23 OPERATION AND MAINTENANCE DATA for all air compressors.

c. HVAC control system sequences of operation formatted as indicated.

d. Procedures for the HVAC system start-up, operation and shut-down including the manufacturer's supplied procedures for each piece of equipment, and procedures for the overall HVAC system.

e. As-built HVAC control system detail drawings formatted as indicated.

f. Routine maintenance checklist. Provide the routine maintenance checklist arranged in a columnar format, where the first column lists all installed devices, the second column states the maintenance activity or that no maintenance required, the third column states the frequency of the maintenance activity, and the fourth column is used for additional comments or reference.

g. Qualified service organization list, including at a minimum company name, contact name and phone number.

h. Start-Up Testing Report.

i. Performance Verification Test (PVT) Procedures and Report.

B. Submittal requirements:

1. Submit 2 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions may be submitted as a Technical Data Package.

2. Submit hardcopy training manuals and all training materials on CD-ROM. Provide one hardcopy manual for each trainee on the Course Attendee List and 2 additional copies for archive at the project site. Provide 2 copies of the Course Attendee List with the archival copies. Training Documentation may be submitted as a Technical Data Package.

3.07 MAINTENANCE AND SERVICE

Provide services, materials and equipment as necessary to maintain the entire system in an operational state as indicated for a period of one year after successful completion and acceptance of the Performance Verification Test. Minimize impacts on facility operations.

a. The integration of the system specified in this section into a Utility Monitoring and Control System must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period. Integration into a UMCS includes but is not limited to establishing communication between devices in the control system and the front end or devices in another system.

b. The changing of configuration properties must not, of itself, void the warranty or otherwise alter the requirement for the one year maintenance and service period.

A. Description of Work

Provide adjustment and repair of the system including the manufacturer's required sensor and actuator (including transducer) calibration, span and range adjustment.

B. Personnel

Use only service personnel qualified to accomplish work promptly and satisfactorily. Advise the Government in writing of the name of the designated service representative, and of any changes in personnel.

C. Scheduled Inspections

Perform two inspections at six-month intervals and provide work required. Perform inspections in June and December. During each inspection perform the indicated tasks:

a. Perform visual checks and operational tests of equipment.

b. Clean control system equipment including interior and exterior surfaces.

c. Check and calibrate each field device. Check and calibrate 50 percent of the total analog inputs and outputs during the first inspection. Check and calibrate the remaining 50 percent of the analog inputs and outputs during the second major inspection. Certify analog test instrumentation accuracy to be twice the specified accuracy of the device being calibrated. Randomly check at least 25 percent of all binary inputs and outputs for proper operation during the

first inspection. Randomly check at least 25 percent of the remaining binary inputs and outputs during the second inspection. If more than 20 percent of checked inputs or outputs failed the calibration check during any inspection, check and recalibrate all inputs and outputs during that inspection.

d. Run system software diagnostics and correct diagnosed problems.

e. Resolve any previous outstanding problems.

D. Scheduled Work

This work must be performed during regular working hours, Monday through Friday, excluding Federal holidays.

E. Emergency Service

The Government will initiate service calls when the system is not functioning properly. Qualified personnel must be available to provide service to the system. A telephone number where the service supervisor can be reached at all times must be provided. Service personnel must be at the site within 24 hours after receiving a request for service. The control system must be restored to proper operating condition as required per Section 01 78 00 CLOSEOUT SUBMITTALS.

F. Operation

After performing scheduled adjustments and repairs, verify control system operation as demonstrated by the applicable tests of the performance verification test.

G. Records and Logs

Keep dated records and logs of each task, with cumulative records for each major component, and for the complete system chronologically. Maintain a continuous log for all devices, including initial analog span and zero calibration values and digital points. Keep complete logs and provide logs for inspection onsite, demonstrating that planned and systematic adjustments and repairs have been accomplished for the control system.

H. Work Requests

Record each service call request as received and include its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. Submit a record of the work performed within 5 days after work is accomplished.

I. System Modifications

Submit recommendations for system modification in writing. Do not make system modifications, including operating parameters and

control settings, without prior approval of the Government.

3.08 TRAINING

Conduct a training course for operating staff members designated by the Government in the maintenance and operation of the system, including specified hardware and software. Conduct 8 hours of training at the project site within 30 days after successful completion of the performance verification test. The Government reserves the right to make audio and visual recordings (using Government supplied equipment) of the training sessions for later use. Provide audiovisual equipment and other training materials and supplies required to conduct training. A training day is defined as 8 hours of classroom instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

A. Training Documentation

Prepare training documentation consisting of:

a. Course Attendee List: Develop the list of course attendees in coordination with and signed by the Controls shop supervisor.

b. Training Manuals: Provide training manuals which include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. When presenting portions of the course material by audiovisuals, deliver copies of those audiovisuals as a part of the printed training manuals.

B. Training Course Content

For guidance in planning the required instruction, assume that attendees will have a high school education, and are familiar with HVAC systems. During the training course, cover all of the material contained in the Operating and Maintenance Instructions, the layout and location of each controller enclosure, the layout of one of each type of equipment and the locations of each, the location of each control device external to the panels, the location of the compressed air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. Present the results of the performance verification test and the Start-Up Testing Report as benchmarks of HVAC control system performance by which to measure operation and maintenance effectiveness.

APPENDIX A

QC CHECKLIST FOR BACNET SYSTEMS			
This checklist is not all-inclusive of the requirements of this specification and should not be interpreted as such. Instructions: Initial each item in the space provided (|____|) verifying that the requirement has been met.			
This checklist is for (circle one:) Pre-Construction QC Checklist Submittal Post-Construction QC Checklist Submittal Close-out QC Checklist Submittal			
Items verified for Pre-Construction, Post-Construction and Closeout QC Checklist Submittals:			
1	All DDC Hardware is numbered on Control System Schematic Drawings.		|____|
2	Signal lines on Control System Schematic are labeled with the signal type.		|____|
3	Local Display Panel (LDP) Locations are shown on Control System Schematic drawings.		|____|
Items verified for Post-Construction and Closeout QC Checklist Submittals:			
4	All sequences are performed as specified using DDC Hardware.		|____|
5	Training schedule and course attendee list has been developed and coordinated with shops and submitted.		|____|
Items verified for Closeout QC Checklist Submittal:			
6	Final As-built Drawings, including all Points Schedule drawings, accurately represent the final installed system.		|____|
7	Programming software has been submitted for all programmable controllers.		|____|
8	All software has been licensed to the Government.		|____|

QC CHECKLIST FOR BACNET SYSTEMS			
9	O&M Instructions have been completed and submitted.		|____|
10	Training course has been completed.		|____|
11	All DDC Hardware is installed on a BACnet ASHRAE 135 network using either MS/TP in accordance with Clause 9 or IP in accordance with Annex J.		|____|
12	All DDC Hardware is BTL listed.		|____|
13	Communication between DDC Hardware is only via BACnet using standard services, except as specifically permitted by the specification. Non-standard services have been fully documented in the DDC Hardware Schedule.		|____|
14	Scheduling, Alarming, and Trending have been implemented using the standard BACnet Objects for these functions.		|____|
15	All Properties indicated as required to be Writeable are Writeable and Overrides have been provided as indicated.		|____|
	_____		_____
	(QC Representative Signature)		(Date)

-- End of Section --

SECTION 23 09 13

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC
11/15

PART 1 GENERAL

1.01 SUMMARY

This section provides for the instrumentation control system components excluding direct digital controllers, network controllers, gateways etc. that are necessary for a completely functional automatic control system. When combined with a Direct Digital Control (DDC) system, the Instrumentation and Control Devices covered under this section must be a complete system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and indicated.

a. Install hardware to perform the control sequences as specified and indicated and to provide control of the equipment as specified and indicated.

b. Install hardware such that individual control equipment can be replaced by similar control equipment from other equipment manufacturers with no loss of system functionality.

c. Install and configure hardware such that the Government or their agents are able to perform repair, replacement, and upgrades of individual hardware without further interaction with the installing Contractor.

A. Verification of Dimensions

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

B. Drawings

The Government will not indicate all offsets, fittings, and accessories that may be required on the drawings. Carefully investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, arrange such work accordingly, and provide all work necessary to meet such conditions.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 500-D	(2012) Laboratory Methods of Testing Dampers for Rating
AMCA 511	(2010) Certified Ratings Program for Air

Control Devices

ASME INTERNATIONAL (ASME)

ASME B16.15	(2013) Cast Copper Alloy Threaded Fittings Classes 125 and 250
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.34	(2013) Valves - Flanged, Threaded and Welding End
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A269/A269M	(2015a) Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B88	(2016) Standard Specification for Seamless Copper Water Tube

FLUID CONTROLS INSTITUTE (FCI)

FCI 70-2	(2013) Control Valve Seat Leakage

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 5085-3	(2006; Reprint Nov 20121) Low Voltage Transformers - Part 3: Class 2 and Class 3 Transformers

1.03 SUBMITTALS

Submittal requirements are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.04 DELIVERY AND STORAGE

Store and protect products from the weather, humidity, and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

1.05 INPUT MEASUREMENT ACCURACY

Select, install and configure sensors, transmitters and DDC Hardware such that the maximum error of the measured value at the input of the DDC hardware is less than the maximum allowable error specified for the sensor or instrumentation.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General Requirements

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

B. Operation Environment Requirements

Unless otherwise specified, provide products rated for continuous operation under the following conditions:

1. Pressure

Pressure conditions normally encountered in the installed location.

2. Vibration

Vibration conditions normally encountered in the installed location.

3. Temperature

a. Products installed indoors: Ambient temperatures in the range of 32 to 112 degrees F and temperature conditions outside this range normally encountered at the installed location.

b. Products installed outdoors or in unconditioned indoor spaces: Ambient temperatures in the range of -35 to +151 degrees F and temperature conditions outside this range normally encountered at the installed location.

4. Humidity

10 to 95 percent relative humidity, noncondensing and also humidity conditions outside this range normally encountered at the installed location.

2.02 WEATHERSHIELDS

Provide weathershields constructed of galvanized steel painted white, unpainted aluminum, aluminum painted white, or white PVC.

2.03 TUBING

A. Copper

Provide ASTM B75/B75M or ASTM B88 rated tubing meeting the following requirements:

1. For tubing 0.375 inch outside diameter and larger provide tubing with minimum wall thickness equal to ASTM B88, Type M

2. For tubing less than 0.375 inch outside diameter provide tubing with minimum wall thickness of 0.025 inch

3. For exposed tubing and tubing for working pressures greater than 30 psig provide hard copper tubing.

4. Provide fittings which are ASME B16.18 or ASME B16.22 solder type using ASTM B32 95-5 tin-antimony solder, or which are ASME B16.26 compression type.

B. Stainless Steel

For stainless steel tubing, provide tubing conforming to ASTM A269/A269M

2.04 WIRE AND CABLE

Provide wire and cable meeting the requirements of NFPA 70 and NFPA 90A in addition to the requirements of this specification and referenced specifications.

A. Terminal Blocks

For terminal blocks which are not integral to other equipment, provide terminal blocks which are insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, suitable for DIN rail mounting, and which have enclosed sides or end plates and partition plates for separation.

B. Control Wiring for Binary Signals

For Control Wiring for Binary Signals, provide 18 AWG copper or

thicker wire rated for 300-volt service.

C. Control Wiring for Analog Signals

For Control Wiring for Analog Signals, provide 18 AWG or thicker, copper, single- or multiple-twisted wire meeting the following requirements:

1. minimum 2 inch lay of twist

2. 100 percent shielded pairs

3. at least 300-volt insulation

4. each pair has a 20 AWG tinned-copper drain wire and individual overall pair insulation

5. cables have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

D. Power Wiring for Control Devices

For 24-volt circuits, provide insulated copper 18 AWG or thicker wire rated for 300 VAC service. For 120-volt circuits, provide 14 AWG or thicker stranded copper wire rated for 600-volt service.

E. Transformers

Provide UL 5085-3 approved transformers. Select transformers sized so that the connected load is no greater than 80 percent of the transformer rated capacity.

2.05 AUTOMATIC CONTROL VALVES

Provide valves with stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Provide valves with bodies meeting ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Unless otherwise specified or indicated, provide valves meeting FCI 70-2 Class IV leakage rating. Provide valves rated for modulating or two-position service as indicated, which close against a differential pressure indicated as the Close-Off pressure and which are Normally-Open, Normally-Closed, or Fail-In-Last-Position as indicated.

A. Valve Type

1. Liquid Service 150 Degrees F or Less

Use either globe valves or ball valves except that butterfly valves may be used for sizes 4 inch and larger.

B. Valve Flow Coefficient and Flow Characteristic

1. Two-Way Modulating Valves

Provide the valve coefficient (Cv) indicated. Provide equal-percentage flow characteristic for liquid service

except for butterfly valves. Provide linear flow characteristic for steam service except for butterfly valves.

C. Two-Position Valves

Use full line size full port valves with maximum available (Cv).

D. Globe Valves

1. Liquid Service Not Exceeding 150 Degrees F

a. Valve body and body connections:

(1) Valves 1-1/2 inches and smaller: brass or bronze body, with threaded or union ends

(2) Valves from 2 inches to 3 inches inclusive: brass, bronze, or iron bodies. 2 inch valves with threaded connections; 2-1/2 to 3 inches valves with flanged connections

b. Internal valve trim: Brass or bronze.

c. Stems: Stainless steel.

d. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

E. Ball Valves

1. Liquid Service Not Exceeding 150 Degrees F

a. Valve body and connections:

(1) Valves 1-1/2 inches and smaller: bodies of brass or bronze, with threaded or union ends

(2) Valves from 2 inches to 3 inches inclusive: bodies of brass, bronze, or iron. 2 inch valves with threaded connections; valves from 2-1/2 to 3 inches with flanged connections.

b. Ball: Stainless steel or nickel-plated brass or chrome-plated brass.

c. Seals: Reinforced Teflon seals and EPDM O-rings.

d. Stem: Stainless steel, blow-out proof.

e. Provide valves compatible with a solution of 50 percent ethylene or propylene glycol.

F. Butterfly Valves

Provide butterfly valves which are threaded lug type suitable for dead-end service and modulation to the fully-closed position, with carbon-steel bodies or with ductile iron bodies in accordance with ASTM A536. Provide butterfly valves with non-corrosive discs, stainless steel shafts supported by

bearings, and EPDM seats suitable for temperatures from -20 to +250 degrees F. Provide valves with rated Cv of the Cv at 70 percent (60 degrees) open position. Provide valves meeting FCI 70-2 Class VI leakage rating.

G. Pressure Independent Control Valves (PICV)

Provide pressure independent control valves which include a regulator valve which maintains the differential pressure across a flow control valve. Pressure independent control valves must accurately control the flow from 0-100 percent full rated flow regardless of changes in the piping pressure and not vary the flow more than plus or minus 5 percent at any given flow control valve position when the PICV differential pressure lies between the manufacturer's stated minimum and maximum. The rated minimum differential pressure for steady flow must not exceed 5 psid across the PICV. Provide either globe or ball type valves meeting the indicated requirements for globe and ball valves. Provide valves with a flow tag listing full rated flow and minimum required pressure drop. Provide valves with factory installed Pressure/Temperature ports ("Pete's Plugs") to measure the pressure drop to determine the valve flow rate.

H. Duct-Coil and Terminal-Unit-Coil Valves

For duct or terminal-unit coils provide control valves with either screw type or solder-type ends.

2.06 DAMPERS

A. Damper Assembly

Provide single damper sections with blades no longer than 48 inches and which are no higher than 72 inches and damper blade width of 8 inches or less. When larger sizes are required, combine damper sections. Provide dampers made of steel, or other materials where indicated and with assembly frames constructed of 0.07 inch minimum thickness galvanized steel channels with mitered and welded corners. Steel channel frames constructed of 0.06 inch minimum thickness are acceptable provided the corners are reinforced.

a. Flat blades must be made rigid by folding the edges. Blade-operating linkages must be within the frame so that blade-connecting devices within the same damper section must not be located directly in the air stream.

b. Damper axles must be 1/2 inch minimum, plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically must be supported by thrust bearings.

c. Provide dampers which do not exceed a pressure drop through the damper of 0.04 inches water gauge at 1000 ft/min in the wide-open position. Provide dampers with frames not less than 2 inch in width. Provide dampers which have been tested in accordance with AMCA 500-D.

B. Operating Linkages

For operating links external to dampers, such as crank arms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers, provide links able to withstand a load equal to at least 300 percent of the maximum required damper-operating force without deforming. Rod lengths must be adjustable. Links must be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises must be brass, bronze, or stainless steel. Adjustments of crank arms must control the open and closed positions of dampers.

C. Damper Types

1. Flow Control Dampers

Provide parallel-blade or opposed blade type dampers for outside air, return air, relief air, exhaust, face and bypass dampers as indicated on the Damper Schedule. Blades must have interlocking edges. The channel frames of the dampers must be provided with jamb seals to minimize air leakage. Unless otherwise indicated, dampers must meet AMCA 511 Class 1 requirements. Outside air damper seals must be suitable for an operating temperature range of -40 to +167 degrees F. Dampers must be rated at not less than 2000 ft/min air velocity.

2.07 SENSORS AND INSTRUMENTATION

Unless otherwise specified, provide sensors and instrumentation which incorporate an integral transmitter. Sensors and instrumentation, including their transmitters, must meet the specified accuracy and drift requirements at the input of the connected DDC Hardware's analog-to-digital conversion.

A. Analog and Binary Transmitters

Provide transmitters which match the characteristics of the sensor. Transmitters providing analog values must produce a linear 4-20 mAdc, 0-10 Vdc signal corresponding to the required operating range and must have zero and span adjustment. Transmitters providing binary values must have dry contacts rated at 1A at 24 Volts AC.

B. Network Transmitters

Sensors and Instrumentation incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS when used in a BACnet network.

C. Temperature Sensors

Provide the same sensor type throughout the project. Temperature sensors may be provided without transmitters. Where transmitters are used, the range must be the smallest available from the manufacturer and suitable for the application such that the range encompasses the expected range of temperatures to be measured.

The end to end accuracy includes the combined effect of sensitivity, hysterisis, linearity and repeatability between the measured variable and the end user interface (graphic presentation) including transmitters if used.

1. Sensor Accuracy and Stability of Control

   a. Conditioned Space Temperature

      Plus or minus 0.5 degree F over the operating range.

   b. Unconditioned Space Temperature

      (1) Plus or minus 1 degree F over the range of 30 to 131 degrees F AND
      (2) Plus or minus 4 degrees F over the rest of the operating range.

   c. Duct Temperature

      Plus or minus 0.5 degree F

   d. Outside Air Temperature

      (1) Plus or minus 2 degrees F over the range of -30 to +130 degrees F AND
      (2) Plus or minus 1 degree F over the range of 30 to 130 degrees F.

   e. Dual Temperature Water

      Plus or minus 2 degrees F.

2. Transmitter Drift

   The maximum allowable transmitter drift: 0.25 degrees F per year.

3. Point Temperature Sensors

   Point Sensors must be encapsulated in epoxy, series 300 stainless steel, anodized aluminum, or copper.

4. Temperature Sensor Details

   a. Room Type

      Provide the sensing element components within a decorative protective cover suitable for surrounding decor.

   b. Duct Probe Type

      Ensure the probe is long enough to properly sense the air stream temperature.

   c. Duct Averaging Type

      Continuous averaging sensors must be one foot in length

for each 1 square foot of duct cross-sectional area, and a minimum length of 5 feet.

d. Pipe Immersion Type

Provide minimum 3 inch immersion. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells must be stainless steel when used in steel piping, and brass when used in copper piping.

e. Outside Air Type

Provide the sensing element rated for outdoor use

D. Differential Pressure Instrumentation

1. Differential Pressure Sensors

Provide Differential Pressure Sensors with ranges as indicated or as required for the application. Pressure sensor ranges must not exceed the high end range indicated on the Points Schedule by more than 50 percent. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor.

The accuracy must be plus or minus 1 percent of full scale. The sensor must have a maximum drift of 2 percent per year

2. Differential Pressure Switch

Provide differential pressure switches with a user-adjustable setpoint which are sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The over pressure rating must be a minimum of 150 percent of the highest design pressure of either input to the sensor. The switch must have two sets of contacts and each contact must have a rating greater than its connected load. Contacts must open or close upon rise of pressure above the setpoint or drop of pressure below the setpoint as indicated.

E. Flow Sensors

1. Venturi Tube

Venturi tube must be made of cast iron or cast steel and must have an accuracy of plus or minus 1 percent of full flow. The throat section must be lined with austenitic stainless steel. Thermal expansion characteristics of the lining must be the same as that of the throat casting material. The surface of the throat lining must be machined to a plus or minus 50 micro inch finish, including the short curvature leading from the converging entrance section into the throat.

2. Insertion Turbine Flowmeter

Provide dual axial turbine flowmeter with all installation

hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Insertion Turbine Flowmeter accuracy must be plus or minus 0.5 percent of rate at calibrated velocity, within plus or minus of rate over a 10:1 turndown and within plus or minus 2 percent of rate over a 50:1 turndown. Repeatability must be plus or minus 0.25 percent of reading. The meter flow sensing element must operate over a range suitable for the installed location with a pressure loss limited to 1 percent of operating pressure at maximum flow rate. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs. The turbine rotor assembly must be constructed of Series 300 stainless steel and use Teflon seals.

3. Vortex Shedding Flowmeter

Vortex Shedding Flowmeter accuracy must be within plus or minus 0.8 percent of the actual reading over the range of the meter. Steam meters must contain density compensation by direct measurement of temperature. Mass flow inferred from specified steam pressure are not acceptable. The flow meter body must be made of austenitic stainless steel and include a weather tight NEMA 4X electronics enclosure. The vortex shedding flowmeter body must not require removal from the piping in order to replace the shedding sensor.

4. Ultrasonic Flow Meter

Provide Ultrasonic Flow Meters complete with matched transducers, self- aligning installation hardware and transducer cables. Ultrasonic transducers must be optimized for the specified pipe and process conditions for the application. The flow meter accuracy must plus or minus 1 percent of rate from 0 to 40 ft/sec. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc output.

5. Insertion Magnetic Flow Meter

Provide insertion type magnetic flowmeters with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. All parts must meet or exceed the pressure classification of the pipe system it is installed in. Flowmeter accuracy must be no greater than plus or minus 1 percent of rate from 2 to 20 feet/sec. Wetted material parts must be 300 series stainless steel. The flowmeter must include either dry contact pulse outputs, 4-20mA, 0-10Vdc or 0-5Vdc outputs.

6. Flow Switch

Flow switch must have a repetitive accuracy of plus or minus 10 percent of actual flow setting. Switch actuation must be adjustable over the operating flow range, and must be sized for the application such that the setpoint is between 25 percent and 75 percent of the full range. The switch must have Form C snap-action contacts, rated for the application.

The flow switch must have non flexible paddle with magnetically actuated contacts and be rated for service at a pressure greater than the installed conditions. Flow switch for use in sewage system must be rated for use in corrosive environments encountered.

F. Electrical Instruments

Provide Electrical Instruments with an input range as indicated or sized for the application. Unless otherwise specified, AC instrumentation must be suitable for 60 Hz operation.

1. Current Transducers

Current transducers must accept an AC current input and must have an accuracy of plus or minus 0.5 percent of full scale. The device must have a means for calibration. Current transducers for variable frequency applications must be rated for variable frequency operation.

2. Current Sensing Relays (CSRs)

Current sensing relays (CSRs) must provide a normally-open contact with a voltage and amperage rating greater than its connected load. Current sensing relays must be of split-core design. The CSR must be rated for operation at 200 percent of the connected load. Voltage isolation must be a minimum of 600 volts. The CSR must auto-calibrate to the connected load or be adjustable and field calibrated. Current sensors for variable frequency applications must be rated for variable frequency operation.

3. Voltage Transducers

Voltage transducers must accept an AC voltage input and have an accuracy of plus or minus 0.25 percent of full scale. The device must have a means for calibration. Line side fuses for transducer protection must be provided.

G. Occupancy Sensors

Occupancy sensors must have occupancy-sensing sensitivity adjustment and an adjustable off-delay timer with a setpoint of 15 minutes. Adjustments accessible from the face of the unit are preferred. Occupancy sensors must be rated for operation in ambient air temperatures ranging from 40 to 95 degrees F or temperatures normally encountered in the installed location. Sensors integral to wall mount on-off light switches must have an auto-off switch. Wall switch sensors must be decorator style and must fit behind a standard decorator type wall plate. All occupancy sensors, power packs, and slave packs must be UL listed. In addition to any outputs required for lighting control, the occupancy sensor must provide an output for the HVAC control system.

1. Passive Infrared (PIR) Occupancy Sensors

PIR occupancy sensors must have a multi-level, multi-segmented viewing lens and a conical field of view

with a viewing angle of 180 degrees and a detection of at least 20 feet unless otherwise indicated or specified. PIR Sensors must provide field-adjustable background light-level adjustment with an adjustment range suitable to the light level in the sensed area, room or space. PIR sensors must be immune to false triggering from RFI and EMI.

2. Ultrasonic Occupancy Sensors

Ultrasonic sensors must operate at a minimum frequency 32 kHz and must be designed to not interfere with hearing aids.

3. Dual-Technology Occupancy Sensor (PIR and Ultrasonic)

Dual-Technology Occupancy Sensors must meet the requirements of both PIR and Ultrasonic Occupancy Sensors.

H. Temperature Switch

1. Duct Mount Temperature Low Limit Safety Switch (Freezestat)

Duct mount temperature low limit switches (Freezestats) must be manual reset, low temperature safety switches at least 1 foot long per square foot of coverage which must respond to the coldest 18 inch segment with an accuracy of plus or minus 3.6 degrees F. The switch must have a field-adjustable setpoint with a range of at least 30 to 50 degrees F. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon drop of temperature below setpoint as indicated and must remain in this state until reset.

2. Pipe Mount Temperature Limit Switch (Aquastat)

Pipe mount temperature limit switches (aquastats) must have a field adjustable setpoint between 60 and 90 degrees F, an accuracy of plus or minus 3.6 degrees F and a 10 degrees F fixed deadband. The switch must have two sets of contacts, and each contact must have a rating greater than its connected load. Contacts must open or close upon change of temperature above or below setpoint as indicated.

I. Damper End Switches

Each end switch must be a hermetically sealed switch with a trip lever and over-travel mechanism. The switch enclosure must be suitable for mounting on the duct exterior and must permit setting the position of the trip lever that actuates the switch. The trip lever must be aligned with the damper blade.

End switches integral to an electric damper actuator are allowed as long as at least one is adjustable over the travel of the actuator.

2.08 INDICATING DEVICES

All indicating devices must display readings in English (inch-pound) units.

A. Thermometers

Provide bi-metal type thermometers at locations indicated. Thermometers must have either 9 inch long scales or 3.5 inch diameter dials, with insertion, immersion, or averaging elements. Provide matching thermowells for pipe-mounted installations. Select scale ranges suitable for the intended service, with the normal operating temperature near the scale's midpoint. The thermometer's accuracy must be plus or minus 2 percent of the scale range.

1. Piping System Thermometers

Piping system thermometers must have brass, malleable iron or aluminum alloy case and frame, clear protective face, permanently stabilized glass tube with indicating-fluid column, white face, black numbers, and a 9 inch scale. Piping system thermometers must have an accuracy of plus or minus 1 percent of scale range. Thermometers for piping systems must have rigid stems with straight, angular, or inclined pattern. Thermometer stems must have expansion heads as required to prevent breakage at extreme temperatures. On rigid-stem thermometers, the space between bulb and stem must be filled with a heat-transfer medium.

B. Pressure Gauges

Provide pipe-mounted pressure gauges at the locations indicated. Gauges must conform to ASME B40.100 and have a 4 inch diameter dial and shutoff cock. Select scale ranges suitable for the intended service, with the normal operating pressure near the scale's midpoint. The gauge's accuracy must be plus or minus 2 percent of the scale range.

Gauges must be suitable for field or panel mounting as required, must have black legend on white background, and must have a pointer traveling through a 270-degree arc. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus 3 percent of scale range. Gauges must meet requirements of ASME B40.100.

C. Low Differential Pressure Gauges

Gauges for low differential pressure measurements must be a minimum of 3.5 inch (nominal) size with two sets of pressure taps, and must have a diaphragm-actuated pointer, white dial with black figures, and pointer zero adjustment. Gauge range must be suitable for the application with an upper end of the range not to exceed 150 percent of the design upper limit. Accuracy must be plus or minus two percent of scale range.

2.09 OUTPUT DEVICES

A. Actuators

Actuators must be electric (electronic). All actuators must be normally open (NO), normally closed (NC) or fail-in-last-position (FILP) as indicated. Normally open and normally closed actuators

must be of mechanical spring return type. Electric actuators must have an electronic cut off or other means to provide burnout protection if stalled. Actuators must have a visible position indicator. Electric actuators must provide position feedback to the controller as indicated. Actuators must smoothly and fully open or close the devices to which they are applied. Electric actuators must have a full stroke response time in both directions of 90 seconds or less at rated load. Electric actuators must be of the foot-mounted type with an oil-immersed gear train or the direct-coupled type. Where multiple electric actuators operate from a common signal, the actuators must provide an output signal identical to its input signal to the additional devices. All actuators must be rated for their operating environment. Actuators used outdoors must be designed and rated for outdoor use. Actuators under continuous exposure to water, such as those used in sumps, must be submersible.

Actuators incorporating an integral network connection are considered DDC Hardware and must meet the DDC Hardware requirements of Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS.

1. Valve Actuators

   Valve actuators must provide shutoff pressures and torques as indicated on the Valve Schedule.

2. Damper Actuators

   Damper actuators must provide the torque necessary per damper manufacturer's instructions to modulate the dampers smoothly over its full range of operation and torque must be at least 6 inch-pounds/1 square foot of damper area for opposed blade dampers and 9 inch-pounds/1 square foot of damper area for parallel blade dampers.

3. Electric Actuators

   Each actuator must have distinct markings indicating the full-open and full-closed position Each actuator must deliver the torque required for continuous uniform motion and must have internal end switches to limit the travel, or be capable of withstanding continuous stalling without damage. Actuators must function properly within 85 to 110 percent of rated line voltage. Provide actuators with hardened steel running shafts and gears of steel or copper alloy. Fiber or reinforced nylon gears may be used for torques less than 16 inch-pounds.

   a. Two-position actuators must be single direction, spring return, or reversing type. Two position actuator signals may either be the control power voltage or line voltage as needed for torque or appropriate interlock circuits.

   b. Modulating actuators must be capable of stopping at any point in the cycle, and starting in either direction from any point. Actuators must be equipped with a switch for reversing direction, and a button to disengage the clutch to allow manual adjustments. Provide the actuator

with a hand crank for manual adjustments, as applicable. Modulating actuator input signals can either be a 4 to 20 mAdc or a 0-10 VDC signal.

c. Floating or pulse width modulation actuators are acceptable for non-fail safe applications unless indicated otherwise provided that the floating point control (timed actuation) must have a scheduled re-calibration of span and position no more than once a day and no less than once a week. The schedule for the re-calibration should not affect occupied conditions and be staggered between equipment to prevent falsely loading or unloading central plant equipment.

B. Relays

Relays must have contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light must be lit when the coil is energized and off when coil is not energized.

Control relay contacts must have utilization category and ratings selected for the application. Each set of contacts must incorporate a normally open (NO), normally closed (NC) and common contact. Relays must be rated for a minimum life of one million operations.

2.10 USER INPUT DEVICES

User Input Devices, including potentiometers, switches and momentary contact push-buttons. Potentiometers must be of the thumb wheel or sliding bar type. Momentary Contact Push-Buttons may include an adjustable timer for their output. User input devices must be labeled for their function.

2.11 MULTIFUNCTION DEVICES

Multifunction devices are products which combine the functions of multiple sensor, user input or output devices into a single product. Unless otherwise specified, the multifunction device must meet all requirements of each component device. Where the requirements for the component devices conflict, the multifunction device must meet the most stringent of the requirements.

A. Current Sensing Relay Command Switch

The Current Sensing Relay portion must meet all requirements of the Current Sensing Relay input device. The Command Switch portion must meet all requirements of the Relay output device except that it must have at least one normally-open (NO) contact.

Current Sensing Relays used for Variable Frequency Drives must be rated for Variable Frequency applications unless installed on the source side of the drive. If used in this situation, the threshold for showing status must be set to allow for the VFD's control power when the drive is not enabled and provide indication of operation when the drive is enabled at minimum speed.

B. Space Sensor Module

Space Sensor Modules must be multifunction devices incorporating a temperature sensor and one or more of the following as specified and indicated on the Space Sensor Module Schedule:

1. A temperature indicating device.

2. A User Input Device which must adjust a temperature setpoint output.

3. A User Input Momentary Contact Button and an output to the control system indicating zone occupancy.

4. A three position User Input Switch labeled to indicate heating, cooling and off positions ('HEAT-COOL-OFF' switch) and providing corresponding outputs to the control system.

5. A two position User Input Switch labeled with 'AUTO' and 'ON' positions and providing corresponding output to the control system.

6. A multi-position User Input Switch with 'OFF' and at least two fan speed positions and providing corresponding outputs to the control system.

Space Sensor Modules cannot contain mercury (Hg).

PART 3 EXECUTION

3.01 INSTALLATION

A. General Installation Requirements

Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

1. Device Mounting Criteria

All devices must be installed in accordance with manufacturer's recommendations and as specified and indicated. Control devices to be installed in piping and ductwork must be provided with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements must not be used except as specified. Spare thermowells must be installed adjacent to each thermowell containing a sensor and as indicated. Devices located outdoors must have a weathershield.

2. Labels and Tags

Match labels and tags to the unique identifiers indicated on the As-Built drawings. Label all enclosures and instrumentation. Tag all sensors and actuators in mechanical rooms. Tag airflow measurement arrays to show flow rate range for signal output range, duct size, and pitot tube

AFMA flow coefficient. Tag duct static pressure taps at the location of the pressure tap. Provide plastic or metal tags, mechanically attached directly to each device or attached by a metal chain or wire. Labels exterior to protective enclosures must be engraved plastic and mechanically attached to the enclosure or instrumentation. Labels inside protective enclosures may attached using adhesive, but must not be hand written.

B. Weathershield

Provide weathershields for sensors located outdoors. Install weathershields such that they prevent the sun from directly striking the sensor and prevent rain from directly striking or dripping onto the sensor. Install weather shields with adequate ventilation so that the sensing element responds to the ambient conditions of the surroundings. When installing weathershields near outside air intake ducts, install them such that normal outside air flow does not cause rainwater to strike the sensor.

C. Room Instrument Mounting

Mount room instruments, including but not limited to wall mounted non-adjustable space sensor modules and sensors located in occupied spaces, 48 inches above the floor unless otherwise indicated. Install adjustable devices to be ADA compliant unless otherwise indicated on the Room Sensor Schedule:

a. Space Sensor Modules for Fan Coil Units may be either unit or wall mounted but not mounted on an exterior wall.

b. Wall mount all other Space Sensor Modules.

D. Indication Devices Installed in Piping and Liquid Systems

Provide snubbers for gauges in piping systems subject to pulsation. For gauges for steam service use pigtail fittings with cock. Install thermometers and temperature sensing elements in liquid systems in thermowells. Provide spare Pressure/Temperature Ports (Pete's Plug) for all temperature and pressure sensing elements installed in liquid systems for calibration/testing.

E. Occupancy Sensors

Provide a sufficient quantity of occupancy sensors to provide complete coverage of the area (room or space). Occupancy sensors are to be ceiling mounted. Install occupancy sensors in accordance with NFPA 70 requirements and the manufacturer's instructions. Do not locate occupancy sensors within 6 feet of HVAC outlets or heating ducts, or where they can "see" beyond any doorway. Installation above doorway(s) is preferred. Do not use ultrasonic sensors in spaces containing ceiling fans. Install sensors to detect motion to within 2 feet of all room entrances and to not trigger due to motion outside the room. Set the off-delay timer to 15 minutes unless otherwise indicated. Adjust sensors prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc. For each controlled area, provide one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits

of single or multiple occupants at any location within the controlled room.

F. Switches

1. Temperature Limit Switch

Provide a temperature limit switch (freezestat) to sense the temperature at the location indicated. Provide a sufficient number of temperature limit switches (freezestats) to provide complete coverage of the duct section but no less than 1 foot in length per square foot of cross sectional area. Install manual reset limit switches in approved, accessible locations where they can be reset easily. Install temperature limit switch (freezestat) sensing elements in a side-to-side (not top-to-bottom) serpentine pattern with the relay section at the highest point and in accordance with the manufacturer's installation instructions.

2. Hand-Off Auto Switches

Wire safety controls such as smoke detectors and freeze protection thermostats to protect the equipment during both hand and auto operation.

G. Temperature Sensors

Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate and install sensors according to manufacturer’s instructions. Select sensors only for intended application as designated or recommended by manufacturer.

1. Room Temperature Sensors

Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of all user-adjustable sensors 54 inches above the floor to meet ADA requirements. Non user-adjustable sensors can be mounted as indicated in paragraph ROOM INSTRUMENT MOUNTING.

2. Duct Temperature Sensors

a. Probe Type

Place tip of the sensor in the middle of the airstream or in accordance with manufacturer's recommendations or instructions. Provide a gasket between the sensor housing and the duct wall. Seal the duct penetration air tight. When installed in insulated duct, provide enclosure or stand off fitting to accommodate the thickness of duct insulation to allow for maintenance or replacement of the sensor and wiring terminations. Seal the duct insulation penetration vapor tight.

b. Averaging Type

Weave the sensing element in a serpentine fashion from side to side perpendicular to the flow, across the duct or air handler cross-section, using durable non-metal supports in accordance with manufacturer's installation instructions. Avoid tight radius bends or kinking of the sensing element. Prevent contact between the sensing element and the duct or air handler internals. Provide a duct access door at the sensor location. The access door must be hinged on the side, factory insulated, have cam type locks, and be as large as the duct will permit, maximum 18 by 18 inches. For sensors inside air handlers, the sensors must be fully accessible through the air handler's access doors without removing any of the air handler's internals.

3. Immersion Temperature Sensors

Provide thermowells for sensors measuring piping, tank, or pressure vessel temperatures. Locate wells to sense continuous flow conditions. Do not install wells using extension couplings. When installed on insulated piping, provide stand enclosure or stand off fitting to accomodate the thickness of the pipe insulation and allow for maintenance or replacement of the sensor or wiring terminations. Where piping diameters are smaller than the length of the wells, provide wells in piping at elbows to sense flow across entire area of well. Wells must not restrict flow area to less than 70 percent of pipe area. Increase piping size as required to avoid restriction. Provide the sensor well with a heat-sensitive transfer agent between the sensor and the well interior ensuring contact between the sensor and the well.

4. Outside Air Temperature Sensors

Provide outside air temperature sensors on the building's north side with a protective weather shade that does not inhibit free air flow across the sensing element, and protects the sensor from snow, ice, and rain. Location must not be near exhaust hoods and other areas such that it is not influenced by radiation or convection sources which may affect the reading. Provide a shield to shade the sensor from direct sunlight.

H. Duct Static Pressure Sensors

Locate the duct static pressure sensing tap at 75 percent of the distance between the first and last air terminal units as indicated on the design documents. If the transmitter output is a 0-10Vdc signal, locate the transmitter in the same enclosure as the air handling unit (AHU) controller for the AHU serving the terminal units. If a remote duct static pressure sensor is to be used, run the signal wire back to the controller for the air handling unit.

I. Meters

1. Flowmeters

Install flowmeters to ensure minimum straight unobstructed piping for at least 10 pipe diameters upstream and at least 5 pipe diameters downstream of the flowmeter, and in accordance with the manufacturer's installation instructions.

J. Dampers

1. Damper Actuators

Provide spring return actuators which fail to a position that protects the served equipment and space on all control dampers related to freeze protection or force protection. For all outside, makeup and relief dampers provide dampers which fail closed. Terminal fan coil units, terminal VAV units, convectors, and unit heaters nay be non-spring return unless indicated otherwise. Do not mount actuators in the air stream. Do not connect multiple actuators to a common drive shaft. Install actuators so that their action seal the damper to the extent required to maintain leakage at or below the specified rate and so that they move the blades smoothly throughout the full range of motion.

2. Damper Installation

Install dampers straight and true, level in all planes, and square in all dimensions. Dampers must move freely without undue stress due to twisting, racking (parallelogramming), bowing, or other installation error. External linkages must operate smoothly over the entire range of motion, without deformation or slipping of any connecting rods, joints or brackets that will prevent a return to its normal position. Blades must close completely and leakage must not exceed that specified at the rated static pressure. Provide structural support for multi-section dampers. Acceptable methods of structural support include but are not limited to U-channel, angle iron, corner angles and bolts, bent galvanized steel stiffeners, sleeve attachments, braces, and building structure. Where multi-section dampers are installed in ducts or sleeves, they must not sag due to lack of support. Do not use jackshafts to link more than three damper sections. Do not use blade to blade linkages. Install outside and return air dampers such that their blades direct their respective air streams towards each other to provide for maximum mixing of air streams.

K. Valves

Install the valves in accordance with the manufacturer's instructions.

1. Valve Actuators

Provide spring return actuators on all control valves where freeze protection is required. Spring return actuators for terminal fan coil units, terminal VAV units, convectors, and

unit heaters are not required unless indicated otherwise.

L. Thermometers and Gauges

1. Thermometers

Mount devices to allow reading while standing on the floor or ground, as applicable.

M. Wire and Cable

Provide complete electrical wiring for the Control System, including wiring to transformer primaries. Wire and Cable must be installed without splices between control devices and in accordance with NFPA 70 and NFPA 90A. Instrumentation grounding must be installed per the device manufacturer's instructions and as necessary to prevent ground loops, noise, and surges from adversely affecting operation of the system. Test installed ground rods as specified in IEEE 142. Cables and conductor wires must be tagged at both ends, with the identifier indicated on the shop drawings. Electrical work must be as specified in Division 26 and as indicated. Wiring external to enclosures must be run in raceways, except low-voltage control and low-voltage network wiring may be installed as follows:

1. plenum rated cable in suspended ceilings over occupied spaces may be run without raceways

2. nonmetallic-sheathed cables or metallic-armored cables may be installed as permitted by NFPA 70.

Install control circuit wiring not in raceways in a neat and safe manner. Wiring must not use the suspended ceiling system (including tiles, frames or hangers) for support. Where conduit or raceways are required, control circuit wiring must not run in the same conduit/raceway as power wiring over 50 volts. Run all circuits over 50 volts in conduit, metallic tubing, covered metal raceways, or armored cable.

N. Copper Tubing

Provide hard-drawn copper tubing in exposed areas and either hard-drawn or annealed copper tubing in concealed areas. Use only tool-made bends. Use only brass or copper solder joint type fittings, except for connections to apparatus. For connections to apparatus use brass compression type fittings.

-- End of Section --

SECTION 23 09 23.02

BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS
11/15

PART 1 GENERAL

1.01 SUMMARY

Provide a complete Direct Digital Control (DDC) system suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

A. System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

1. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the internetwork can communicate using standard ASHRAE 135 Services.

2. Install and configure control hardware to provide ASHRAE 135 Objects and Properties as indicated and as needed to meet the requirements of this specification.

B. Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 135 (2016; INT 1 2016; ERTA 1 2016) BACnet—A Data Communication Protocol for Building

Automation and Control Networks

BACNET INTERNATIONAL (BTL)

BTL Guide	(v.46; 2015) BACnet Testing Laboratory Implementation Guidelines

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3	(2015; CORR 2017) Ethernet

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485	(1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 916	(2007; Reprint Aug 2014) Standard for Energy Management Equipment

1.03 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

1.04 SUBMITTALS

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section.

2.01 NETWORK HARDWARE

A. BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and must support the NM-RC-B BIBB.

B. BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet

Gateway must meet the following requirements:

1. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.

2. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.

3. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.

4. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements they are not DDC Hardware and must not be used when DDC Hardware is required.

C. Ethernet Switch

Ethernet Switches must autoconfigure between 10,100 and 1000 megabits per second (MBPS).

2.02 CONTROL NETWORK WIRING

A. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 30 pF per foot.

B. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3.

2.03 DIRECT DIGITAL CONTROL (DDC) HARDWARE

A. General Requirements

All DDC Hardware must meet the following requirements:

1. It must be locally powered and must incorporate a light to indicate the device is receiving power.

2. It must conform to the BTL Guide

3. It must be BACnet Testing Laboratory (BTL) Listed.

4. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

5. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.

6. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.

7. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.

8. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:

    a. Application programs must persist regardless of the length of time power is lost.

    b. Configured settings must persist for any loss of power less than 2,500 hours.

    c. Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.

9. Internal Clocks:

    a. Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.

    b. DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.

10. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects as specified and as indicated on the Points Schedule.

11. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).

12. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.

13. Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION.

14. User interfaces which allow for modification of Properties or settings must be password-protected.

15. Devices communicating BACnet MS/TP must meet the following

requirements:

a. Must have a configurable Max_Master Property.

b. DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max_Info_Frames Property.

c. Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".

d. Must use twisted pair with reference and shield (3-wire media) wiring.

16. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.

17. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.

18. DDC Hardware controlling a single terminal unit must have:

    a. Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.

    b. A configurable Device Object Name.

    c. A configurable Device Object Description Property at least 16 characters in length.

19. Except for Objects in DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:

    a. Have a configurable Object Name Property of at least 12 characters in length.

    b. Have a configurable Object Description Property of at least 24 characters in length.

20. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

21. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

B. Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

1. Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

2. Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mAdc or 0-10 Vdc. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent

3. Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

4. Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

a. Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

b. Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

5. Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against transients of 50 VAC, and accept rates of at least 20 pulses per second.

6. ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

7. Integrated H-O-A Switches

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via any valid BACnet method, including the use of proprietary Objects, Properties, or Services.

C. Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of ASHRAE 135. Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

D. Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

1. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

2. A single piece of hardware connected (tethered) to a base

unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

E. Supervisory Control Requirements

1. Alarm Generation Hardware

DDC Hardware used for alarm generation must meet the following requirements:

a. Device must support the AE-N-I-B BIBB

b. The Recipient_List Property must be Writeable for all Notification Class Objects used for alarm generation.

c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writeable:

(1) Time_Delay
(2) High_Limit
(3) Low_Limit
(4) Deadband
(5) Event_Enable
(6) Time_Delay_Normal must be writeable.

d. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.

PART 3 EXECUTION

3.01 CONTROL SYSTEM INSTALLATION

A. Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

1. Building Control Network IP Backbone

   Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

   Use UDP port 0xBAC0 for all BACnet traffic on the IP network.

2. BACnet MS/TP Networks

   When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2012 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

   a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.

   b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.

   c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.

   d. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the electrical specifications of TIA-485.

   e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.

   f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.

   g. Connect each MS/TP network to the BCN backbone via a BACnet Router.

   h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.

i. Configure the Max_Master Property of all devices to be 31.

3. Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

a. Install all DDC Hardware connected to the Building Control Network.

b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.

c. Traffic between BACnet networks must be exclusively via BACnet routers.

B. DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in lockable enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.

b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.

c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

1. Device Identifiers, Network Addresses, and IP addresses

a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site.

2. Object Name Property and Object Description Property

Configure the Object_Names and Object_Descriptions properties of all Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

a. Except for DDC Hardware controlling a single terminal unit, configure the Object_Name and Object_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.

b. In DDC Hardware controlling a single terminal unit, configure the Device Object_Name and Device

Object_Description as indicated on the Points Schedule and as specified.

3. Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches for all DDC Hardware analog outputs and binary outputs used for control of systems other than terminal units, as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.

b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.

c. For eternal H-O-A switches used for analog outputs, provide for overriding through the range of 0 percent to 100 percent.

4. Local Display Panels

Provide LDPs to display and override values of ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units in a mechanical room central to the group of terminal units it serves. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 10.

5. MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any devices to act as slave devices.

6. Change of Value (COV) and Read Property

a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.

b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

7. Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

a. OCCUPIED mode: a value of one
b. UNOCCUPIED mode: a value of two
c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

8. Use of BACnet Objects

Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O).

b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.

c. Use Analog Value Objects for analog setpoints.

d. Use Accumulator Objects or Analog Value Objects for pulse inputs.

e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.

f. Intrinsic Alarming, and Notification Class Objects for alarm generation.

g. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

9. Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

10. Device Application Configuration

a. For every property, setting or value shown on the Points

Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) BACnet services (including proprietary services)
(2) Hardware settings on the device

b. For every property, setting or value shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:

(1) A Writeable Property of a standard BACnet Object
(2) A Property of a standard BACnet Object that is Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable.

C. Scheduling, Alarming, Trending, and Overrides

1. Scheduling

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service) or group of stand-alone Terminal Units acting according to a common schedule.

2. Configuration of Alarm Generation

Generation must meet the following requirements:

a. Send alarm events as Alarms (not Events).

b. Use the Confirmed Notification Service for alarm events.

c. For alarm generation, support two priority levels for alarms: critical and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

(1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.

(2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.

(3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).

(4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical)

even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High_Limit used or only Low_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

(1) Notification_Class to point to the non-Critical Notification Class Object in that device.

(2) Limit_Enable to enable both the HighLimitEnable and LowLimitEnable

(3) Notify_Type to Alarm

3. Overrides

Provide an override for each point shown on the Points Schedule as requiring an override.

Unless otherwise approved, provide Commandable Objects to support all Overrides. With specific approval from the contracting officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.

b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writeable when Out_Of_Service is TRUE and Out_Of_Service is Writeable. Use this point as an Override of the normal value when Out_Of_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when Out_Of_Service is TRUE.

D. BACnet Gateways

The requirements in this paragraph do not permit the installation of hardware not meeting the other requirements of this section. All control hardware installed under this project must meet the requirements of this specification, including control hardware provided as part of a package unit or as part of equipment

specified under another section. Only use gateways to connect to pre-existing control devices.

Provide BACnet Gateways to non-BACnet control hardware as required to connect existing non-BACnet packaged units and in accordance with the following:

1. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit.

2. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment.

3. Configure gateways to map writeable data points in the controlled equipment to Writeable Properties of Standard Objects as indicated in the Points Schedule and as specified.

4. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects as indicated in the Points Schedule and as specified.

5. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.

6. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls.

7. Do not use non-BACnet control hardware for system scheduling functions.

8. Non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) and the gateway.

-- End of Section --

SECTION 23 21 23

HYDRONIC PUMPS
08/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 189.1	(2014; ERTA 1 2017) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions
HI 1.3	(2013) Rotodynamic (Centrifugal) Pump Applications
HI 9.6.4	(2009) Rotodynamic Pumps for Vibration Analysis and Allowable Values
HI ANSI/HI 14.6	(2011) Rotodynamic Pumps for Hydraulic Performance Acceptance Tests - A136
HI ANSI/HI 2.1-2.2	(2014) Rotodynamic Vertical Pumps of Radial, Mixed, and Axial Flow Types for Nomenclature and Definitions
HI ANSI/HI 9.6.3	(2017) Rotodynamic Pumps - Guideline for Operating Regions - B120

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA Z535.4	(2011) American National Standard for Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 21	(1982; E 2004) White or Colored Silicone Alkyd Paint (Type I, High Gloss and Type II, Medium Gloss)
SSPC Paint 25	(1997; E 2004) Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.219	Mechanical Power Transmission Apparatus

UNDERWRITERS LABORATORIES (UL)

UL 778	(2016) UL Standard for Safety Motor-Operated Water Pumps

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Coordination; G

SD-03 Product Data

Instructions; G

Equipment Data; G

Training Period; G

SD-06 Test Reports

Factory Tests; G

Field Quality Control; G

SD-07 Certificates

Manufacturer's Representative

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

Training; G

1.03 QUALITY ASSURANCE

A. Manufacturer Services

Provide the services of a manufacturer's representative experienced in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, testing of the equipment, and conduct training.

Submit the names and qualifications of the manufacturer's representative and training engineers and written certification from the manufacturer that the representative and trainers are technically qualified.

B. Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate equipment that has been in satisfactory HVAC operation at least 2 years prior to issuance of this solicitation. Support equipment with a service organization that is reasonably convenient to the jobsite. Pumps and motors of the same types must each be the product of one manufacturer.

C. Conformance with Agency Requirements

Where materials or equipment are specified to be an approved type, attach the seal or label of approval from a nationally recognized testing agency, adequately equipped and competent to perform such services. A written certificate from the testing agency must accompany the materials or equipment and be submitted stating that the items have been tested and that they conform to the applicable requirements of the specifications and to the standards listed herein. The certificate must indicate the methods of testing used by the testing agency. In lieu of a certificate from a testing agency, published catalog specification data, accompanied by the manufacturer's certified statement to the effect that the items are in accordance with the applicable requirements of the specifications and the referenced standards, will be considered and may be acceptable as evidence that the items conform with agency requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

Protect equipment, delivered and designated for storage, from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

Hydronic pumps used for heating and air conditioning applications are defined by the type of impeller, number of impellers, type of casing, method of connection to the driver, and mounting position. Provide centrifugal water pumps of the types indicated and specified. Use an electric motor driving unit for each pump as indicated and specified.

A. Selection Criteria

Select pumps at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency in the construction design documents. Pumps having impeller diameters larger or smaller than manufacturer's published maximum and minimum impeller diameters for a given impeller casing combination will be rejected. Pump performance data, as shown in performance curves, must be based on factory tests using precision instrumentation and exacting procedures as detailed in HI ANSI/HI 14.6.

B. System Coordination

Submit drawings containing complete wiring and piping schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show the proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation. Provide a complete listing of equipment, materials and miscellaneous components including mechanical seals, bearings, and couplings.

C. Safety Requirements

Fully enclose or guard couplings, projecting set-screws, keys, and other rotating parts, that pose an entangling hazards.

2.02 MATERIALS AND EQUIPMENT

A. Nameplates

Securely affix a standard nameplate to pumps and motors in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, for each pump show the capacity in gpm at rated speed in rpm and total head in feet of water. For each electric motor show at least the minimum information required by NEMA MG 1. Show such other information as the manufacturer may consider necessary to complete identification on the nameplate. Pumps must be listed and labeled by UL, and comply with UL 778 for pumps not using universal motors rated more than 250 volts such as circulating pumps.

B. Framed Instructions

Submit proposed diagrams, instructions, and other sheets, prior

to posting. Post approved wiring and control diagrams showing the complete layout of the entire system, including equipment, piping valves, and control sequence, framed under glass or in approved laminated plastic, where directed. Provide condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post the framed instructions before acceptance testing of the systems.

C. Pump Characteristic

Construct hydronic water pumps in accordance with HI 1.1-1.2 and HI ANSI/HI 2.1-2.2. The pumps must be capable of discharging quantities at total discharge heads measured at the discharge flange, between the following limits:

Operate pumps at optimum efficiencies to produce the most economical pumping system under the conditions encountered and size to make optimum match with the system head curve as shown. Pumps must furnish not less than 150 percent of rated capacity at a total discharge head of not less than 65 percent of total rated head. Operate pumps at specified system fluid temperatures without vapor binding and cavitation. Operate pumps to HI ANSI/HI 9.6.3 standard for Preferred Operating Region (POR).

D. Pump Drivers

Provide electric motors as indicated for each pump and in compliance with Section 26 24 19 LOW-VOLTAGE MOTOR CONTROL.

E. Equipment Data

Submit manufacturer's descriptive data and technical literature, performance charts and curves for all impeller sizes for a given casing, catalog cuts, and installation instructions. Provide spare parts data for each different item of material and equipment specified, after approval of the detail drawings and not later than 3 months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and local source of supply with contact information.

Submit catalog information, certified pumps curves, rated capacities, final impeller dimensions, and accessories provided for the product indicated. Indicate operating point of each pump on curves. Furnish pump curves for each pump and combination of pumps designed to operate in parallel. The pump curve must show as a minimum; bhp, flow, total dynamic head, efficiency, NPSH, impeller diameter and system curve (individually and in combination for each pump operating in a parallel application). Select pumps operating in parallel operation to cross the system curve when operating individually.

2.03 HYDRONIC PUMPS

Provide centrifugal, single-stage type designed for HVAC service in the following configurations:

A. Small In-Line

Provide pumps with capacities as indicated, suitable for 225 degrees F operation at 175 psig working pressure. The pump must be single stage, in-line design, in cast iron bronze fitted construction. The pump internals must be capable of being serviced without disturbing piping connections.

B. Pump Shaft

The pump must have a solid steel shaft with a coupler between the pump and motor shafts. For non-stainless steel shafts, employ a non-ferrous shaft sleeve to completely cover the wetted area under the seal.

C. Bearing

The bearing assembly must house maintenance-free permanently lubricated bearings.

D. Seal Assembly

Equip the pump with an internal self-flushing mechanical seal assembly. Seal assembly must have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.

E. Impeller

Provide impeller of cast bronze or brass material. Impeller must be hydraulically and dynamically balanced to HI 9.6.4 balance grade G6.3, keyed to the shaft and secured by a locking capscrew or nut.

F. Volute

Pump volute must be of cast iron. The connection style on cast iron pumps must be flanged.

G. Motor Mount

To ensure alignment, mount the motor to the bearing assembly via a bolted motor bracket assembly. Use a replaceable resilient rubber motor mount to assist in aligning the motor shaft with the pump shaft.

H. Motors

NEMA MG 1; premium efficiency; non-overloading at any point on the pump curve; maintenance free with permanently lubricated bearings; and resilient mounted for smaller sizes, rigid mounted otherwise.

2.04 ELECTRICAL WORK

Provide electrical motor driven equipment specified herein complete with motors, motor starters, and controls. Provide electric equipment

and wiring in accordance with Division 26. Electrical characteristics must be as indicated. Provide motor starters complete with properly sized thermal overload protection in each phase and other appurtenances necessary for the motor control specified. Each motor must be of sufficient capacity to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor when operating at proper electrical system voltage and frequency. Manual or automatic control and protective or signal devices required for the operation herein specified and any control wiring required for controls and devices but not indicated must be provided under this section of the specifications.

2.05 ELECTRICAL EQUIPMENT

Provide electrical equipment in conformance with Division 26. Provide electrical motor driven equipment herein specified complete with motors, motor starters, and controls. Motor controls, equipment, and wiring must be in accordance with NFPA 70.

A. Electric Motors

Drive each electric motor-driven pump by a continuous-duty electric motor with enclosure type for specific service as defined in paragraph HYDRONIC PUMPS. Motor must have a 1.5 service factor. Provide squirrel-cage induction motors having normal-starting-torque and low-starting-current characteristics, and of sufficient size so that the nameplate horsepower rating will not be exceeded throughout the entire published pump characteristic curve. Integral size motors must be the premium efficiency type in accordance with NEMA MG 1. Pump electric motor efficiencies must meet or exceed the requirements of ASHRAE 189.1, Table C-13. Motor bearings must provide smooth operations under the conditions encountered for the life of the motor. Provide adequate thrust bearing in the motor to carry the weight of all rotating parts plus the hydraulic thrust and be capable of withstanding upthrust imposed during pump starting and under variable pumping head conditions specified. Provide motors in conformance with NEMA MG 1.

B. Control Equipment

Automatically controlled pumps must have three-position "MANUAL-OFF-AUTOMATIC" selector switch in cover. Provide additional controls or protective devices as indicated.

C. Variable Speed Control

The variable speed motor controllers must meet the requirements of UFGS 26 29 23 VARIABLE FREQUENCY MOTOR CONTROLLERS.

2.06 EQUIPMENT APPURTENANCES

A. Attachments

Furnish all necessary bolts, nuts, washers, bolt sleeves, and other types of attachments with the equipment for the installation of the equipment. Bolts conform to the requirements of ASTM A307 and hexagonal nuts of the same quality as the bolts used. Threads must be clean-cut and conform to ASME B1.1. Bolts,

nuts, and washers specified to be galvanized or not otherwise indicated or specified, must be zinc coated after being threaded, by the hot-dip process conforming to ASTM A123/A123M as appropriate. Bolts, nuts, and washers specified or indicated to be stainless steel must be Type 316.

B. Equipment Guards

Provide equipment driven by open shafts, belts, chains, or gears with all-metal guards enclosing the drive mechanism. Secure guards in position with steel braces or straps that permit easy removal for servicing the equipment. Coupler guards must comply with current national safety standards including 29 CFR 1910.219 and NEMA Z535.4. Provide guards with gaps no greater than 0.250 inches, safety orange in color, and have an NEMA Z535.4 compliant warning label.

C. Tools

Furnish a complete set of all special tools which may be necessary for the adjustment, operation, maintenance, and disassembly of all equipment. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools must be high-grade, smooth, forged, alloy, tool steel. Furnish one pressure grease gun for each type of grease required. Deliver all tools at the same time as the equipment to which they pertain. Properly store and safeguard such tools until completion of the work, at which time deliver them to the Contracting Officer.

2.07 FINISHES

All motors, pump casings, and similar parts of equipment must be thoroughly cleaned, primed, and given two finish coats of paint at the factory in accordance with the recommendations of the manufacturer. Give ferrous surfaces not to be painted a shop coat of grease or other suitable rust-resistant coating.

2.08 FACTORY TESTS

Pumps must be tested by the manufacturer or a nationally recognized testing agency in compliance with HI 1.3. Submit certified test results.

PART 3 EXECUTION

3.01 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.02 INSTALLATION

Install each pump and motor in accordance with the written instructions of the manufacturer. Provide access space around the device for servicing no less than the minimum recommended by the manufacturer.

3.03 FIELD QUALITY CONTROL

After installation of the pumping units and appurtenances, including coupling guard, is complete, carry out operating tests to assure that the pumping installation operates properly. Give each pumping unit a running field test in the presence of the Contracting Officer for a minimum of 2 hours. Operate each pumping unit at its rated capacity or such other point on its head-capacity curve selected by the Contracting Officer. Provide an accurate and acceptable method of measuring the discharge flow. Tests must assure that the units and appurtenances have been installed correctly, that there is no objectionable heating, vibration, or noise from any parts, and that all manual and automatic controls function properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests.

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report must indicate the final position of controls.

3.04 FIELD PAINTING

Do not paint stainless steel, galvanized steel, and nonferrous surfaces.

A. Touch-up painting

Factory painted items requiring touching up in the field must be thoroughly cleaned of all foreign material, and primed and topcoated with the manufacturer's standard factory finish.

B. Exposed Ferrous Surfaces

Paint exposed ferrous surfaces with two coats of enamel paint conforming to SSPC Paint 21. Solvent clean factory primed surfaces before painting. Surfaces that have not been factory primed must be prepared and primed with one coat of SSPC Paint 25 or in accordance with the enamel paint manufacturer's recommendations.

3.05 CLOSEOUT ACTIVITIES

A. Operation and Maintenance Manuals

Submit one complete set at the time the tests procedure is submitted; remaining sets before the contract is completed. Permanently bind each in a hard cover. Inscribe the following identification on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the building, name of the Contractor, and contract number. Place flysheets before instructions covering each subject. Use 8-1/2 by 11 inches paper for instruction sheets, with large sheets of drawings folded in.

Include, but do not limit to, the following in the Instructions:

1. System layout showing piping, valves, and controls.

2. Approved wiring and control diagrams including variable frequency drives.

3. A control sequence describing startup, operation, and shutdown.

4. Operating and maintenance instructions for each piece of equipment, including task list for routine maintenance, routine inspections, intermediate inspections, and annual inspections; lubrication instructions; and troubleshooting guide.

5. Manufacturer's bulletins, cuts, and descriptive data; and parts list and recommended spare parts.

B. Training

Upon completion of the work, and at a time designated by the Contracting Officer, provide the services of one or more competent engineers for a training period of not less than 4 hours to instruct a representative of the Government in the contents of the operation and maintenance manuals for the equipment furnished under these specifications. These field instructions must cover all the items contained in the bound instructions. Submit the training course curriculum and training instructions 14 days prior to the start of training.

-- End of Section --

SECTION 23 64 26

CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS
08/09

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.22/CSA 4.4	(2015) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)
ASSE 1017	(2009) Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems - (ANSI approved 2010)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2013) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2013) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.39	(2014) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B31.9	(2014; Errata 2015) Building Services Piping
ASME B40.100	(2013) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2013) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008; R 2014) Standard Specification for Solder Metal
ASTM B42	(2015a) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B813	(2016) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B88	(2016) Standard Specification for Seamless Copper Water Tube
ASTM D3308	(2012) PTFE Resin Skived Tape
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM D596	(2001; R 2011) Reporting Results of Analysis of Water
ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM F1120	(1987; R 2015) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(1988; R 2015) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2014) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-110	(2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
MSS SP-25	(2013) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011; Errata 2013) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

1.02 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Calibrated Balancing Valves; G

Automatic Flow Control Valves; G

Water Temperature Mixing Valve; G

Water Temperature Regulating Valves; G

Water Pressure Reducing Valve; G

Pressure Relief Valve; G

Combination Pressure and Temperature Relief Valves; G

Expansion Joints; G

Pumps; G

Expansion Tanks; G

Air Separator Tanks; G

Water Treatment Systems; G

Water Treatment Plan; G

SD-06 Test Reports

Condenser Water Quality Test Reports; G

Pressure Tests Reports; G, AE

SD-07 Certificates

Fittings

Unions

Flanges

Gaskets

Bolting

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G

SD-10 Operation and Maintenance Data

Spare Parts Data For Each Different Item Of Equipment; G

Water Treatment System Operation Manual; G

Water Treatment System Maintenance Manual; G

Calibrated Balancing Valves, Data Package 3; G

Automatic Flow Control Valves, Data Package 3; G

Water Temperature Mixing Valve, Data Package 3; G

Water Temperature Regulating Valves, Data Package 3; G

Water Pressure Reducing Valve, Data Package 3; G

Pressure Relief Valve, Data Package 2; G

Combination Pressure and Temperature Relief Valves, Data Package 2; G

Expansion Joints, Data Package 2; G

Pumps, Data Package 3; G

Expansion Tanks, Data Package 2; G

Air Separator Tanks, Data Package 2; G

1.04 MODIFICATIONS TO REFERENCES

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

A. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer."

B. Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

1.05 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.06 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.07 PROJECT/SITE CONDITIONS

A. Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

B. Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

C. Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.01 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures.

Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Certificates shall be submitted for the fittings, unions, flanges, gaskets, and bolting showing conformance with the referenced standards contained in this section.

2.02 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with an ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

A. Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

B. Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, or welded connections. Piping and fittings 3 inches and larger shall have welded, or

flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

1. Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2. Flanged Connections

Flanges shall conform to ASME B16.1, Class 125. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

3. Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges

and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.03 COPPER TUBING

Provide copper tubing and fittings with an ANSI/ASME Class 125 service rating, which for 150 degrees F., the pressure rating is 175 psig.

A. Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

B. Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 4 inches shall have brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

C. Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

D. Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.04 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

A. Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

B. Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

C. Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 3 inches and larger shall conform to MSS SP-71, Class 125.

D. Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 8 inches shall have throttling handles with a minimum of two locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position

indicators.

E. Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

F. Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading.

G. Automatic Flow Control Valves

Valve shall automatically maintain the constant flow indicated on the design drawings. Valve shall modulate by sensing the pressure differential across the valve body. Valve shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve materials shall be the same as specified for the ball or plug valves.

Provide valve that are electric type as indicated. Valve shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

H. Water Temperature Mixing Valve

Valve, ASSE 1017 for water service.

I. Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

J. Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body.

K. Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

L. Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

M. Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter. Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.

N. Air Venting Valves

Manually-operated general service type air venting valves, brass or bronze valves that are furnished with threaded plugs or caps. Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

O. Vacuum Relief Valves

ANSI Z21.22/CSA 4.4

2.05 PIPING ACCESSORIES

A. Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge corrosion-resistant

steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

B. Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

C. Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

D. Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

1. Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2. Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

E. Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69.

F. Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

G. Expansion Joints

1. Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.06 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be totally enclosed, and have sufficient horsepower for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

A. Construction

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

B. Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.

C. Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.07 EXPANSION TANKS

Tank shall be welded steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Provide tanks precharged to the minimum operating pressure. Tank shall have a replaceable polypropylene or butyl lined diaphragm which keeps the air charge separated from the water; shall be the captive air type.

Tanks shall accommodate expanded water of the system generated within the normal operating temperature range, limiting this pressure increase at all components in the system to the maximum allowable pressure at those components. Each tank air chamber shall be fitted with a drain, fill, an air charging valve, and system connections. Tank shall be supported by steel legs or bases for vertical installation or steel saddles for horizontal installations. The only air in the system shall be the permanent sealed-in air cushion contained within the expansion tank.

2.08 AIR SEPARATOR TANKS

External air separation tank shall have an internal design constructed of stainless steel and suitable for creating the required vortex and subsequent air separation. Tank shall be steel, constructed for, and tested to pressure-temperature rating of 125 psi at 150 degrees F. Tank shall have tangential inlets and outlets connections, threaded for 2 inches and smaller and flanged for sizes 2-1/2 inches and larger. Air released from a tank shall be vented as indicated. Tank shall be provided with a blow-down connection.

2.09 WATER TREATMENT SYSTEMS

When water treatment is specified, the use of chemical-treatment products containing equivalent chromium (CPR) is prohibited.

A. Chilled and Condenser Water

Water to be used in the chilled and condenser water systems shall

be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

B. Water Treatment Services

The services of a company regularly engaged in the treatment of condenser water systems shall be used to determine the correct chemicals required, the concentrations required, and the water treatment equipment sizes and flow rates required. The company shall maintain the chemical treatment and provide all chemicals required for the condenser water systems for a period of 1 year from the date of occupancy. The chemical treatment and services provided over the 1 year period shall meet the requirements of this specification as well as the recommendations from the manufacturers of the condenser and evaporator coils. Acid treatment and proprietary chemicals shall not be used.

C. Condenser Water

The water treatment system shall be capable of automatically feeding chemicals and bleeding the system to prevent corrosion, scale, and biological formations. Automatic chemical feed systems shall automatically feed chemicals into the condenser water based on varying system conditions.

1. Chemical Feed Pump

One pump shall be provided for each chemical feed tank. The chemical feed pumps shall be positive displacement diaphragm type. The flow rate of the pumps shall be adjustable from 0 to 100 percent while in operation. The discharge pressure of pumps shall not be less than 1.5 times the line pressure at the point of connection. The pumps shall be provided with a pressure relief valve and a check valve mounted in the pump discharge.

2. Tanks

Two chemical tanks shall be provided. The tanks shall be constructed of high density polyethylene with a hinged cover. The tanks shall have sufficient capacity to require recharging only once per 7 days during normal operation. A level indicating device shall be included with each tank. An electric agitator shall be provided for each tank.

3. Injection Assembly

An injection assembly shall be provided at each chemical injection point along the condenser water piping as indicated. The injection assemblies shall be constructed of stainless steel. The discharge of the assemblies shall extend to the centerline of the condenser water piping. Each assembly shall include a shutoff valve and check valve at the point of entrance into the condenser water line.

4. Water Meter

Water meters shall be provided with an electric contacting register and remote accumulative counter. The meter shall be installed within the make-up water line, as indicated.

5. Timers

Timers shall be of the automatic reset, adjustable type, and electrically operated. The timers shall be suitable for a 120 volt current. The timers shall be located within the water treatment control panel.

6. Water Treatment Control Panel

The control panel shall be a NEMA 12 enclosure suitable for surface mounting. The panel shall be constructed of steel with a hinged door and lock. The panel shall contain a laminated plastic nameplate identifying each of the following functions:

(1) Main power switch and indicating light
(2) MAN-OFF-AUTO selector switch
(3) Indicating lamp for bleed-off valve
(4) Indicating lamp for each chemical feed pump
(5) Set point reading for each timer

7. Chemical Piping

The piping and fittings shall be constructed of stainless steel suitable for the water treatment chemicals.

8. Sequence of Operation

The chemicals shall be added based upon sensing the make-up water flow rate and activating appropriate timers. A separate timer shall be provided for each chemical. The blow down shall be controlled based upon the make-up water flow rate and a separate timer. The system shall contain an adjustable valve for continuous blow down. The flow rate from the appropriate chemical tanks shall be manually set at the metering pump for continuous chemical feed. The injection of the chemical required for biological control shall be controlled by a timer which can be manually set for proper chemical feed. Timer set points, blow down rates, and chemical pump flow rates shall be determined and set by the water treatment company.

9. Test Kits

One test kit of each type required to determine the water quality as outlined within the operation and maintenance manuals shall be provided.

10. Bleed Line

A bleed line with a flow valve of the needle-valve type sized for the flow requirement or fixed orifice shall be provided in the pump return to the tower. The bleed line

shall be extended to the nearest drain for continuous discharge.

11. Water Treatment Plan

Submit proposed water treatment plan including a layout, control scheme, a list of existing make-up water conditions including the items listed in paragraph WATER ANALYSIS", a list of chemicals, the proportion of chemicals to be added, the final treated water conditions, and a description of environmental concerns for handling the chemicals.

2.10 ELECTRICAL WORK

Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring, as specified in Division 26. Manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Provide variable frequency drives for motors as specified in Section 26 29 23 VARIABLE FREQUENCY MOTOR CONTROLLERS.

2.11 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied or shop applied, and shall be as specified herein, and provided under each individual section.

A. Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. The factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located

outdoors shall withstand 500 hours in a salt-spray fog test.

Salt-spray fog test shall be in accordance with ASTM B117, and for that test, the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen.

If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

B. Shop Painting Systems for Metal Surfaces

Clean, retreat, prime and paint metal surfaces; except aluminum surfaces need not be painted. Apply coatings to clean dry surfaces. Clean the surfaces to remove dust, dirt, rust, oil and grease by wire brushing and solvent degreasing prior to application of paint, except metal surfaces subject to temperatures in excess of 120 degrees F shall be cleaned to bare metal.

Where hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

2.12 FACTORY APPLIED INSULATION

Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 25 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E84.

Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.13 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. Plates shall be durable and legible throughout equipment life and made of anodized aluminum. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.14 RELATED COMPONENTS/SERVICES

A. Drain and Make-Up Water Piping

Requirements for drain and make-up water piping and backflow preventer is specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE.

B. Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

2.15 OPERATION AND MAINTENANCE DATA

1. Requirements for data packages are specified Section 01 78 23 OPERATION AND MAINTENANCE DATA, except as supplemented and modified by this specification section.

2. For the Water Treatment System submit the following:

   a. Water Treatment System operation manual in bound 8-1/2 by 11 inch booklets listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown. Include testing procedures used in determining water quality.

   b. Water Treatment System maintenance manual in bound 8-1/2 by 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide.

3. Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

4. Submit a list of qualified permanent service organizations with operation and maintenance data packages. Include service organization addresses and service area or expertise. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 3 EXECUTION

3.01 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

A. Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

B. Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

C. Fittings and End Connections

1. Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads

only. Not more than three threads shall show after the joint is made.

2. Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3. Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

D. Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

E. Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

F. Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

G. Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

H. Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

I. Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

1. Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

2. Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3. C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

4. Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

5. Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

6. Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

7. Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

8. Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

9. Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

10. Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

11. Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown,

shall be provided under this section.

J. Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

K. Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

1. General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

2. Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a .17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor

penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3. Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 13 PENETRATION FIRESTOPPING.

4. Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

L. Access Panels

Access panels shall be provided where indicated for all concealed valves, vents, controls, and additionally for items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS.

3.02 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturer's instructions.

3.03 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system
has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.04 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

A. Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

B. Pressure Tests

Each piping system, except for polypropylene piping, shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

C. Condenser Water Quality Test Reports

The condenser water system shall be analyzed by the water treatment company a minimum of once a month for a period of one year after system acceptance. Submit for approval the specified

condenser water quality test reports. The analysis and resulting reports shall include the following information recorded in accordance with ASTM D596.

Date of Sample	
Temperature	degrees F
Silica (Sino 2)	pp (mg/l)
Insoluble	pp (mg/l)
Iron and Aluminum Oxides	pp (mg/l)
Calcium (Ca)	pp (mg/l)
Magnesium (Mg)	pp (mg/l)
Sodium and Potassium (Nan and AK)	pp (mg/l)
Carbonate (HO 3)	pp (mg/l)
Sulfate (SO 4)	pp (mg/l)
Chloride (JCL)	pp (mg/l)
Nitrate (NO 3	pp (mg/l)
Turbidity	unit
pH	
Residual Chlorine	ppm (mg/l)
Total Alkalinity	epm (meq/l)
Non-Carbonate Hardness	epm (meq/l)
Total Hardness	epm (meq/l)
Dissolved Solids	ppm (mg/l)
Fluorine	ppm (mg/l)
Conductivity	microhm/cm

D. Related Field Inspections and Testing

1. HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.05 INSTRUCTION TO GOVERNMENT PERSONNEL

Furnish the services of competent instructors to give full instruction to the designated Government personnel in the adjustment, operation, and maintenance, including pertinent safety requirements, of the condenser water piping systems. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be one man-day. Use approximately half of the time for classroom instruction and the other time for instruction at the location of equipment or system.

When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instruction to acquaint the operating personnel with the changes or modifications.

-- End of Section --

SECTION 23 81 47

WATER-LOOP AND GROUND-LOOP HEAT PUMP SYSTEMS
08/08

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2013) Ventilation for Acceptable Indoor Air Quality
ASHRAE FUN IP	(2017) Fundamentals Handbook, I-P Edition
ASHRAE Item 90376	(1997) Ground-Source Heat Pumps, Design of Geothermal Systems for Commercial and Institutional Buildings

ASME INTERNATIONAL (ASME)

ASME B31.5	(2016) Refrigeration Piping and Heat Transfer Components
ASME B31.9	(2014; Errata 2015) Building Services Piping

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2015; E 2016) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2016) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B424	(2011; R 2016) Standard Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08221, and UNS N06845) Plate, Sheet, and Strip
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings

ASTM D3892	(1993; R 2009) Packaging/Packing of Plastics
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

INTERNATIONAL GROUND SOURCE HEAT PUMP ASSOCIATION (IGSHPA)

IGSHPA 21010	(1991) Grouting Procedures for Ground-Source Heat Pump Systems
IGSHPA 21015	(2000) Grouting for Vertical GHP Systems
IGSHPA 21020	(1988) Closed-Loop/Ground-Source Heat Pump System/Installation Guide
IGSHPA 21030	(2005) Design and Installation Standards
IGSHPA 21060	(1989) Soil and Rock Classification Field Manual

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 13256-1	(1998) Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps
ISO 13256-2	(1998) Water-Source Heat Pumps - Testing and Rating for Performance - Part 2: Water-to-Water and Brine-to-Water Heat Pumps

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 704	(2017) Standard System for the

	Identification of the Hazards of Materials for Emergency Response

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.02 SYSTEM DESCRIPTION

Provide new water-loop heat pump systems complete and ready for operation. Systems include heat pumps, system equipment, piping, pumps, electrical equipment, and controls. Installation of water-loop heat pump systems including equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with ASME B31.9, ASME B31.5, ASHRAE FUN IP, IGSHPA 21010, IGSHPA 21015, IGSHPA 21020, IGSHPA 21030, IGSHPA 21060, NFPA 70, ASHRAE Item 90376, ISO 13256-1and ISO 13256-2 as supplemented and modified by this section.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

SD-02 Shop Drawings

System Diagrams; G

Well and Piping System Layout Drawings; G

SD-03 Product Data

Water-Source Water-to-Water Heat Pumps; G

Plate Heat Exchangers; G

Pumps; G

Pipe, Fittings, and Piping Components; G

Expansion Tanks; G

Air Separators; G

SD-06 Test Reports

Water-Source Water-To-Water Heat Pumps - Field Acceptance Test Plan; G

Plate Heat Exchangers - Field Acceptance Test Plan; G

Water-Source Water-To-Water Heat Pumps - Field Acceptance Test Report; G

Plate Heat Exchangers - Field Acceptance Test Report; G

SD-07 Certificates

ARI/ISO Performance Data For Water Source Heat Pumps; G

Hydrostatic Test; G

SD-08 Manufacturer's Instructions

Water-Source Water-To-Water Heat Pumps - Installation Instructions; G

Plate Heat Exchangers - Installation Instructions; G

On-Site Training; G

SD-10 Operation and Maintenance Data

Water-source water-to-water heat pumps, Data Package 2; G

Plate Heat Exchangers, Data Package 2; G

SD-11 Closeout Submittals

As-Built Drawings; G

1.04 QUALITY ASSURANCE

A. Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

B. Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

C. Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

D. Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable. As applicable the ENERGY STAR label also affixed to the equipment.

E. Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

1. Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer".

2. Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Officer in Charge of Construction to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

F. System Diagrams

After completion, but before final acceptance, submit well and piping system layout drawings that show the layout of equipment,

piping, and circulation pumps, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Product data for integral or appurtenant space temperature controls (STC) supplied with the listed equipment shall include shall include point-to-point electrical wiring diagrams for each STC.

G. Operation and Maintenance Data

Submit Plate Heat Exchangers, Data Package 2 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.05 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material Safety Data Sheet (SDS) in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe, fittings, and piping components shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D3892. Upon delivery of piping, fitting, components, and equipment to the site, inspect items for damage and verify items meet project requirements.

1.06 SAFETY REQUIREMENTS

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired.

1.07 PROJECT/SITE CONDITIONS

A. Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions indicated in the field, and advise the Contracting Officer of any discrepancy before performing any work.

B. Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

C. Accessibility

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

2.01 EQUIPMENT

Equipment using CFC-based refrigerants, or refrigerants with ozone depleting potential (ODP) greater than 0.0 will not be permitted.

A. Water-Source Water-to-Water Heat Pumps (WWHP)

Provide water-source water-to-water heat pump units factory assembled, designed, tested, and rated in accordance with ISO 13256-2. Units shall be listed by ETL, or listed in ISO 13256-2. Units shall include compressor, reversing valve, expansion valve, refrigerant-to-water condensing coil, refrigerant-to-water evaporator coil, hose kits, dampers, bypass for flushing and purging, and controls. A permanent label shall be affixed to each heat pump unit indicating basic information for that unit. The information shall include: nominal flow rate gpm, pressure drop feet, temperature drop/rise degree F, and capacity Btu/hr. Provide certificates of ARI/ISO Performance Data For Water Source Heat Pumps.

a. Cabinet: Provide manufacturer's standard galvanized steel cabinet. Provide access panels for inspection and access to internal parts. Insulate cabinet with minimum 1/2 inch multi-density, fiberglass insulation. Provide copper or stainless steel female threaded pipe connections for supply water and return water connections; these connections shall be mechanically fastened to the cabinet. Water piping shall be insulated.

b. Compressor: Provide hermetically sealed type compressor, installed on vibration isolators enclosed in an acoustically treated enclosure. Provide high and low pressure switches, low suction temperature cut-out, motor thermal overload protection, 5 minute anti-recycle timer, and start capacitor kit. Provide capability to reset compressor lockout circuit at the remote thermostat and at the disconnect.

c. Reversing Valve: Provide solenoid activated refrigerant reversing valves energized only during the cooling mode and

designed to fail in the heating position.

d. Refrigerant-to-Water Heat Exchangers: Provide refrigerant-to-water heat exchangers of coaxial type (tube-in-tube), with inner cupronickel water tube and outer steel refrigerant tube. The refrigerant side of the heat exchanger shall be tested and rated for 450 psig refrigerant working pressure. The water side of the heat exchanger shall be tested and rated for 400 psig working pressure. A parallel capillary tube/thermal expansion valve assembly shall provide superheat over the entire liquid temperature range. Refrigerant-to-water heat exchangers and refrigerant piping shall be insulated to prevent condensation on the piping containing low temperature water.

f. Hose Kits: Kits shall include two 2 foot long metal (stainless steel) braided hoses with swivel connectors on one end, an flow control valve with test ports, two shutoff ball valves with memory stops (one with test port), blow down ball valve, and Y-strainer. Hoses shall be fire rated to meet UL 94. Hoses shall have a maximum working pressure of 300 psi.

g. Bypass for Purging and Flushing: Provide a bypass around the heat pump unit condenser coil. The bypass includes isolation valves and piping that allows for purging and flushing of the system piping. Provide the necessary flushing pump, hoses, and isolation valves.

h. Hanger Kits: Provide units with hanger kits consisting of galvanized steel brackets, bolts, washers, and vibration isolators. The hanger kit shall be designed to support the unit from below and suspend from threaded rods.

i. Controls: Controls and safety devices shall be factory wired and mounted within the control box of the unit cabinet.

   (1) Provide a microprocessor based controller. The microprocessor shall control sequencing, high and low pressure switch monitoring, freeze protection, lockout control, night setback, emergency shutdown, short cycle protection, random start, LED mode and fault indicators, fault memory, input and output diagnostics, and a communications port. Provide a factory-installed low voltage terminal block for field control wiring and a low voltage transformer. Provide communications capability for remote direct digital control (DDC). Use standard communication protocol such as BACnet protocol.

   (2) Provide 24 volt electromechanical controls supplied with a low voltage transformer, pump relay, controls for compressor, reversing valve coil, and lock out relay. Controls shall include a random start relay, a night setback relay, and a compressor cycling relay for demand load shedding, and a condensate overflow switch. Provide a low voltage terminal block for field control wiring.

j. Space Temperature Controls: Provide electronic multi-stage, auto-changeover, adjustable thermostats with OFF-HEAT-AUTO-COOL-EMERGENCY system switch and AUTO-ON fan

switch. Thermostats shall be furnished by the unit manufacturer. Provide relays, transformers, contractors, and control wiring between thermostats and unit. Thermostats shall read out in degrees C and degrees F.

B. Plate Heat Exchangers

Plates, frames, and gaskets shall be designed for a working pressure of 300 psi and factory tested at 450 psi. Medium temperature water, low temperature water, and pressure relief valve connections shall be located in accordance with the manufacturer's standard practice. Connections larger than 3 inches shall be ASME 300 pound flanged. Plates shall be corrugated Type 304 stainless steel or Nickel-iron-chromium alloy conforming to ASTM B424.

C. Pumps

1. In-Line Pumps

Provide pumps constructed of manufacturer's standard materials suitable for chilled water and hot water heating systems. Pumps shall have mechanical seals and drip-proof electric motors. Motors one Hp and greater shall be the premium efficiency type in accordance with NEMA MG 1.

2.02 ELECTRICAL WORK

Provide electrical motor driven equipment specified complete with motors, motor starters, and controls as specified herein and in Division 26. Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. In addition to the requirements of Division 26, provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period.

Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

2.03 ABOVEGROUND PIPING SYSTEMS

Provide above ground piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

2.04 PIPING ACCESSORIES

A. Pipe Hangers and Supports

Provide MSS SP-58 and MSS SP-69. Type 1 with adjustable type steel support rods, except as specified or indicated otherwise. Attach to steel joists with Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor. Provide Type 40 insulation protection shields for insulated piping.

B. Strainers

ASTM A126, Class B, flanged iron body, for 2.5 inches and larger. ASTM B62, cast iron or bronze for 2 inches and smaller. Provide basket or Y type. Tee type is acceptable for water service. Provide screens constructed of bronze, monel metal, or 18-8 stainless steel, free area not less than 2.5 times pipe area, with perforations as follows:

a. 3 inches and smaller: 0.045 inches diameter perforations for liquids.

C. Pressure Gauges

Provide single style pressure gauge with 4.5 inch dial, brass or aluminum case, bronze tube, gauge cock, pressure snubber, and syphon. Provide scale range for intended service. Gauges shall have an accuracy of 0.5 percent of the span. Provide gauges that have a dial layout with major ticks with numbers every 10 pressure units and minor ticks every one pressure unit. Provide pressure gauges with dual range dials, kpa and psi.

D. Pressure/Temperature Test Provisions

1. Pete's Plug

Provide 0.5 inch MPT by 3 inches long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gauge test connections shown on the drawings.

2. Testing Accessories

Provide one each of the following test items to the Contracting Officer:

a. 0.25 inch FPT by 0.125 inch diameter stainless steel pressure gauge adapter probe for extra long test plug.

b. 3.5 inch diameter, one percent accuracy, compound pressure gauge, 0 to 200 psi range.

c. minus 20 to 120 degree F pocket thermometer one-half degree accuracy, one inch dial, 5 inch long stainless steel stem, stainless steel wetted materials, and stainless steel external materials.

E. Thermometers

Provide bi-metal dial type thermometers with stainless steel case, stem, and fixed thread connection; 3 inch diameter dial with glass face gasketed within the case; and accuracy within 2 percent of scale range. Provide scale range for intended service.

F. Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid where indicated. Connectors shall be suitable for the intended service.

G. Expansion Tanks

Construct of steel for minimum working pressure of 125 psi. Tank shall have polypropylene or butyl lined diaphragm which keeps the air charge separated from the water.

H. Air Separators

Design to separate air from water and to direct released air to automatic air vent. Unit shall be of one piece cast-iron construction with internal baffles and two air chambers at top of unit; one air chamber shall have outlet to expansion tank and other air chamber shall be provided with automatic air release device. Unit shall be for minimum working pressure of 125 psi.

I. Building Surface Penetrations

Except as indicated otherwise, provide pipe sleeves as specified in this section. Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, roofs, and floors. Provide one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole.

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in non-load bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

1. Sleeves in Masonry and Concrete

Provide steel standard weight pipe sleeves. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction.

2. Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly

shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3. Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 13 PENETRATION FIRESTOPPING.

J. Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.05 AUXILIARY DRAIN PAN, DRAIN CONNECTIONS, AND DRAIN LINES

Provide galvanized steel auxiliary drain pans under units where indicated. Provide separate drain lines for the unit drain and auxiliary drain pans. Drain pans shall be fully and freely draining in compliance with ASHRAE 62.1. Trap drain pans to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points shall conform to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

2.06 CHEMICAL FEED PROVISIONS

A. Aboveground Condenser Water Piping System

Add borate-nitrite corrosion inhibitors, acceptable to heat pump component manufacturers, to initial fill water for heating and cooling water systems in concentrations of 0.5 ounce/gal of system water if corrosion inhibitors are not contained in freeze protection solution in the ground heat exchanger loop.

2.07 PAINTING OF NEW EQUIPMENT

New equipment painting shall be factory applied and shall be as specified herein. New equipment surfaces constructed of non-ferrous surfaces and materials do not have to be factory or shop painted.

A. Factory Painting Systems

Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Field applied coatings are not acceptable. Provide a factory coating system on the fins of exterior heat transfer equipment that meets ASTM B117.85 salt-fog test duration for 500 hr. Salt-spray fog test shall be in accordance with ASTM B117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust

creepage beyond 0.125 inch on either side of the scratch mark.

The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

2.08 CONTROLS

Controls for the water-loop heat pump systems complete and ready for operation shall be integrated with the HVAC system controls package specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Systems include heat pumps, system equipment, piping, pumps, electrical equipment, controls, and condenser Controls shall be designed in accordance with the manufacturer's recommendations and to comply with the sequence of controls shown on the drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Heat Pump System

Maintenance access to each piece of equipment shall not be compromised by any type of piping, electrical conduit, or any other utility. Further, install equipment in accordance with NFPA 70 and with the manufacturer's written installation instructions, including the following:

1. Water-source water-to-water heat pumps - installation instructions

2. Plate Heat Exchangers - installation instructions

3. As-Built Drawings of the installed systems. As-built drawings shall also show and document the as-constructed locations of the well field with dimensions, including all wells and loop fields.

B. Installer Qualifications

Submit a letter not later than 14 days after the Notice to Proceed, providing the name and Statement of Qualifications of the individual(s) who will serve as Ground Source Heat Pump (GSHP) Installer.

3.02 ABOVEGROUND PIPING

Provide above ground piping as specified in Section 23 64 26 CHILLED, CHILLED-HOT, CONDENSER WATER PIPING SYSTEMS.

a. Cleaning of Piping: Keep interior and ends of new piping and existing piping, affected by Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and

foreign matter. Inspect piping before placing into position.

b. Flushing and Purging of Piping: Before connection of the header to the polyethylene ground heat exchanger loops, flush and purge the entire aboveground piping system thoroughly in accordance with IGSHPA 21020 recommendations and leave filled with clean water. If the header is not immediately joined to the ground heat exchanger loop, the open ends shall be taped or capped. Purge and vent the above ground system piping of all air.

3.03 ADJUSTMENTS

Adjust controls and equipment so as to give satisfactory operation. Adjust entire water temperature control system and place in operation so that water quantities circulated are as indicated. Adjust and balance air duct systems so that air quantities at outlets are as indicated and so that distribution from supply outlets is free from drafts and has uniform velocity over the face of each outlet.

3.04 INSTRUCTING OPERATING PERSONNEL

Upon completion of work and at time designated by Contracting Officer, provide services of water source heat pump manufacturer's technical representative for period of not less than one 8-hour working day for instruction of Government operating personnel in proper operation and maintenance of equipment.

3.05 FIELD QUALITY CONTROL

Upon completion and before final acceptance of work, test each system in service to demonstrate compliance with the contract requirements. Adjust controls and balance systems prior to final acceptance of completed systems. Test controls through every cycle of operation. Test safety controls to demonstrate performance of required function. Correct defects in work provided by Contractor and repeat tests. Furnish fuel, water, electricity, instruments, connecting devices, and personnel for tests. Flush and clean piping before placing in operation. Clean equipment, piping, strainers, ducts, and filters.

A. Piping Systems Except for Ground Heat Exchanger and Refrigerant

For above ground piping systems, and steel or copper piping systems: Before insulating, perform a hydrostatic test on each new piping system at not less than 1.5 times the system working pressure. Maintain pressure for 2 hours with no leakage or reduction in gauge pressure. Obtain approval before applying insulation.

B. Equipment Tests

1. Field Testing

Test each item of equipment in operation, for continuous period of not more than 24 hours under every condition of operation in accordance with each equipment manufacturer's recommendation. Verify that each item of equipment operating parameters are within limits recommended by the manufacturer.

2. Field Test Plans

Furnish water-source heat pump field test plans developed by each equipment manufacturer detailing recommended field test procedures for each item of equipment. Field test plans developed by the installing Contractor, or the equipment sales agency furnishing the equipment will not be acceptable. The Contracting Officer will review and approve the field test plan for each item of equipment listed below prior to commencement of field testing of the equipment.

a. Equipment Items to Test:

1) Water-source water-to-water heat pumps - field acceptance test plan

2) Plate Heat Exchangers - field acceptance test plan

b. Coordinated Testing: Indicate in each field test plan when work required by this section requires coordination with test work required by other specification sections. Furnish test procedures for the simultaneous or integrated testing of equipment controls which interlock and interface with controls factory prewired or external controls for the equipment provided under Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

c. Prerequisite Testing: Equipment for which performance testing is dependent upon the completion of the work covered by 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC shall have that work completed as a prerequisite to testing work under this section. Indicate in each field test plan when such prerequisite work is required.

d. Test Procedure: Indicate in each field test plan each equipment manufacturer's published installation, start-up, and field acceptance test procedures. Include in each test plan a detailed step-by-step procedure for testing automatic controls provided by the manufacturer. Each test plan shall include the required test reporting forms to be completed by the Contractor's testing representatives. Structure procedures to test the controls through all modes of control to confirm that the controls are performing with the intended sequence of control. Controllers shall be verified to be properly calibrated and have the proper set point to provide stable control of their respective equipment.

e. Performance Variables: Each test plan shall list performance variables that are required to be measured or tested as part of the field test. Include in the listed variables performance requirements indicated on the equipment schedules on the design drawings. Furnish with each test procedure a description of acceptable results that have been verified. Identify the acceptable limits or tolerances within which each tested performance variable shall acceptably operate.

f. Job Specific: Each test plan shall be job specific and shall address the particular item of equipment and particular conditions which exist with this contract. Generic or general preprinted test procedures are not acceptable.

g. Specialized Components: Each test plan shall include procedures for field testing and field adjusting specialized components, such as hot gas bypass control valves, or pressure valves.

3. Field Test Reports

a. Equipment Items to Test:

Water-source water-to-water heat pumps - field acceptance test report

Plate Heat Exchangers - field acceptance test report

b. Manufacturer's Recommended Test: Conduct the manufacturer's recommended field testing in compliance with the approved test plan specified above. Furnish a factory trained field representative authorized by and to represent the equipment manufacturer at the complete execution of the field testing.

c. Operational Test: Conduct a standard operational test for each item of equipment. Equipment shutdown before the test period is completed shall result in the test period being started again and run for the required duration. For the duration of the test period, compile an operational log of each item of equipment. Log required entries every 2 hours. Use the test report forms for logging the operational variables.

d. Notice of Tests: Conduct the manufacturer's recommended tests and the operational tests; record the required data using the approved reporting forms. Notify the Contracting Officer in writing at least 15 calendar days prior to the testing. Within 30 calendar days after acceptable completion of testing, submit each test report for review and approval.

e. Report Forms: Type data entries and writing on the test report forms. Completed test report forms for each item of equipment shall be reviewed, approved, and signed by the Contractor's test director and the QC Manager. The manufacturer's field test representative shall review, approve, and sign the report of the manufacturer's recommended test. Signatures shall be accompanied by the person's name typed.

f. Deficiency Resolution: The test requirements acceptably met; deficiencies identified during the tests shall be corrected in compliance with the manufacturer's recommendations and corrections retested to verify compliance.

C. Additional Field Testing

Requirements for testing, adjusting, and balancing (TAB) of ducts, piping, and equipment are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Testing, adjusting, and balancing shall begin only when the entire HVAC system, including controls, has been completed with the exception of performance tests.

Balance air flows to that indicated in accordance with SMACNA 1966, as supplemented and modified by this section. Testing, adjusting, and balancing shall begin only when the entire HVAC system, including controls, has been completed with the exception of performance tests. Where required the heat pump systems shall be charged with premixed antifreeze solution (type and concentration as indicated prior to testing, adjusting, and balancing). Submit written certificate to report the following:

a. Water source heat pump unit nameplate data, and actual voltage and ampere consumption.

b. Supply and return terminal airflow, and equipment used to measure airflow.

c. Water source heat pump cfm and entering and leaving air temperatures.

d. Water source heat pump unit condenser water gpm and entering and leaving temperatures.

e. Ambient outside air temperature, date, and person testing, balancing, and reporting.

D. On-Site Training

The Ground Source Heat Pump Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 16 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The on-site training shall cover all of the items contained in the approved Operation and Maintenance Data packages.

-- End of Section --

DIVISION 25 – INTEGRATED AUTOMATION

SECTION 25 01 00

MASTER CONTROL SYSTEM
09/17

PART 1 GENERAL

1.01 REFERENCE STANDARDS

The following organizations have generated standards that are to be used as references in assuring the quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in this Specification and in the Contract Drawings:

A. ISA, Instrumentation, System, and Automation Society.

B. UL, Underwriter's Laboratory Inc.

C. NEMA, National Electrical Manufacturers Association.

D. ANSI, American National Standards Institute.

E. MIL, Military Standards.

F. JIC, Joint Industries Council.

G. IEEE, Institute of Electronic and Electrical Engineers.

H. NEC, National Electrical Code.

I. FM, Factory Mutual

1.02 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Contract Specification Sections, where referenced.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

System Description; G

Equipment Hardware; G

Instruments; G

MCS Cabinets And RDP Information; G

SD-03 Product Data

Product Information For All Sensors/Transducers And Instruments; G

Software Description; G

SD-10 Operation and Maintenance Data; G

Control System Operation And Maintenance Manual; G

SD-11 Closeout Submittals

Record Drawings And Documentation; G

1.04 SUMMARY

A. Contractor shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish install, calibrate, and place in operation a complete Master Control System (MCS) for the Groundwater Extraction and Treatment System (GETS) Facility. The MCS shall be comprised of two major components, the Local Control System (LCS) and the Remote Display Panel (RDP).

B. The Master Control System shall be provided by a single system supplier who shall assume responsibility for providing a complete and integrated MCS. Major MCS work items are:

1. One Master Control Unit to be located at the GETS Facility building designated instrumentation and control area, as shown on the contract drawing.

2. One Remote Display is also to be located in the designated area within the GETS Facility building Conference Room, as shown on the Contract Drawings.

3. The MCS shall receive 4-20 mA / MODBUS or analog dry contact inputs from magnetic flowmeters, pressure transducers, liquid level sensors, and switches. The MCS shall display these process values on a human-machine interface (HMI), and provide data logging of all values. The MCS shall have the capability to export data via USB 2.0 port in the .CSV (Microsoft Excel™) format. The MCS shall have the capability of accepting user-defined setpoints for all inputs. The MCS shall have the capability of outputting a "master alarm" condition if any user-defined input is out of set range. Master Alarm condition shall be displayed on the HMI, with additional output via Form C contacts.

4. The Remote Display shall display the identical screen as displayed on the MCS HMI.

5. The MCS shall have one dedicated Ethernet communications port and one RS-232 serial communication port for future provision of SCADA equipment. These ports shall be usable as a Modbus RTU protocol slave device.

6. All required programming and configuration of the MCS to accomplish the functional requirements are outlined in Part 3 and the Contract Drawings.

7. The panels and enclosures listed above shall conform to the requirements as set forth in Part 2, Control Panels and Enclosures. All internal panel devices shall conform to the requirements as set forth in Part 2, Panel Instruments and Devices

8. Testing and checkout of the MCS in accord with Part 1 and 2.

9. Training in accordance with Parts 1 and 2.

1.05 QUALITY ASSURANCE

A. General

The Contractor shall provide a complete and functional MCS.

All equipment, components, and materials required for the MCS shall be furnished by the respective supplier who shall assume responsibility for the adequacy and performance of all items.

B. MCS Supplier's Qualifications

1. The MCS Supplier must be a financially sound manufacturer of process control equipment, routinely involved in supplying process control systems of the type specified for a minimum of five continuous years. Supplier's experience shall be on projects comparable to the MCS installation project in terms of hardware, software, cost, and complexity. Supplier shall have in existence at the time of the Contract award, a permanent experienced engineering and technical staff to design, implement, adjust, test, and place the entire MCS into operation and train the Owner's personnel in its use. The supplier shall not be allowed to subcontract the system software preparation, project management, training, systems engineering or system startup.

2. The MCS provided for this project shall be a standard system. Custom software and customized hardware components shall not be acceptable. A standard system is defined as one which is available, at time of bid, with fully tested software and hardware and full documentation such that no development must be done beyond system hardware configuration and applications software configuration. Equipment must be part of the supplier's established product line and be supported as a standard product.

3. The MCS supplier shall have a minimum of five years experience in hardware application and programming of microprocessor based process controllers. The MCS supplier shall also have a minimum of five years experience in the installation and calibration of various field instruments, including level and flow instrumentation.

4. The MCS supplier shall have a thorough working knowledge of process control suitable to the system in question and in accordance with standard practices in the water and wastewater industry.

C. Supplier's Responsibilities

The MCS Supplier shall be the manufacturer of the MCS and shall assume the responsibilities specified below:

1. Design, fabrication, implementation, system startup, and application support of the MCS in accordance with the Contract Documents and all referenced standards and codes.

2. Preparation, assembly, and correction of all MCS submittals in accordance with the Contract Documents.

3. Proper interfacing of the MCS hardware software, and panels, including required interfacing with packaged control systems furnished by other equipment suppliers, and with the local electrical system.

4. Supervision of the installation of the MCS, panels, cabinets, wiring, and other components required.

5. Calibration, testing, and startup of the MCS. This will be limited to demonstrating all functions related to the MCS required by Part 3, Execution.

D. Coordination Meetings

1. In accordance with Section 01 31 19, PROJECT MEETINGS.

2. Location: Site.

3. Minimum of three are required. Specific dates shall be established as the Project progresses.

4. First Meeting: Within 30 days after Notice to Proceed.

1.06 SYSTEM SUPPLIER PROJECT PERSONNEL

Supplier shall provide the following project personnel:

1. Project Manager:

a. The MCS supplier shall appoint a Project Manager who shall coordinate and schedule all work and assure the project schedule is met.

b. The Project Manager shall act as liaison with the Contractor and Contracting Officer for the installation of the MCS equipment and shall assist in all matters required for the proper coordination of all equipment.

2. Field Engineer:

a. The system supplier shall appoint a Field Engineer with responsibilities as follows:

1) Provide advice and technical consultation relative to the installation techniques and procedures for the equipment furnished.
2) Installed system checkout, calibration, adjustment and

startup including tuning of every control loop.
3) Involvement of the on-site training of operating personnel.
4) Resolving of control problems encountered during initial startup and testing of the MCS.

b. The Field Engineer shall have a minimum of five years experience in systems engineering and startup and shall have a through working knowledge of both the hardware and software supplied for the MCS.

PART 2 PRODUCTS

2.01 MASTER CONTROL SYSTEM CONTROL PANELS AND ENCLOSURES

Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all control panels and enclosures.

A. General Construction Requirements

1. Provide all electrical and hydraulic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the MCS complete and operational.

2. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.

3. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

4. Provide sub-panels for installation of all relays and other internally mounted components. All wiring to panel connections from field instruments devices, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise noted.

5. Provide copper ground studs for all panel equipment. Panels and enclosures shall meet NEMA 4X requirements.

2.02 MASTER CONTROL SYSTEM PROVISIONS

Contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to set up and install the MCS to accomplish the functionality specified herein. Provide the following major components:

A. Panels:

1. Treatment Building Master Control System: The panel in the Treatment Structure shall be a NEMA 4X panel and shall host the MCU PLC display panel, I/O modules, power supplies, fiber termination units, and all necessary appurtenances.

2. Conference Room Remote Display Panel: The panel in the Conference Room shall be a wall-mount NEMA 1 enclosure and

shall host a minimum 10 inch, color LCD type display panel, or approved equal, power supplies, fiber termination units, and all necessary appurtenances.

B. Instruments:

1. T-100 and T-700 Level Sensors: The level sensors shall be of the hydrostatic type, range to be 0-10 feet WC. Power supply shall be 11-28 VDC. Output shall be 4-20 mA/RS485. Submersible transmitter shall be of all 316L stainless steel construction with NEMA 4 rated junction box.

2. Differential Transmitters: Differential Transmitters shall be of 316 stainless steel or cast-aluminum construction suitable for an industrial environment, having 1/4 inch FPT ports unless otherwise indicated on drawings. Pressure range shall be 0-25 PSI. Power supply shall be 11-28 VDC with NEMA 4X junction box. Output shall be 4-20 mA/RS485.

3. Flowmeters: The flowmeters shall be of an electromagnetic type with the location and pipe size as indicated on drawings. Flowmeter liners shall be compatible with contaminated groundwater. Power supply shall be 11-28 VDC with NEMA 4X junction box. Output shall be 4-20 mA/RS485.

4. Pressure Transducers: The pressure transducers shall have a range of 0-250 PSI and be of 316L stainless steel with stainless steel diaphragm. Pipe connection shall be 1/4 inch MPT unless otherwise noted on drawings. Power supply shall be 11-28 VDC with NEMA 4X junction box. Output shall be 4-20 mA/RS485.

5. Mass Flowmeter: The mass flowmeter shall be of the thermal or venturi type suitable for flow measurement of wet hydrocarbon gasses with the pipe sizes and location as shown on drawings. Instrument shall have a range of 0-500 SCFM. Power supply shall be 11-28 VDC with NEMA 4X junction box. Output shall be 4-20 mA/RS485.

6. Station flood alarm: The station flood alarm to be installed within the floor sump, shall be an epoxy coated 316 stainless steel spherical float switch with factory assembled and sealed type SO cable and normally open contacts.

2.03 PRODUCT INFORMATION

Submit the following product information:

A. Shop Drawings

1. General

a. Shop Drawings are to be submitted in accordance with the requirements of the Contract Documents.

b. Manufacture of the MCS shall not commence until related submittals have been approved by the Contracting Officer.

c. The Contracting Officer may request clarification of additional information.

2. Requirements

a. Instruments Submittal:

Provide product information for all sensors/transducers and instruments. Include all the following:

1) List of all instruments and quantities provided.
2) Manufacturer's product name and model number.
3) Instrument Tag Number from the Contract Documents.
4) Manufacturer's standard catalog product data.
5) Description of construction features.
6) Performance and operation data.
7) Installation and mounting details, instructions and recommendations.
8) Service requirements.
9) Dimensions.
10) Electrical and wiring information.

b. PLC Hardware and Software Submittals

1) System Description:

a) Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
b) Software language and organization.
c) Man-machine interface details.
d) Control and failure modes

e) Database listing including all input/output points.
f) List of spare parts and test equipment.

2) Equipment Hardware:

a) Layout drawings showing front, rear, end, and plan views to scale of all processing equipment, I/O components, power supplies, and peripheral devices.
b) Construction details and features.
c) Plan showing equipment layout on RDP.
d) Installation requirements, instructions, and/or recommendations.

3) Software Description:

a) Standard documentation covering all aspects of the MCS and programmable logic controller software functions and capabilities, including instruction set description and programming procedures related to control, monitoring, display, logging, reporting and alarming functions.
b) Standard technical and instructional documentation covering software for utility,

system support, system documentation, display, communications, and alarming features to be provided and functions to be performed.

c) MCS Cabinets and RDP information: For each system provide the following submittals:

(1) Layout drawings, including the following:

(a) Front, rear, end, and plane views to scale.
(b) Dimensional information.
(c) Tag Number or Functional Name of components mounted in and on cabinet or Gauge Board.
(d) Nameplate location and legend including text, letter size, and colors to be used.
(e) Location of anchoring locations and holes.
(f) Location of external wiring and piping connections, mounting and installation details.
(g) Proposed layouts and sizes of graphic display panels.

(2) Wiring and Piping diagrams, including the following:

(a) Wiring sizes and types.
(b) Piping sizes and types.
(c) Terminal strip numbers.
(d) Color coding.
(e) Functional name for components to which wiring and piping are connected.

(3) Electrical control Schematics.
(4) Plan showing equipment layout in each area.
(5) Field piping Diagrams, including pipe sizes and types and functional name of items to which piping is connected.
(6) Instrument loop diagrams for all analog and discrete display control, and I/O loops including the following:

(a) Instrument Tag or Functional Name of each item.
(b) Manufacturer's model, product, or catalog number for each item.
(c) Location of each item.
(d) Wiring interface details.

B. Control System Operation and Maintenance Manual

1. Furnish both electronic and hard copies of O&M Manuals as specified herein for the MCS in accordance with the Contract Specifications, and the supplemental requirements below.

2. Provide three hard copy sets of and three electronic copies of manuals for the MCS. The electronic copies shall be submitted in Adobe PDF on Compact Disc, or other format agreed to with the Contracting Officer.

3. The O&M Manuals shall contain the following:

   a. The name, address, and telephone number of each supplier's local service representative.

   b. Complete list of supplied system hardware parts with full model numbers referred to system part designations, including spare parts and test equipment provided.

   c. Complete up to date system software documentation.

   d. Manufacturers' copies of hardware, software, and installation manuals for control system components and other instruments and panel devices.

   e. General descriptive information covering basic features of the equipment.

   f. Principles of operation to explain the logic of operation.

   g. Maintenance procedures including checkout, troubleshooting, and servicing; checkout procedures shall provide the means to verify the satisfactory operation of equipment, troubleshooting procedures shall serve as a guide in determining faulty components and servicing procedure shall cover requirements and recommended time schedule for calibration, cleaning, lubrication, and other preventative maintenance procedures.

   h. Wiring, schematic, and logic diagrams.

C. Record Drawings and Documentation:

1. Contractor and system suppliers shall electronically revise all system shop drawings, submittals and software documentation to reflect as-built conditions in accordance with the Contract Documents.

2. Three hard copies and three electronic copies of all revised shop drawings and documentation shall be submitted to the Contracting Officer to replace outdated drawings and information contained in the O&M Manuals.

PART 3 EXECUTION

3.01 MASTER CONTROL SYSTEM PROVISION

The required control for the various unit operations is a combination of the representation on the Contract Drawings and the requirements specified herein. The general operating control strategy shall be as follows:

A. GETS Facility Control Inputs

The control inputs for the GETS Facility shall be as follows, and as noted on the Contract Drawings:

1. Influent Groundwater: Contaminated influent groundwater shall be supplied to the treatment process via submersible pumps EW-1 through EW-5. The flow and discharge pressure from each individual well is metered by flowmeters FM-100 through FM-104 and pressure transducers PT-100 through PT-104, respectively. The consolidated flow from EW-1 through EW-5 is conveyed to equalization tank T-100 via flowmeter FM-105 and pressure transducer PT-105. Level sensor LS-100 indicates the water level within T-100.

2. Filtration: Water from equalization tank T-100 is conveyed to pressure filters PF-200A and PF-200B via feed pumps P-100A and P-100B. Flow through PF-200A and PF-200B is measured by FM-106 installed between the equalization tank T-100 and feed pumps P-100A and P-100B. . Differential pressure across PF-200A and PF-200B is measured by DP-100 and DP-101, respectively.

3. Phase Separation: Filtered water from PF-200A / PF-200B passes through air stripper AS-300. VOCs are transferred from the water to the air. The gas-phase products flow through mass flowmeter MFM-100 to vapor phase GAC vessels VPGAC-401 and VPGAC-402 by auxiliary vacuum blower V-300B, where VOC's are removed before the air is discharged to atmosphere. Differential pressure gauges DP-102 and DP-103 indicate pressure drop across the media bed.

4. Liquid-phase VOC removal: Treated water from Air Stripper AS-300 is conveyed to liquid-phase GAC vessels LPGAC-501 and LPGAC-502 by feed pumps P-300A and P-300B. Differential pressure gauges DP-104 and DP-105 indicate air pressure drop across the media bed.

5. Treated Water Storage and Discharge: Treated water from liquid-phase GAC vessels is conveyed to Treated Water Tank (T-700) by feed pumps P-300A and P-300B. Level sensor LS-200 indicates the water level within T-700.

6. Floor Sump (Treatment Area): Water collected within the floor sump located within the secondary containment curb in the treatment area shall be conveyed to either sanitary sewer connection or equalization tank T-100 via sump pump P-800A (or spare P-800B) and motorized control valve MV-100. Motorized control valve MV-100 shall normally direct flow to T-100. When backwash pump P-700A is called upon to run, MV-100 shall direct flow to the sump through Pressure Filters PF-600A and PF-600B. Differential pressure across PF-600A and PF-600B is measured by DP-106 and DP-107, respectively. Level sensor LS-300 indicates the water level within the Floor Sump.

B. Valves and Pumps

Refer to Contract Drawings for information regarding valve and

pump designations and valve positions.

C. GETS Facility Control Strategy

The control strategy for the GETS Facility shall be as follows, and as referenced on the contract drawings:

1. The groundwater extraction wells (EW-1 through EW-5) shall be started manually via the PLC, or machine-side control (H-O-A).

2. The level within each extraction well EW-1 through EW-5 shall be measured by level sensors LS-081 through LS-085, respectively. Level sensors LS-081 through LS-085 shall be separate inputs to the PLC. The PLC shall provide separate speed control signals to the VFD's of EW-1 through EW-5 to maintain the water level of each well at a user-defined setpoint. The PLC shall display the well water level indicated by level sensors LS-081 through LS-085.

3. The level within each observation well OW-1 through OW-5 shall be measured by level sensors LS-091 through LS-095, respectively. Level sensors LS-091 through LS-095 shall be separate inputs to the PLC. The PLC shall display the well water level indicated by level sensors LS-091 through LS-095. Two user-defined setpoints shall also be provided for the water levels at each of the Observation Wells. The function of the user-defined setpoints shall be to provide future automation of the extraction well pumping rates based on the levels measured by LS-091 through LS-095 in relation to the user-defined setpoints.

4. The surface water level at Bound Brook shall be measured at a designated stage monitoring location (Gauging Station) by a level sensor LS-096. The PLC shall display the level in units of feet and tenths of feet.

5. The level within EQ Tank T-100 shall be measured by submersible level sensor LS-100. T-100 shall have four user-defined tank levels: Low Level (LL), Pump On, High (H), and High High (HH). The PLC shall display an alarm condition when the water within T-100 reaches the H setpoint.

6. EQ tank T-100 will begin to fill. When the tank level rises to the user-defined "pump on" level (i.e., between LL and HH level as defined by LS-100, and in agreement with the float switches, the PLC shall start the following equipment:

   a) Feed Pumps P-100 A/B (single pump alternating start by local pump control)
   b) Air Stripper AS-300 and associated blowers B-300A and V-300B; and
   c) Feed Pumps P-300 A/B (single pump alternating start by local pump control).

7. If the level in EQ Tank T-100 rises to the HH level as defined by either LS-100 OR the HH float switch, the PLC

shall stop EW-1 through EW-5, all equipment under P-100 A/B, AS-300, P-300 A/B, and display an alarm condition.

8. If the level in EQ Tank T-100 falls to the LL level as defined by either LS-100 OR the LL float switch, the PLC shall stop all equipment under P-100 A/B, AS-300 (and associated blowers B-300A and V-300B), P-300 A/B, and display an alarm condition.

9. If a user-defined "HIGH DP" condition across Pressure Filter PF-200A or PF-200B occurs, the PLC shall display an alarm condition.

10 If a "HIGH DP" condition across liquid phase GAC vessels LPGAC-501 or LPGAC-502 occurs, the vessels shall backwash under local control.

11. If a user-defined "HIGH DP" condition across gas phase GAC vessels VPGAC-401 OR LPGAC-402 occurs, the PLC shall display an alarm condition. The operator shall manually place the standby vessel into service.

12. Treated Water Tank T-700 begins to fill. When the tank level rises to the user-defined HH level as defined by either LS-200 OR the HH float control, the PLC shall stop EW-1 through EW-5, all equipment in Paragraph 3.01.A.1 through 3.01.A.5 above, and display an alarm condition.

13. Backwash pump P-700A shall be controlled via the LPGAC controls, or by manual machine-side control (H-O-A).

14. If a user-defined "HIGH DP" condition across backwash Pressure Filter PF-600A or PF-600B occurs, the PLC shall display an alarm condition.

15. Sump Pump P-800A (and spare P-800B) shall be controlled by local float switch and/or wall-mounted control (H-O-A). When the water level in the sump rises to the user-defined "pump on" level as defined by LS-300, and in agreement with the float switch, the PLC shall display a "pump on" condition. Flow from P-800A (or P-800B) shall normally be directed to T-100. When backwash pump P-700A is called upon to run, motorized valve MV-100 shall direct flow from P-800A (or P-800B) to sanitary sewer connection through Pressure Filter PF-600A or PF-600B.

16. Booster Pump P-700B shall be controlled by local pressure switch.

17. Actuating the EMERGENCY STOP control shall stop EW-1 through EW-5, all equipment under P-100 A/B, AS-300 (and associated blowers B-300A and V-300B), P-300 A/B, and display an alarm condition.

18. Upon contact closure of station flood float switch FS-100 in the floor sump, the PLC shall stop EW-1 through EW-5, all equipment under P-100 A/B, AS-300 (and associated blowers B-300A and V-300B), P-300 A/B, and display an alarm condition.

D. Instrumentation and Control Loops

A description of instrumentation and Control Loops is as follows:

1. Extraction wells EW-1 through EW-5 shall be operated via machine-side controls (H-O-A switches) or via the PLC. The PLC shall display the operating status (run/stop) of EW-1 through EW-5.

2. Each extraction well EW-1 through EW-5 shall be furnished with level sensors LS-081 through LS-085, respectively. Level sensors LS-081 through LS-085 shall be separate inputs to the PLC. The PLC shall provide separate speed control signals to the VFD's of EW-1 through EW-5 to maintain the water level of each well at a user-defined setpoint. The PLC shall display the well water level indicated by level sensors LS-081 through LS-085.

3. Each observation well OW-1 through OW-5 shall be furnished with level sensors LS-091 through LS-095, respectively. Level sensors LS-091 through LS-095 shall be separate inputs to the PLC. The PLC shall display the well water level indicated by level sensors LS-091 through LS-095. Two user-defined setpoints shall also be provided for the water levels at each of the Observation Wells. The function of the user-defined setpoints shall be to provide future automation of the extraction well pumping rates based on the levels measured by LS-091 through LS-095 in relation to the user-defined setpoints.

4. The designated stage monitoring location (Gauging Station) at Bound Brook shall be furnished with a level sensor LS-096. The PLC shall display the level in units of feet and tenths of feet.

5. Production water flow from groundwater extraction wells EW-1 through EW-5 is metered through flowmeters FM-100 through FM-104, respectively. Pump pressure is measured by pressure transducers PT-100 through PT-104, respectively. If pressure indicated by PT-100 through PT-104 falls below or exceeds user-defined high/low setpoints, an alarm condition shall be indicated. The PLC shall display the values from FM-100 through FM-104 in units of GPM and totalized flow in units of gallons.

6. Consolidated water production from extraction wells EW-1 through EW-5 is metered through flowmeter FM-105. Collection system manifold pressure is measured by pressure transducer PT-105. These values are stored in units of gallons (totalized flow) and PSI, respectively. If the flow recorded through flowmeter FM-105 is less than 2 gpm AND any pump EW-1 through EW-5 is operating, an alarm condition shall be displayed. (For example, such a condition could result from a break in the collection system manifold). The value of FM-105 is displayed in units of gallons per minute.

7. The level within Equalization Tank T-100 is measured by Pressure Transducer LS-100. The PLC shall display T-100 level in units of feet and tenths of feet. Four level points of LL,

Pump On, H, and HH shall be user-defined. When the level in T-100 reaches the Pump On point, the PLC shall start the following equipment:

8. Flowmeter FM-106 measures the volume of water flowing to the inlet of Feed Pumps P-100 A/B (single pump alternating start by local pump control). This value is stored in units of totalized gallons. It has no control function.

9. Feed Pumps P-100 A/B (single pump alternating start by local pump control.)

10. Air Stripper AS-300 and associated blowers B-300A and V-300B.

11. Flowmeter FM-107 measures the volume of water flowing to the inlet of Feed Pumps P-300 A/B (single pump alternating start by local pump control). This value is stored in units of totalized gallons. It has no control function.

12. Feed Pumps P-300 A/B (single pump alternating start by local pump control).

13. When the level within T-100 reaches the H level, the PLC shall display an alarm condition.

14. Two single pole normally open float switches shall be installed in T-100, set to close at the LL and HH points. The closure of these respective switches shall be in agreement with the level range indicated by Pressure Transducer LS-100. The PLC shall start the equipment under P-100 A/B, AS-300 (and associated blowers B-300A and V-300B), P-300 A/B only if the float switches are in agreement with LS-100. If LS-100 is not in agreement with the float switches, an alarm message shall be displayed.

15. Mass Flow Meter MFM-100 measures the volume of air discharged to GAC vessels VPGAC 401/402. This value is stored in units of totalized cubic feet. It has no control function.

16. Differential pressure gauges DP-102 and DP-103 measure the differential pressure across GAC tanks VPGAC-401 and VPGAC-402, respectively. If the differential pressure exceeds a user-defined setpoint, the PLC shall display an alarm message. It has no other control function.

17. Differential pressure gauges DP-104 and DP-105 measure the differential pressure across GAC tanks LPGAC-501 and LPGAC-502, respectively. If the differential pressure exceeds a user-defined setpoint, the PLC shall display an alarm message.

18. Finish water is conveyed to Treated Water Tank T-700. The level within T-700 is measured by Pressure Transducer LS-200. The PLC shall display T-700 level in units of fee and tenths of feet. The three level points of LL, HL, and HH shall be user-defined. When the level in T-700 rises to the HH level as defined by either LS-200 OR the HH float control, The PLC shall display an alarm message AND stop Extraction wells EW-1 through EW-5, and the equipment defined under P-100 A/B,

AS-300 (and associated blowers B-300A and V-300B), P-300 A/B.

19. Two single pole normally open float switches shall be installed in T-700, set to close at the LL and HH points. The closure of these respective switches shall be in agreement with the level range indicated by Pressure Transducer LS-200. If they are not in agreement, an alarm message shall be displayed.

20. Flowmeter FM-108 measures the volume of treated water discharged to surface water. The value in gallons per minute shall be displayed on the PLC. This value shall be recorded in totalized gallons. If the flow recorded through flowmeter FM-108 is less than 2 gpm AND any pump EW-1 through EW-5 is operating, an alarm condition shall be displayed. (For example, such a condition could result from a break anywhere through the process train).

21. LPGAC 501 and LPGAC 502 backwash pump P-700A shall be operated by local differential pressure controls, part of the LPGAC 501 and LPGAC 502 assembly, or by local (H-O-A) control.

22. Backwash pump P-700A shall be discharged to the sump through Pressure Filters PF-600A or PF-600B with local differential pressure controls DP-106 and DP-107, respectively. Flowmeter FM-109 measures the volume of backwash water discharged to the sump.

23. Floor Sump shall be furnished with a pressure transducer LS-300, which shall measure the water level within the sump. The PLC shall display Floor Sump level in units of feet and tenths of feet. The sump shall also be furnished with a local float switch. When water level rises to a user-defined "pump on" level at LS-300, and in agreement with the float switch, the PLC shall display "pump on" condition. Flow from P-800A (or P-800B) shall normally be directed to T-100. When backwash pump P-700A is called upon to run, motorized valve MV-100 shall direct flow from P-800A (or P-800B) to sanitary sewer connection through Pressure Filter PF-600A or PF-600B.

E. Auxilliary I/O Functions:

1. A minimum of five spare input and output metering and control connections shall be provided as follows:

   a. One input capable of accepting Form C dry contact closure from the Fire Alarm Control Panel. Upon receipt of contact closure the PLC shall display a fire alarm condition.

   b. Two spare analog (dry contact) I/O connections reserved for future use.

   c. Two spare 4-20 mA/RS485 I/O connections reserved for future use.

-- End of Section --

DIVISION 26 – ELECTRICAL

SECTION 26 05 02

BASIC ELECTRICAL REQUIREMENTS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2015; ERTA 2016) Life Safety Code
NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 72	(2016) National Fire Alarm and Signaling Code

1.02 RELATED DOCUMENTS

Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this section.

1.03 SUMMARY

A. This Section includes general requirements for all Division 26 work.

B. Work Included.

Furnish all labor and materials and perform all operations necessary for the installation of complete and operating electrical systems subject to the conditions of the contract. The work also includes the completion of such electrical details not mentioned or shown which are necessary for the successful operation of all systems. Prove satisfactory operation of all equipment and controls to the Contracting Officer on request.

C. Work Not Included (Specified elsewhere).

Certain labor and materials may be furnished and/or installed under other Divisions of these specifications. Coordinate with all other applicable trades and arrange all electrical work to make the components fit together to provide complete and operational systems.

1.04 REFERENCE STANDARDS

A. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. The date of the standard that is in effect at the bid date, or date of Contracting Officer/Contractor Agreement when there are no bids, except when a specific date is specified or when the standard is part of an applicable code which includes an edition date.

C. When required by individual Specifications Section, obtain copy of standard. Maintain copy at job site during work until Substantial Completion.

1.05 REGULATORY AND CODE REQUIREMENTS

A. Apply for and pay for all permits, fees, licenses and inspections for this Division of work.

B. Include the cost of any "Electric Service Application Fee" charged by the Utility Company.

C. Comply with state and local code requirements and ordinances. Comply with requirements of the Utility Companies. In the case of differences between these requirements and ordinances, the most stringent shall govern. Call for inspections required by Local Building Inspection Authority.

D. Applicable Building Codes and Ordinances: Including but not limited to the following:

1. International Building Code NFPA 101 - Life Safety Code, Latest Edition

2. PSE&G, Utility Company Requirements

3. State of New Jersey Department of Labor Requirements

4. State of New Jersey Department of Health Requirements

5. National Fire Protection Association Standards

6. State and Federal Safety and Health Laws

7. NFPA 70 National Electrical Code

8. NFPA 72 - Fire Alarm, Latest Edition Enforced by Local Jurisdiction

9. Local Building Codes, Latest Editions

10. International Energy Conservation Code

E. References: The latest editions of the following standards (including supplements and official interpretations) are minimum requirements.

1. Underwriter's Laboratories, Inc. (UL)

2. National Electrical Manufacturers Association (NEMA)

3. American National Standards Institute (ANSI)

4. Insulated Cable Engineers Association (ICEA)

5. National Electrical Safety Code (NESC)

6. NECA Standard of Installation

1.06 DEFINITIONS

A. "Provide" means Contractor is responsible for the furnishing and installation of.

B. "Exposed" means where it can be seen after the building is completed such as in equipment rooms, unfinished areas, accessible tunnels, etc. where conduit/equipment is accessible.

C. "Concealed" means where it cannot be seen after the building is completed such as in spaces as chases, trenches, above ceilings, in walls and buried where conduit/wire is inaccessible when building is completed.

1.07 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

A. Comply with Division 01 and individual Division 26 Specification Sections. Furnish number of sets as required in Division 01, but not less than three.

B. Submit shop drawings and product data for products and equipment listed in each Division 26 Specification Section. Make submittals to Contracting Officer via the general contractor.

1. If the shop drawings deviate from the Contract Documents advise the Contracting Officer of the deviations via written format, accompanying the shop drawings. Include the reason for the deviation(s). Coordinate all required changes with the other trades affected. If the changes are occasioned by the Contractor, the Contractor shall pay any costs involved.

2. Show any changes required in electrical wiring, space allocation, etc. Contractor shall be responsible to make all changes required to accommodate these changes. Coordinate changes required with all other trades. If the changes are occasioned by the Contractor, the Contractor shall pay any costs involved.

C. Submit test reports as required in each Division 26 Specification Section.

D. Submit certificates of operation as required in each Division 26 Specification Section.

E. Where shop drawing submittals are required, do not begin work until one copy that has not been rejected or required to be resubmitted again has been returned.

F. Review of shop drawings is for general conformance with the design concept of the project and does not relieve Contractor from the responsibility of furnishing equipment and materials of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents. Review does not relieve Contractor from responsibility for errors on the shop drawings. Approval of a specific item does not include approval of the assembly of which the item is a component.

1.08 PRODUCT ALTERNATES AND SUBSTITUTIONS

A. Comply with Division 01, individual Division 26 Specification Sections and the following:

1. Should the Contractor wish to have products considered other than those specified, he/she must submit those items in accordance with Division 26 Section "Basic Electrical Requirements" and Division 01. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. Action for substitutions specified herein will be given only after the receipt of complete data showing manufacturer, model number, performance criteria, physical dimensions and material construction all SPECIFICALLY marked for the individual item. Letter of transmittal with at least 1 copy of all descriptive data shall be submitted to the Contracting Officer's office. Data may not be returned; reference addenda for approval to bid.

3. Voluntary product substitutions from the Contractor will not be considered without prior approval. Contractor will be required to submit the total savings (anticipated savings) to the Contracting Officer.

1.09 QUALITY ASSURANCE

A. Preparation

Base final installation of materials and equipment on actual dimensions and conditions at the project site. Field measure for materials or equipment requiring exact fit.

B. Workmanship

All electrical work shall be performed, or under direct supervision of, a licensed electrician. Provide qualified skilled workmen, licensed as required. Perform work in accordance with ANSI/NECA 1. The appearance of the finished work shall be of equal importance with its electrical operation. The Contracting Officer may reject work if

workmanship and appearance are not satisfactory.

C. Supervision

Be responsible for and coordinate the work of all subcontractors working under Division 26.

D. Installation Procedures

Confer and cooperate with other trades and coordinate the work in proper relation with theirs. Coordinate ceiling cavity space carefully with other trades.

Protection shall be provided for interior cabinet components when drilling to keep metal shavings off of electrical components in cabinet.

E. Materials

All electrical materials shall be new unless noted otherwise, and acceptable for installation only if labeled or listed as defined in NFPA 70, Article 100, by UL or by a recognized testing laboratory where standards have been established and acceptable to the Authority Having Jurisdiction. Labeled or listed equipment shall be installed in accordance with any instructions or labeling provided with the equipment.

F. Manufacturer's Instruction

Install equipment and materials in accordance with manufacturers' recommendations unless specifically indicated otherwise, or where local codes or regulations take precedence.

G. Protection

Where there are existing facilities, be responsible for the protection thereof, whether or not such facility is to be removed or relocated. Moving or removing any facility must be done so as not to cause interruption of the work or Contracting Officer's operation.

1.10 DELIVERY, STORAGE AND HANDLING

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. Do not allow delivery of materials and equipment until approved by Contractor in accordance with the project scheduled.

C. Provide for proper storage of all materials and equipment and assume responsibility for losses due to any cause. All storage shall be within the contract limit lines of the building site. Off-site storage will be allowed if permitted under Division 01 requirements. Cover and store all equipment and materials out of elements and off of the ground; any rusted or weather damaged item will not be permitted to be used. Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Acceptance: Check and sign for materials to be furnished by others

for installation under Division 26 upon delivery. Assume responsibility for the storage and safekeeping of such materials from time of delivery until final acceptance.

1.11 COORDINATION

A. Inspection: Inspect work preceding or interfacing with work of Division 26 Sections and report any known or observed defects that affect the work to the General Contractor. Do not proceed with work until defects are corrected.

B. Coordinate electrical service connections to components furnished by utility companies.

1. Make arrangements with Utility Companies to obtain permanent services to the project.

2. Utility interruptions: Coordinate electrical utility interruptions with the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

3. Coordinate installation and connection of exterior underground and/or overhead utilities and services, including provisions for electrical-metering components.

4. Comply with requirements of Authorities Having Jurisdiction and of utility company providing electrical power and other services.

C. Existing Utilities: The plans indicate the location, type and sizes of various utilities within the site where known. These utilities are indicated as accurately as possible. If utilities are encountered during construction which are not shown on the drawings, ask for instructions from the Contracting Officer. Any relocation or remodeling required will then be directed. Assume all responsibility for protection of all utilities, shown or not, and repair any damage caused by this construction at no extra charge to the Contracting Officer.

1. Contractor shall be responsible for calling "Utilities Location Hot Line" to schedule underground utilities location marking.

2. Owners of all underground facilities shall be notified at least three business days prior to excavation so that the owners can locate and mark underground facilities.

D. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

E. Sequence, coordinate and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Drawings and Specifications

1. Electrical drawings are diagrammatic and because of the small scale, it is not possible to indicate every required offset, fitting, etc. Drawings are not to be scaled for dimensions. Take all dimensions from Architectural drawings, certified equipment drawings and from the structure itself before fabricating any work. Verify all space requirements, coordinating with other trades, and install the systems in the space provided without extra charges to the Contracting Officer.

2. Examine Drawings and Specifications for other parts of the work, and for any discrepancies. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the Contracting Officer in writing before the date of bid opening. In the event such discrepancies exist and the Contracting Officer is not so notified, the adjudication of responsibility shall be solely at the discretion of the Contracting Officer. Obtain written instructions for any necessary changes.

3. The precedence of electrical construction documents is as follows:

a. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.

b. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.

c. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.

d. Should a conflict arise between the Drawings and the Specifications for products indicated on the Drawings, the Specifications shall have precedence.

e. Should there be a conflict in dimensions or locations between Electrical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

1.12 WARRANTIES

A. All materials and equipment shall be new unless otherwise specified.

B. Provide a written warranty to the Contracting Officer covering the

entire electrical work to be free from defective materials, equipment and workmanship for a period of one year unless noted otherwise in individual Sections, after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Contracting Officer. Provide certificates (include in O & M Manuals) for such materials and equipment, which have warranties in excess of one year. Include dates of start and end of the warranty and manufacturer's representative name and telephone number.

1.13 CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

A. General: Comply with Division 01.

B. Temporary Lighting and Power.

1. Provide all temporary facilities required to supply construction power and light. Install and maintain facilities in a manner that will protect the public and workmen. Comply with all applicable laws and regulations.

2. Provide covered walkway lights and obstruction lights where required, which shall be kept burning continuously between sunset and sunrise.

3. Upon completion of the work, remove all temporary facilities from the site.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacements of components. Connect for ease of disconnection, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

E. Waterproofing: Seal all existing openings (created by demolition) and all new openings at exterior building foundation and wall penetrations so that they are watertight.

F. Electrical Provisions for Roofs

1. Raceways penetrating roofs shall be installed in a manner to preserve the integrity of the roof and not void warranty. Provide flashing and counter flashing for all roof penetrations required for the work.

2. All conduits routed above roofs shall be installed a minimum of twelve inches above the finished roof surface, supported on metal stands installed with flashing and counter flashing, with a maximum spacing of ten feet.

G. Trenching and Backfilling: Dig trenches to the depth required, minimum 24 inches or as specified. Concrete or sand encase conduits or cables as specified or shown. Backfill with earth in 6 inch layers. Thoroughly tamp each layer and compact to 95 percent density in accordance with Section 31 23 16. Remove all rocks, stones, etc., from bottom of trench from backfill material and exercise necessary precautions so as to avoid damage to conduit and/or cable runs. Restore subsurface and surface to original condition where trenching is done in specially treated areas, such as paving, concrete, asphalt, etc. Repair and restore trenches and surface where settlement occurs for a period of one year from date of acceptance of work by Contracting Officer. Provide safety barriers in existing areas during all times that trench is open and whenever it will cause a hazard to drivers or pedestrians. Refer to Division 31 for additional requirements.

1. Refer to Division 27 Section 27 05 28 "PATHWAYS FOR COMMUNICATIONS SYSTEMS" for spacing requirements between power and communications conduit and/or cable.

H. Cutting and Patching

1. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Cutting shall be performed by skilled workmen of trades involved.

2. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

I. Refinishing and Touchup Paint: Paint materials and application requirements are specified in Division 09 Painting.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

2. Follow Paint manufacturers written instructions for surface preparation and for timing and application of successive coats.

3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

4. Repair damage to PVC or paint finished with matching touchup coating recommended by manufacturer.

J. Cleaning and Protection

1. Comply with Division 01 and individual requirements of each Division 26 Specification Section.

2. On completion of installation, including outlets, fittings and devices, inspect exposed finish. Remove burrs, dirt, paint spots and construction debris.

3. Protect equipment and installations and maintain conditions to ensure that coatings, finished, and cabinets are without damage or deterioration at time of Substantial Completion.

3.02 FINAL OBSERVATION

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. Prior to notifying the Contracting Officer that the project is ready for the final observation the Contractor must submit the O & M manuals fifteen (15) days prior to the date of final observation or as required in Division 01, and shall verify in writing, that:

1. All systems are complete.

2. All systems have been properly started and are operational.

C. When the Contractor notifies the Contracting Officer that the project is ready for a final observation, the Contracting Officer will visit the job site and will prepare a final observation list of all the items on the project that shall be finished or corrected before the project can be accepted.

D. When the Contractor notifies the Contracting Officer that all items on the above final observation list have been completed and corrected, the Contracting Officer will visit the project to ascertain that all the items on the final observation list have been corrected and can be accepted.

3.03 PROJECT RECORD DRAWINGS

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. File at job site one copy of Drawings, Specifications, Addenda, approved shop drawings, change orders, field orders, test records, other modifications to Contract Documents.

C. Do not use Project Record Documents for construction purposes.

D. Legibly mark with red pencil field changes, such as the following, referenced to permanent and accessible features of the site or building as applicable. Do not permanently conceal any work until required information is recorded.

1. Drawings:

a. Locations of underground work.

b. Locations of concealed utilities.
c. Field changes of dimension and detail.
d. Changes resulting from change order or field order.
e. Details not on original drawings.
f. Approved (should be inclusive of all variations of drawings) circuiting changes, or routing changes.
g. Manufacturer, model number of equipment actually installed.
h. Update all panel schedules with revised circuit numbers and loads.

2. Shop Drawings. Changes made after Contracting Officer's approval.

E. At completion of Work transfer all project record document information onto CADD files. Deliver completed Project Record Documents to Contracting Officer. Project Record Documents shall include any special system and "project record" shop drawings.

3.04 OPERATION AND MAINTENANCE DATA

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. Submit number as required by Division 01, typed and hard bound copies of Operating and Maintenance Manuals to Contracting Officer for approval prior to scheduling any system demonstration for the Contracting Officer and fifteen (15) days prior to final observation. Books shall be arranged in sequence to match the specification Sections.

C. The books shall contain, but not be limited to, the following general items; each item shall be provided with a separate index tab.

1. Instructions (On Contractor's Letterhead Stationery) on who to call for service during guarantee period including name, address, and 24 hour telephone number of company responsible for servicing each piece of equipment or system.

2. Maintenance instructions (On Contractor's Letterhead Stationery) shall include: (can be referenced to manufacturer's manual with appropriate page numbers, etc.)

Preventative maintenance schedule for necessary cleaning, lug tightening, system tests, periodic operation of emergency power systems, etc.

3. Manufacturer's manuals for each piece of equipment installed. Manuals shall include the following, as applicable:

a. Description of unit and component parts:

1) Function, normal operating characteristics and limiting conditions.
2) Complete nomenclature and commercial part number of replaceable parts.
3) Installation instruction sheets.
4) Complete wiring diagrams.

b. Recommended procedures:

1) Start-up, break-in, routine lubrication (if applicable) and operating instructions and cautions.
2) Regulation, control, start/stop, shutdown and emergency instructions.
3) Special summer and winter operating cautions.

c. Maintenance:

1) Routine care.
2) Guide to troubleshooting.
3) Disassembly, repair and reassembly.
4) List of required lubricants and schedule (if applicable).
5) Parts list, illustrations, assembly drawings and diagrams required for maintenance.
6) Predicted life of parts subject to wear.

4. All warranties provided by the Manufacturer on their equipment that run longer than the one year warranty by the Contractor.

5. All test reports.

6. All Certificates of Operation.

7. Certificate of Final Inspection.

3.05 DEMONSTRATION

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. Conduct demonstrations only after systems have been through start up procedures, systems are complete and operating, and operating and maintenance data is complete.

C. Instruct the Contracting Officer's representatives on the proper operation and maintenance of the electrical systems.

D. Contractor's Representatives:

1. Contractor's representatives shall have a thorough knowledge of the particular installation.

2. Manufacturer's representatives shall have a thorough understanding of each particular piece of equipment.

E. Scheduling: Arrange and schedule demonstration times with Contracting Officer.

F. Location: Conduct demonstrations at project including tours of systems.

G. Operating and Maintenance Data: Arrange for data to be at demonstrations. Include review of data at demonstrations.

H. Time Allotment: Provide demonstrations of adequate time periods, except as noted elsewhere, to ensure proper understanding of systems by Contracting Officer's representative.

I. Furnish ladders, tools, etc. as required to provide access to all equipment and controls for demonstrations.

3.06 CONTRACT CLOSEOUT PROCEDURE

A. Comply with Division 01 and individual Division 26 Specification Sections.

B. Approval for final payment will not be given until all contract closeout procedures comply with Division 01 Requirements.

C. Submit Keys for electrical switches, panels, cabinets, enclosures, etc. to the General Contractor.

D. Remove all materials, scrap, etc. related to the electrical installation. Leave premises in a clean and orderly condition.

-- End of Section --

SECTION 26 05 04

BASIC ELECTRICAL MATERIALS AND METHODS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A1011/A1011M	(2017) 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
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

UNDERWRITERS LABORATORIES (UL)

UL 1059	(2001; Reprint Oct 2011) Standard for Terminal Blocks
UL 248-1	(2011) Low Voltage Fuses - Part 1: General Requirements
UL 486E	(2009; Reprint May 2013) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

UL 943 (2016) UL Standard for Safety Ground-Fault Circuit-Interrupters

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Control Devices; G, AE

Control Relays; G, AE

Circuit Breakers; G, AE

Fused Switches; G, AE

Non-Fused Switches; G, AE

Fuses; G, AE

Magnetic Contactors; G, AE

Intrinsic Safety Barriers; G, AE

Fire Stopping Systems; G, AE

Extra Materials; G, AE

Fuses, 0 To 600 Volts; G, AE

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Provide product data for the following:

1. Control Devices.
2. Control relays.
3. Circuit breakers.
4. Fused switches.
5. Non-fused switches.
6. Fuses.
7. Magnetic contactors.
8. Intrinsic safety barriers.
9. Fire stopping systems.

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

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

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

2.02 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.

2. Trip Ratings: 15-800 amps.

3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.

4. Suitable for mounting and operating in any position.

5. NEMA AB 1 and UL 489.

B. Operating Mechanism:

1. Over-center, trip-free, toggle type handle.

2. Quick-make, quick-break action.

3. Locking provisions for padlocking breaker in open position.

4. ON/OFF and TRIPPED indicating positions of operating handle.

5. Operating handle to assume a center position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.

2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.

3. Two and three pole, common trip.

4. Automatically opens all poles when over-current occurs on one pole.

5. Test button on cover.

6. Calibrated for 40 degrees C ambient, unless shown otherwise.

7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or

interrupting rating shown.

2. Not less than the following RMS symmetrical currents for the indicated trip ratings:

   a. Up to 100A less than 250V ac: 10,000.

   b. Up to 100A, 250-600V ac: 42,000.

   c. Over 100A: 42,000.

3. Series Connected Ratings: Do not apply series connected short circuit ratings.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5 mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.

2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30 mA ground fault (UL-listed for equipment ground fault protection).

G. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

H. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.

I. Connections:

1. Supply (line side) at either end.

2. Mechanical wire lugs, except crimp compression lugs where shown.

3. Lugs removable/replaceable for breaker frames greater than 100 amperes.

4. Suitable for 75 degrees C rated conductors without de-rating breaker or conductor ampacity.

5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.

J. Enclosures for Independent Mounting:

1. See Article Enclosures.

2. Service Entrance Use: Breakers in required enclosure and

required accessories shall be UL 489 listed.

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

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

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

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

D. Auxiliary Contact:

1. Operation: Make before power contacts make and break before power contacts break.

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

E. Enclosures: See Article Enclosures.

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

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

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

2. Provide to fit mountings specified with switches.

3. UL 248-1.

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

1. Class: RK 1.

2. Type: Dual element, with time delay.

3. Manufacturers and Products:

a. Bussmann; Types LPS RK (600 volts) and LPN RK (250 volts).
b. Littelfuse; Types LLS RK (600 volts) and LLN-RK (250 volts).
c. Or approved equal.

C. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.

2. Ampere Ratings: 1/10 amp to 30 amps.

3. Dual-element time-delay, time-delay, or nontime-delay as required.

4. Provide with blocks or holders as indicated and suitable for location and use.

5. Manufacturers:

   a. Bussmann.
   b. Littlefuse, Inc.
   c. Or approved equal.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

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

B. Selector Switch Operating Lever: Standard. Indicating Light: Push-to-test. LED, full voltage.

C. Pushbutton Color:

   1. ON or START: Black.
   2. OFF or STOP: Red.

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

E. Legend Plate:

   1. Material: Aluminum.

   2. Engraving: Enamel filled in high contrasting color.

   3. Text Arrangement: 11 character/spaces on one line, 14 character/spaces on each of two lines, as required, indicating specific function.

   4. Letter Height: 7/64 inch.

F. Manufacturers and Products:

   1. Heavy-Duty, Oil-Tight Type:

      a. General Electric Co.; Type CR 104P.
      b. Square D Co.; Type T.
      c. Eaton/Cutler-Hammer; Type 10250T.
      d. Or approved equal.

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

      a. Square D Co.; Type SK.
      b. General Electric Co.; Type CR 104P.
      c. Eaton/Cutler-Hammer; Type E34.
      d. Crouse-Hinds; Type NCS.
      e. Or approved equal.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

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

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

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

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

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

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

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

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

3. Individual, rail mounted.

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

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.
4. Or approved equal.

2.07 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12 gauge minimum, ASTM A1011/A1011M, Grade 33.

2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40 mil polyvinyl chloride coating.

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

E. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063 T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052 H32.

F. Nonmetallic Framing Channel:

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

G. Manufacturers:

1. B Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.
4. Or approved equal.

2.08 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrode position process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

ENCLOSURES			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor	Unfinished	Industrial Use	12
Indoor and Outdoor	Any	Wet	4
Indoor and Outdoor	Any	Wet and Corrosive	4X

PART 3 EXECUTION

3.01 GENERAL

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

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

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

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

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:

a. Aluminum Raceway: Extruded aluminum.

b. PVC-Coated Conduit: PVC coated.

c. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.

2. Interior, Corrosive (Wet or Dry) Locations:

a. Aluminum Raceway: Extruded aluminum.

b. PVC Conduit: Type 316 stainless steel or nonmetallic.

c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.

3. Outdoor, Noncorrosive Locations:

a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.

b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.

4. Outdoor Well Head Chamber Locations:

a. PVC Conduit: Type 316 stainless steel.

b. Aluminum Raceway: Aluminum.

c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel PVC coated steel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.

2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.

3. Nonmetallic Channel: Epoxy resin sealer.

4. PVC-Coated Channel: PVC patch.

-- End of Section --

SECTION 26 05 05

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Related Sections may include but are not limited to the following.

1. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Written Report; G, AE

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL, or by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.05 EXTRA MATERIALS

A. Provide crimp tool as required. Crimp tool must be certified for use with lugs being provided.

1.06 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 70	(2009) Power Cable Rated 2000 V or Less for the Distribution of Electrical Energy--S95-658

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following requirements apply for products selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 CONDUCTORS AND CABLES

A. All low voltage conductors shall be copper only. Aluminum conductors shall not be allowed.

B. Manufacturers:

1. American Insulated Wire Corp.; a Leviton Company.
2. Encore Wire
3. The Okonite Company.
4. Southwire Company
5. Or approved equal.

C. Refer to Part 3 "Conductor and Insulation Applications" Paragraphfor insulation type, cable construction, and ratings.

D. Conductor Material: Copper unless noted otherwise; complying with NEMA WC 70; solid conductor for No. 12 AWG and smaller, stranded for No. 10 AWG and larger.

E. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 70.

2.03 CONNECTORS AND SPLICES

A. Manufacturers:

1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC>
5. 3M Company; Electrical Products Division.
6. Ideal Industries.
7. Thomas & Betts Electrical.
8. Burndy Electrical.

9. Or approved equal.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. No. 6 AWG and smaller: Twist-on wire connectors

D. No. 4 AWG and larger: Solderless or compression type CU/ALR lugs.

PART 3 EXECUTION

3.01 CONDUCTOR AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN or XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN pr XHHW, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway or Power-limited cable, concealed in building finishes.

3.02 INSTALLATION

A. Conceal conduit in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use minimum No. 12 AWG for power and lighting circuits, minimum No. 14 AWG for control wiring.

C. Increase conductor sizes as necessary to limit branch circuit voltage drop to 3 percent and service/feeder voltage drop to 2 percent.

D. Neatly train and lace wiring inside boxes, equipment, and panelboards. Make temporary connections to panelboard devices with sufficient slack wire to facilitate reconnections required

for balancing loads between phases.

E. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure wiring has been completed.

1. Provide protection for exposed cables where subject to damage.

F. Where the use of existing wiring is permissible, connect new Work to existing in a manner that will ensure continuous wiring from outlet to outlet and that all splices and insulation are in good condition.

H. Use manufacturer-approved pulling compound or lubricant for No. 4 AWG and larger and where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Completely and thoroughly swab raceway system before installing conductors.

I. Pull all conductors into a raceway at the same time. Use pulling means, including fish tape, cable, rope, and basket-weave wire/ cable grips that will not damage cables or raceway.

J. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. In plenums, cables shall be plenum rated.

K. Support cables according to Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".

I. Color-code conductors and cables according to Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

3.03 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Splice only in accessible junction boxes.

2. Make splices, taps, and terminations to carry full ampacity of conductors without perceptible temperature rise. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.

3. All below grade splices shall be suitable for use for an indefinite period of time while submerged in water.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack to allow for connection to device.

3.04 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. Torque test conductor connections and terminations to manufacturer's recommended values.

2. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

3. Insulation Test: Measure the insulation of service conductors, and feeder conductors. Measurements shall be taken between conductors and between conductors and ground. Resistance shall be 1,000,000 ohms or more when tested at 500 volts by Megger without circuit loads.

a. Furnish all instruments, equipment and personnel required for testing.

B. Test Report: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

-- End of Section --

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL, or by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

1. Comply with UL 467.

1.04 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM B3	(2013) Standard Specification for Soft or Annealed Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62561-7	(2011) Lightning Protection System Components (LPSC) - Part 7: Requirements for Earthing Enhancing Compounds

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 837	(1989; R 2014) Standard for Qualifying Permanent Connections Used in Substation Grounding

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a. Erico Inc.; Cadweld Electrical Products Group.
b. Burndy Electrical.
c. ILSCO.
d. Kearney/Cooper Power Systems.
e. O-Z/Gedney Co.; a business of the EGS Electrical Group.
f. Thomas & Betts, Electrical.
g. Or approved equal.

2.02 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 26 05 05 "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B3.

2. Assembly of Stranded Conductors: ASTM B8.

G. Copper Bonding Conductors: As follows:

1. Bonding Conductor: No. 4 or No. 6 AWG, bare, stranded copper conductor unless noted otherwise.

2. Bonding Jumper: Bare, braided, copper strip, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick. Bonding jumpers shall be used as indicated in other parts of this specification and for bonding items which move such as gates, doors, etc.

H. Grounding Bus: Bare, annealed copper bar of rectangular cross section with insulators. Use insulated spacer, space 1 inch from wall and 6 inches above finished floor. Copper ground bar 1/4 inch W by 3 inches H by 18 inches L with predrilled 3/8 inch holes 2 inches on center lengthwise.

2.03 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturers written instructions.

2.04 MADE GROUNDING ELECTRODES

A. Ground Rods: Chemical Rod, 3/4 inch diameter, minimum 10 feet long.

B. Ground Enhancement Material (GEM) conforms to IEC 62561-7.

PART 3 EXECUTION

3.01 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground and/or buried connections.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

3.02 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and branch circuits.

C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

D. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to main service location, terminal cabinet, wiring closet, or central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4 inch by 2 inch by 12 inch copper grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.03 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. If bend(s) are required, each bend shall be no more than 90 degrees.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

C. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

D. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

E. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

F. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, Paragraph 250-81(c), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least 4 locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

G. Ground Rods: Install at least one rod. If more than one rod is required space rods at least one-rod length from each other and locate at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 18 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors.

Use exothermic welds. Make connections without exposing steel or damaging copper coating.

H. If required by the Utility Company providing service to the project, provide grounding and bonding at the utility transformer and metering equipment per the Utility Companies requirements and standards.

3.04 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials if required to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturers written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Metal Raceway Terminations: Metallic raceways that terminate at metal equipment enclosures, cabinets, etc.; terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in enclosure, cabinet, etc. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B. Use UL 486A for copper and UL 486B for aluminum.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately

compressed on grounding conductor.

-- End of Section --

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008; Errata 2008) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.03 SUMMARY

A. This Section includes the following:

1. Conduit and Equipment Supports.

2. Anchors and Fasteners.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL or by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1. Provide hangers and supports for suspended equipment over 4,500 lbs that complies with Seismic Category 1 requirements. It shall be the responsibility of the Contractor to provide

the required seismic documentation.

1.05 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported equipment and its content.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Thomas & Betts Corporation - Super Strut.
2. Unistrut
3. B-Line
4. Powerstrut
5. Or approved equal.

2.02 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to Authorities Having Jurisdiction, and of type adequate to carry the loads of equipment, raceways and cables, including weight of wire in raceway.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch diameter slotted holes at a maximum of 2 inches o.c., in webs.

1. Channel Thickness: Selected to suit structural loading.

2. Fittings and Accessories: Products of the same manufacturer as channel supports.

D. Raceway and Cable Supports, 120 Volts and Above: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

E. Pipe Sleeves: ASTM A53/A53M, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

I. Powder-Driven Threaded Studs: Heat-treated steel approved by the Contracting Officer.

PART 3 EXECUTION

3.01 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturers written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.02 SUPPORT INSTALLATION

A. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation" and in accordance with manufacturer's recommendations.

1. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.

2. Do not drill or cut structural members.

3. Obtain permission form Contracting Officer before drilling or cutting structural members.

B. Install support devices to securely and permanently fasten and support electrical components.

C. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

D. Install surface-mounted cabinets and panelboards with minimum of four anchors.

E. In wet and damp locations use steel channel supports to stand cabinets and panelboards 1 inch off wall.

F. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

G. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

H. Support parallel runs of horizontal raceways together on trapeze-

or bracket-type hangers.

I. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

J. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

K. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.

L. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

M. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

N. Simultaneously install vertical conductor supports with conductors.

O. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

P. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

Q. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.

2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

3. New Concrete: Concrete inserts with machine screws and bolts.

4. Steel: Welded threaded studs or spring-tension clamps on steel.

5. Field Welding: Comply with AWS D1.1/D1.1Mand/or AWS D1.3/D1.3M.

6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

7. Light Steel: Sheet-metal screws.

8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.03 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Supporting devices for electrical components.

-- End of Section --

SECTION 26 05 33.10

RACEWAYS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.3	(2015) American National Standard for Electrical Metallic Tubing (EMT)
ANSI C80.6	(2005) American National Standard for Electrical Intermediate Metal Conduit (EIMC)
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1660	(2014) Liquid-Tight Flexible Nonmetallic Conduit
UL 360	(2013; Reprint Jan 2015) Liquid-Tight Flexible Steel Conduit

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes raceways, fittings, and boxes, for

electrical wiring.

B. Related Sections may include but are not limited to the following:

1. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

2. Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".

1.04 ABBREVIATIONS

A. GRC: Galvanized Rigid Steel Conduit.

B. EMT: Electrical metallic tubing.

C. FMC: Flexible metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. RNC: Rigid nonmetallic conduit.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surface Raceways, Wireways, And Fittings Required On The Project; G, AE

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL, or by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate layout and installation of raceways, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce

lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2. Product Data shall be supplied for all surface raceways, wireways, and fittings required on the project.

2.02 METAL CONDUIT AND TUBING

Manufacturer's catalog data shall be submitted for surface raceways, wireways, and fittings required on the project.

A. Manufacturers:

1. Electri-Flex Co.
2. Allied Tube and Conduit Div.
3. LTV Conduit.
4. Robroy.
5. Thomas & Betts, Electrical.
6. Wheatland.
7. Or approved equal.

B. GRC: ANSI C80.1.

C. IMC: ANSI C80.6.

D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

E. Plastic-Coated IMC and Fittings: NEMA RN 1.

F. EMT and Fittings: ANSI C80.3.

1. Fittings: Steel set-screw or compression type.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket, UL 360.

I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.03 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

1. Carlon.
2. Cantex.
3. Kraloy.
4. P.W. Pipe.
5. Or approved equal.

B. RNC: NEMA TC 2, Schedule 40 PVC.

C. LFNC: UL 1660.

2.04 METAL WIREWAYS

A. Manufacturers:

1. B-Line.
2. Hoffman.
3. Square D.
4. Rittal.
5. Wiremold.
6. Or approved equal.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA configuration to meet environmental conditions of installed location. Provide minimum 16 gauge steel with knockouts on sides and bottom.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required to complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

PART 3 EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: GRC.

2. Concealed: GRC.

3. Underground, Single Run: PVC, and coated GRC.

4. Underground, Grouped: PVC, and coated GRC.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

B. Indoors:

1. Exposed: GRC.

2. Concealed: GRC.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

4. Damp or Wet Locations: GRC.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Steel and Intermediate Steel Conduit: Use threaded

rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Coat all exposed metal surfaces such as exposed threads, with PVC coating. Patch all nicks and scrapes in PVC coating after installing conduits.

3. PVC: Use only fitting and sealing compound approved for use with that material.

3.02 RACEWAY SIZING

A. Minimum Raceway Size: 3/4 inch trade size.

B. Conduit sizes not noted on the drawings shall be sized in accordance with NFPA 70 NEC Table C3 (except Table 350-12 for luminaire flexible connections) for the quantities and sizes of wire installed. Size shall conform to fill requirements with the ground wire as an additional current carrying conductor.

3.03 INSTALLATION

A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Install temporary closures to prevent foreign matter from entering raceways.

D. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

E. Make bends and offsets so inside diameter is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

1. Use conduit bodies to make sharp changes in direction, as around beams.

2. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.

3. For Nonmetallic Conduit (PVC): Use PVC-coated rigid steel factory elbows for bends in conduit runs longer than 100 feet, or in conduit runs which have more than two bends regardless of length.

F. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

2. Install no more than the equivalent of four 90-degree bends between boxes, unless noted otherwise.

G. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of concrete cover. Do not route raceways to cross each other, unless structural engineer on project has given other installation approval.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

2. Space raceways laterally to prevent voids in concrete.

3. Run conduit larger than 1 inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.

4. Change from nonmetallic tubing to GRC, or IMC before rising above the floor.

H. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

I. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

2. For Nonmetallic Conduit (RNC): Wipe conduit clean and dry before joining. Apply full, even coat of cement to entire area that will be inserted into fitting. Follow manufacturer's recommendations.

J. Lay out work in advance to avoid excessive concentrations of multiple conduit runs. Locate conduits so that the strength of structural members is unaffected and the conduits do not conflict with the services of the other trades.

K. Provide expansion joints or expansion-deflection joints with bonding conductor at building expansion joints, seismic joints and where required to compensate for conduit or building thermal expansion and contraction.

L. Cut conduit square using a saw or pipe cutter; de-burr cut ends.

M. Bring conduit to the shoulder of fittings and couplings and fasten securely.

N. Avoid moisture traps where possible: where unavoidable, provide junction box with drain fitting at conduit low point.

O. Tighten set screws of threadless fittings with suitable tools.

P. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box.

2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

R. Telephone and Signal System Raceways: In addition to above requirements, install raceways in maximum lengths of 150 feet. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

1. Pull boxes shall be the following minimum sizes:

a. 6 inches by 6 inches by 6 inches for 1 inch and smaller conduit runs.

b. 6 inches by 6 inches by 36 inches for 1-1/4 inch and larger conduit runs.

2. All 1 inch conduit and smaller shall have a maximum of two 6-inch minimum radius bends for each length of 150 feet or less. Ninety degree bends or "LB" type conduit bodies are not allowed.

3. All conduits larger than 1 inch shall have a maximum of three 24-inch minimum radius bends for each length of 150 feet or less. Ninety degree bends or "LB" type conduit bodies are not allowed.

S. Communication Device Raceways: In addition to above requirements, provide one 3/4 inch conduit from each communication outlet box to above nearest accessible ceiling space, unless indicated otherwise. Provide bushing.

1. Sealing: Install raceway sealing fittings where required by NFPA 70 and where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces using UL listed sealing compound.

T. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

U. Flexible Connections: Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72 inches of flexible conduit. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

V. Surface Raceways: Install a separate, green ground conductor in all raceways from panelboard to receptacle or fixture ground terminals.

3.04 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings and finishes are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

-- End of Section --

SECTION 26 05 33.20

BOXES, ENCLOSURES, AND CABINETS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA OS 1	(2013) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
ANSI/NEMA OS 2	(2013) Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FB 1	(2014) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections may include but are not limited to the following:

1. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

2. Division 26 Section 26 27 26 "WIRING DEVICES".

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Floor Boxes, Hinged-Cover Enclosures, And Cabinets; G, AE

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL, or by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate layout and installation of boxes, enclosures, and cabinets, with other construction including conduit, piping, equipment, light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following requirements apply for product selection, in other Part 2 paragraphs where subparagraph titles below introduce lists:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2. Product Data shall be supplied for Floor boxes, Hinged-cover enclosures, and Cabinets. Data shall include information on finishes, dimensions, and any manufacturer's instructions. Data shall include manufacturer's information on finishes, dimensions, and any manufacturer's instructions for Floor boxes, Hinged-cover enclosures, and Cabinets.

2.02 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturer(s):

1. Cooper Cruse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/Gerneral Signal; Appleton Electric Company, O-ZGedney.
3. Hoffman.
4. Hubbell, Inc.
5. Carlon.
6. Robroy Industries, Inc.; Enclosure Division.
7. Spring City Electrical Manufacturing Co.
8. Thomas & Betts Corporation, Steel City.
9. Stahlin.
10. Wiremold.
11. Or approved equal.

B. Sheet Metal Outlet and Device Boxes: ANSI/NEMA OS 1, galvanized steel. Except for luminaire and communication outlet boxes,

provide size to accommodate the number of conductors entering the box in addition to the device installed.

1. Luminaire and Equipment Supporting Boxes: Minimum 4 inch square, rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

2. Communication Outlet Boxes: 4 inch square with single gang ring and blank wall plate.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: ANSI/NEMA OS 2.

E. Small Sheet Metal Pull and Junction Boxes: ANSI/NEMA OS 1, galvanized steel.

F. Cast-Metal Pull and Junction Boxes: 150 cubic inches or less, NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: Over 150 cubic inches or as indicated, NEMA 250, Type 1, for indoor clean and dry locations, with continuous hinge cover and flush lockable latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

3. Fronts for flush cabinets shall be approximately 3/4 inch larger on all sides than cabinet and set so the front will rest firmly against the finished wall surface.

4. Key latch as directed by Contracting Officer.

H. Cabinets: NEMA 250, Type 1, for indoor clean and dry locations, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush lockable latch and concealed hinge. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

1. Fronts for flush cabinets shall be approximately 3/4 inch larger on all sides than cabinet and set so the front will rest firmly against the finished wall surface.

2. Key latch as directed by Contracting Officer.

2.03 ENCLOSURES

A. For other than indoor clean dry locations, NEMA 250 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, type 3R.

2. Other Wet or Damp Indoor Locations: NEMA 250, type 4.

2.04 FACTORY FINISHES

A. For other than indoor clean dry locations, provide-applied finish in manufacturer's standard color or as specified including undersurfaces treated with corrosion resistant undercoating.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosures and cabinets plumb. Anchor securely to wall and structural supports at each corner under provisions of Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS."

B. Install boxes, enclosures, and cabinets in accordance with NECA "Standard of Installation."

C. Coordinate installation of outlet boxes for equipment connected under Division 26 Section 26 27 26 "WIRING DEVICES".

D. Set wall mounted boxes vertically or horizontally and at elevations to accommodate mounting heights indicated in Division 26 Section 26 27 26 "WIRING DEVICES" or as indicated on the drawings.

E. Electrical boxes are shown on drawings in approximate locations unless dimensioned.

1. Adjust box locations up to 10 feet if required to accommodate intended purpose.

F. Maintain headroom and present neat mechanical appearance.

G. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only, unless noted otherwise.

H. Inaccessible Ceiling Areas: Install outlet and junction boxes not more than 6 inches from ceiling access panel or from removable recessed luminaire.

I. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

J. Locate outlet boxes to allow luminaries positioned as shown on reflected ceiling plan.

K. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

L. Use flush mounted outlet boxes in finished areas, unless noted otherwise.

M. Locate flush mounting boxes in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

N. Do not install flush mounting box back-to-back in walls; provide minimum 12 inches separation. Provide minimum 24 inches separation in acoustic rated walls.

O. Secure flush mounting boxes to interior wall and partition studs. Accurately position to allow for surface finish thickness.

P. Use stamped steel bridges to fasten flush mounted outlet boxes between studs.

Q. Install flush mounting boxes without damaging wall insulation or reducing its effectiveness.

R. Use adjustable steel channel fasteners for hung ceiling outlet boxes.

S. Do not fasten boxes to ceiling support wires.

T. Support boxes independently of conduit.

U. Use gang boxes where more than one device is mounted together. Do not use sectional boxes.

V. Use gang boxes with plaster rings for single device outlets.

W. Use cast outlet boxes in exterior locations exposed to weather and wet locations.

X. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal boxes in other locations.

3.02 IDENTIFICATION

A. Identify each box, enclosure, and cabinet as specified in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

3.03 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.

B. Install knockout closures in unused box openings.

3.04 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.05 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

-- End of Section --

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.

2. Manholes, handholes and boxes.

1.03 DEFINITIONS

A. RNC: Rigid nonmetallic conduit.

B. Duct: Electrical conduit and other raceway, either metallic or nonmetallic, used underground, embedded in earth.

C. Duct Bank: Two or more conduits or other raceway installed underground in the same trench.

D. Manhole/Handhole: An underground junction box in a duct or duct bank.

1.04 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges
AASHTO M 306	(2010; R 2015) Standard Specification for Drainage, Sewer, Utility, and Related Castings

ASTM INTERNATIONAL (ASTM)

ASTM E329	(2014a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

ANSI C2	(2017) National Electric Safety Code (NESC)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 10012	(2003) Measurement Management Systems -- Requirements for Measurement Processes And Measuring Equipment
ISO 9000	(2015) Quality Management Systems-Fundamentals and Vocabulary

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

SOCIETY OF CABLE TELECOMMUNICATIONS ENGINEERS (SCTE)

ANSI/SCTE 77	(2013) Specification for Underground Enclosure Integrity

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.7	Definition and Requirements for a Nationally Recognized Testing Laboratory

UNDERWRITERS LABORATORIES (UL)

UL 514B	(2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings
UL 6	(2007; Reprint Nov 2014) Electrical Rigid Metal Conduit-Steel
UL 651	(2011; Reprint Jun 2016) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings

Additional guidance documents not referenced in this Section but applicable to project include:

ASTM F512 - Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Conduits and Fittings for Underground Installation

NEMA TC 6 & 8 - PVC Plastic Utilities Duct for Underground Installation

NEMA TC 9 - Fittings for PVC Plastic Utility Duct for Underground Installation

UL E53373 - Underground Fiber Reinforced Epoxy Conduit (FRE)

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Data For Professional Engineer, Firms And Testing Agency.; G

SD-02 Shop Drawings

Duct-Bank Coordination Drawings; G, AE

SD-03 Product Data

Duct-Bank Materials; G, AE

Ducts And Conduits And Their Accessories; G, AE

Accessories For Manholes/Handholes, Boxes; G, AE

Warning Tape; G

SD-06 Test Reports

Source Quality-Control Test Reports; G

Field Quality-Control Test Reports; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G, AE

SD-11 Closeout Submittals

Project Record Documents; G

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

B. Manufacturer Qualifications: Firm experienced in installing underground ducts and raceways, manholes and handholes similar to those indicated for this Project. Firm must have a record of successful in service performance.

C. Comply with NFPA 70 "National Electrical Code" and ANSI C2 "National Electrical Safety Code" for components and installation.

1. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

2. The Terms "Listed" and "Labeled": As defined in the NFPA 70 "National Electrical Code," Article 100.

   a) Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 29 CFR 1910.7.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Inspect and protect ducts during installation to ensure that there is no debris within ducts that could damage the feeders and to ensure that the conduit do not have any deformities. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect from dirt, water, construction debris, and traffic.

D. Lift and support precast concrete units only at designated lifting or supporting points.

E. Deliver ducts to project site with end capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming

1.08 COORDINATION

A. Coordinate layout and installation of ducts manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes, handholes, and as approved by Contracting Officer.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall provide the following information for specified materials and services.

A. Product Data

1. Duct-bank materials, including separators and miscellaneous

components.

2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Accessories for manholes/handholes, boxes

4. Warning tape.

B. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

2. Drawings shall be signed and sealed by a qualified professional engineer.

C. Qualification Data for professional engineer, firms and testing agency. Include list of completed projects with project names, addresses, names of Architect and owner, and other information specified.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Manufacturer's Installation Instructions:

1. Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

G. Closeout Submittals:

1. Project Record Documents: Record actual routing of conduits and duct banks

2.02 CONDUIT

A. Rigid Steel Conduit (RSC): ANSI C80.1, UL 6, heavy wall, hot dipped, galvanized steel with PVC coating.

B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Size:

1. 1 inch, 2 inch and 4 inch nominal for voltages below 600 V.

2.03 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.

2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.
12. Or approved equal.

B. Duct Accessories:

1. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling. Horizontal and vertical locking separation of 4 inches between ducts.

2. Elbows: Material to match conduit; minimum bend radius of 36 inches.

3. Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit; pre-manufactured system for PVC with conduit seals, provisions for roughing into the concrete pour and waste stops, when entering a new building, a new manhole, or a new handhole.

4. Bushings: Groundable steel bushings of appropriate sizes on all metal conduits where bell ends are not used; pre-manufactured system for PVC with conduit seals, provisions for roughing into concrete pour and water stops, when entering a building, a new manhole or a handhole.

5. Seals: Mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with manufacturer's instructions, when entering a building, a handhole below grade and concrete shall be core drilled for the appropriate size conduit and seal.

6. Plugs: Closure plugs or caps of same material as conduit at ends of unused sections.

7. Pull Tape: Nylon pull tape with measurement markings in uniform lengths in each empty duct.

C. Warning Tape: Underground line warning tape specified in Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

D. Solvent Cement: Recommended by conduit manufacturer.

2.04 MANHOLES, HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with ANSI/SCTE 77.

1. Color of Frame and Cover: Gray.

2. Configuration: Units shall be traffic-rated and designed for flush burial with a closed bottom, unless otherwise indicated.

3. Cover: Weatherproof, lockable , secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRIC.", or as indicated for each service.

6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

8. Handholes 4 feet wide by 6 feet long by 4 feet deep shall have factory-installed inserts for cable racks and pulling-in irons

B. Polymer Concrete Manholes, Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

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

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.
e. Or approved equal.

2.05 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Manhole, Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with ANSI/SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration

certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 EXECUTION

3.01 COORDINATION

A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct bank entrances into manholes and handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes, handholes, and as approved by Contracting Officer.

C. Adjust the depth of electrical utilities to avoid existing utilities with no change to contract price.

D. Duct Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

2. Drawings shall be signed and sealed by a qualified professional engineer.

3.02 EXISTING UTILITIES

A. The existing utilities shown on Contract Drawings have been plotted from available records. No guarantee is made as to accuracy of locations indicated, and is shown for the benefit of Contractor.

B. Protect shown, visible and located utilities from damage. Promptly repair all active shown, visible and located utilities damaged by construction. This repair shall be made solely at the expense of the Contractor.

3.03 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Contracting Officer's no fewer than 2 days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contracting Officer's written permission.

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated. All 90-degree sweeps with radius 10 feet or less: Rigid steel conduit.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane. Do not use conduit that requires the use of couplings for straight runs. Use acceptable PVC terminal adapters when joining PVC conduit to metallic fittings or rigid metal conduit.

D. Duct Entrances to Concrete and Polymer Concrete Manholes and Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.

   2. Direct Buried Duct Banks: Install an expansion and deflection fitting in each conduit in area of disturbed earth adjacent to manhole or handhole.

   3. Concrete Enclosed Duct Banks: Install watertight expansion fitting in each conduit, with internal bonding jumper to allow for 3/4 inch movement in any direction.

   4. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 5 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Section 26 05 33.10 "RACEWAYS" and Section 26 05 33.20 "BOXES, ENCLOSURES, AND CABINETS".

F. Expansion Fittings: Provide suitable expansion fittings or other suitable means to compensate for expansion and contraction for raceways crossing expansion joints in structures or concrete slabs between two adjacent structures and between a duct bank and structure. Provide for the high rate of thermal expansion and contraction of PVC conduit by providing PVC expansion joints as recommended by manufacturer and as required.

G. Sealing: Provide temporary closure at termination of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand minimum of 15 psig hydrostatic pressure. Provide watertight entrance sealing device where an underground conduit enters a structure through a concrete waterproofed wall or floor. Contractor shall seal all conduits

once pull cords have been installed.

H. Fire Stops: Provide fire stop openings around electrical penetrations to maintain fire-resistance rating, where underground raceways penetrate fire-rated walls or floors.

I. Pulling Cord: Install 100-lbf-test nylon cord in ducts, including spares. Identify with tags at each end and at any intermediate pull point the origin and destination of each spare duct. Provide a removable permanent cap over each end of each spare duct.

J. Direct Buried Duct Banks:

1. Install ducts with a minimum of 3 inches between ducts. Depth: Install top of duct bank at least 30 inches below finished grade, unless otherwise indicated.

2. Set elevation of bottom of duct bank below the frost line.

3. Maintain a 12 inch separation between electrical duct banks and other utilities like gas, water etc.

K. Stub-Ups:

1. Use manufactured PVC coated RGS duct elbows for stub-ups at lighting fixtures poles and bases.

L. Arrangement and Routing:

1. Arrange multiple duct runs substantially in accordance with details shown on drawings. Locate underground ducts where indicated on drawings.

2. Make minor changes in location or cross-section as necessary to avoid obstructions or conflicts. Where duct runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, refer the condition to the Contracting Officer for written instructions before further work is done.

3. Maintain a 12-inch minimum vertical separation between ducts and other systems at crossings where other utility piping systems are encountered or being installed along a raceway route. Maintain a 12-inch minimum separation between ducts and other systems in parallel runs. Do not place ducts over valves or couplings in other piping systems. Refer conflicts with these requirements to the Contracting Officer for written instructions before further work is done.

4. Enter manholes, handholes and structures with ducts at right angles.

3.05 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

B. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

C. Underground Ducts Crossing paved paths, walks and driveways: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, installed by means of directional drilling.

3.06 UNDERGROUND ENCLOSURE APPLICATION

A. Manholes, Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB-17, AASHTO M 306 for H-20 loads, Polymer concrete, ANSI/SCTE 77, Tier 15, Fiberglass enclosures with polymer concrete frame and cover, ANSI/SCTE 77, Tier 15. structural load rating.

3.07 EXAMINATION

A. Examine site to receive ducts, manholes and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts, manholes and handholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.08 EARTHWORK

A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Restore paving areas (concrete sidewalks, asphalt cap, etc.) disturbed by trenching, storing of dirt, cable laying, and other work. Restore paving areas to original conditions.

3.09 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install manholes, handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted or as indicated on plans to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install manholes, handholes and boxes with bottom below the frost line, Insert depth of frost line below grade at Project site below

grade.

E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.10 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements upon completion of installation of underground duct.

a. Duct Integrity: Rod ducts with a mandrel 1/4-inch smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.

b. Water Tightness: Make internal inspection of handholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Re-inspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

B. Preparation for pulling in conductors:

1. Do not install crushed or deformed raceways. Avoid traps in raceways where possible. Take care to prevent the lodging of plaster, concrete, dirt, or trash in raceways, boxes, fittings, and equipment during the course of construction. Make raceways entirely free of obstructions or replace them. Ream all raceways, remove burrs, and clean raceway interior before introducing conductors or pull wires.

2. Immediately after installation, plug or cap all raceway ends with watertight and dust-tight seals until the time for pulling in conductors.

C. Do not backfill underground direct buried until the Contracting Officer has inspected them. Notify Contracting Officer 24 hours in advance of duct concrete pour, or backfill of direct buried ducts.

D. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.11 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, handholes, including sump if applicable. Remove foreign material.

-- End of Section --

SECTION 26 05 48

VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A570	(1998) Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled
ASTM A576	(1990b; R 2012) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A603	(1998; R 2014) Standard Specification for Zinc-Coated Steel Structural Wire Rope

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.81	(1989; R 2017) IEEE Guide for Seismic Qualification of Class 1E Metal-Enclosed Power Switchgear Assemblies

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.03 SUMMARY

A. This Section includes seismic restraints and other

earthquake-damage-reduction measures for electrical components. It complements optional seismic construction requirements in the various electrical component Sections.

1.04 DEFINITIONS

A. BOCA: BOCA National Building Code.

B. SBC: Standard Building Code.

C. UBC: Uniform Building Code.

D. IBC: International Building Code

E. Seismic Force: A force applied in the application of an earthquake-generated excitation on a structure. The IBC presents procedures for the calculation of the seismic forces on a building structure, on an element of the building structure, on a non-building structure, and on an item attached to the building or non-building structure.

F. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.

G. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during an earthquake.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Data for Firms and Professional Engineer; G

SD-02 Shop Drawings

Anchorage And Bracing Not Defined By Details And Charts On Drawings; G, AE

Details of Fabrication And Arrangements; G

Coordination Drawings; G, AE

Connections to Building Structure; G

SD-03 Product Data

Seismic Restraint Component; G, AE

SD-05 Design Data

Design Analysis Report; G

SD-07 Certificates

Product Certificates for Seismic Requirements

1.06 QUALITY ASSURANCE

A. Comply with seismic restraint requirements in IEEE C37.81 unless requirements in this Section are more stringent.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing seismic engineering services, including the design of seismic restraints, that are similar to those indicated for this Project.

1.07 COORDINATION

A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in the vicinity.

B. Coordinate concrete bases with building structural system.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic restraint component used.

1. Anchor Bolts and Studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as required by IEEE C37.81.

B. Shop Drawings: For anchorage and bracing not defined by details and charts on Drawings. Indicate materials, and show designs and calculations signed and sealed by a professional engineer with 5 years of seismic experience.

1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

2. Details: Detail fabrication and arrangements. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacings, identifying components and listing their strengths. Indicate direction and value of forces transmitted to the structure during seismic events.

3. Preapproval and Evaluation Documentation: As required by IEEE C37.81 showing maximum ratings and restraints and the basis of approval (tests or calculations).

C. Coordination Drawings: Plans and sections drawn to scale and coordinating seismic bracing for electrical components with other systems and equipment, including other seismic restraints, in the vicinity.

D. Connections to the building structure shall be designed and detailed considering the limited capacities of the building frame, such as concrete and steel strengths, slab thickness, steel plate thickness, etc., and shall deliver loads to the centroid of the building members without causing warping or twisting. Design, detail, provide, and install stiffeners, kickers, etc. as required. See Structural Notes on structural drawings for load limitations on floor and roof slabs and beams.

E. Product Certificates: Signed by manufacturers of seismic restraints certifying that products furnished comply with requirements.

F. Qualification Data: For firms and persons specified in "Quality Assurance" paragraph.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. B-Line Systems, Inc.
3. Erico, Inc.
4. GS Metals Corp.
5. Loos & Company, Inc.
6. Mason Industries, Inc,
7. Powerstrut.
8. Thomas & Betts Corp.
9. Unistrut Corporation.
10. Or approved equal.

2.03 MATERIALS

A. Use the following materials for restraints:

1. Indoor Dry Locations: Steel, zinc plated.

2. Outdoors and Damp Locations: Galvanized steel.

3. Corrosive Locations: Stainless steel.

2.04 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

2. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.

3. Concrete Inserts: Steel-channel type.

4. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A325.

5. Welding Lugs: Comply with MSS SP-69, Type 57.

6. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

7. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

8. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.05 SEISMIC BRACING COMPONENTS

A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch- (2.7-mm-) thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.

1. Materials for Channel: ASTM A570, GR 33.

2. Materials for Fittings and Accessories: ASTM A575, ASTM A576, or ASTM A36/A36M.

3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.

4. Finish: Baked, rust inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.

B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.

C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.

1. Arrange units for attachment to the braced component at one end and to the structure at the other end.

2. Wire Rope Cable: Comply with ASTM A603. Use 49- or 133-strand cable with a minimum strength of 2 times the calculated maximum seismic force to be resisted.

D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.02 STRUCTURAL ATTACHMENTS

A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.

B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.

C. Attachments to Existing Concrete: Use expansion anchors.

D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.

F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.

G. Attachments to Wood Structural Members: Install bolts through members.

H. Attachments to Steel: Bolt to clamps on flanges of beams or an upper truss chords of bar joists.

3.03 ELECTRICAL EQUIPMENT ANCHORAGE

A. Anchor rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.

B. Anchor panelboards, motor controllers, disconnect switches, transfer switches, communication system components, and electronic signal processing, control, and distribution units as follows:

1. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.

3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.

4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.

5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

3.04 SEISMIC BRACING INSTALLATION

A. Install bracing according to spacings and strengths indicated by approved analysis.

B. Expansion and Contraction: Install to allow for thermal movement of braced components.

C. Cable Braces: Install with maximum cable slack recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.05 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in raceways, cables, wire ways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

-- End of Section --

SECTION 26 05 53

ELECTRICAL SYSTEMS IDENTIFICATION
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Work under this Section is subject to requirements of Contract Documents including General Conditions, Supplementary Conditions, and sections under Division 01 - General Requirements.

1.02 DESCRIPTION

A. Section includes the following:

1. Identification for raceway.

2. Identification for conductors

3. Equipment identification nameplates.

4. Wiring devices identification.

5. Miscellaneous identification products.

6. Underground-line warning tape.

B. Refer to the respective Division 26 Sections, and Sections in other Divisions that specify electrical components, for additional electrical identification requirements.

1.03 REFERENCES

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z535.4	(2011) Product Safety Signs and Labels

ASME INTERNATIONAL (ASME)

ASME A13.1	(2015) Scheme for the Identification of Piping Systems

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

ANSI C2	(2017) National Electric Safety Code (NESC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.145	Accident Prevention Signs and Tags

UNDERWRITERS LABORATORIES (UL)

UL 969 (2017) UL Standard for Safety Marking and Labeling Systems

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Each Electrical Identification Product; G, AE

SD-04 Samples

Nameplate Schedule; G

Samples For Each Type Of Label And Sign; G

1.05 QUALITY ASSURANCE

A. Comply with ASME A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

D. Comply with ASME A13.1 and NFPA 70 for color-coding.

E. Comply with ANSI Z535.4 for safety signs and labels

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.06 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for each electrical identification product indicated.

B. Nameplate Schedule: Prior to making nameplates, submit a complete schedule to Contracting Officer for approval indicating nameplate size, lettering size, color and actual nameplate information.

C. Samples for each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

2.02 RACEWAY CABLE IDENTIFICATION MATERIALS

A. Comply with ASME A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MSI), Seton, or approved equal.

C. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.

2. Legend: Indicate system or service and voltage, if applicable.

D. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

E. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

F. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action when placed in position.

2.03 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive, vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

D. Metal Tags: Brass or aluminum, 2 inches by 2 inches by 0.05 inches, with stamped legend, punched for use with self-locking nylon tie fastener.

E. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.04 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Engraved, Three-layer, Laminated Acrylic or Melamine Nameplate: Punched or drilled for screw mounting. White letters on a black background, except emergency power equipment nameplates are to have white letters on a red background. Minimum letter height shall be 3/8 inch unless noted otherwise.

B. Stenciled Legend: In non-fading, waterproof, black ink or oil-based, alkyd enamel paint. Minimum letter height shall be 1 inch.

1. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.05 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In non-fading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch

2. Tensile Strength: 50 lb minimum.

3. Temperature Range: Minus 40 to plus 185 deg F

4. Color: Black, except where used for color-coding.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.07 UNDERGROUND-LINE WARNING TAPE

A. Manufacturers: Brady USA, Ideal, Marking Services, Inc. (MRI), Seton, or approved equal.

B. Description: Permanent, bright RED colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend shall indicate type of underground line.

5. Underground-line warning tape shall be installed 18 inches below finished grade. Refer to drawings for detail.

PART 3 EXECUTION

3.01 APPLICATION

A. Accessible Raceways Cables, 600 V or Less, for Feeder, and Branch Circuits More Than 30A: Identify with orange snap-around labels.

1. Identify 4 inch round, 4 inch square and 4-11/16 inch junction boxes concealed above ceiling or exposed with neat lettering on cover with permanent black marking pen. Identify source, circuit number, phase, and control circuit number.

B. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

C. Conductors to Be Extended in the Future and Spare Conductors: Attach marker tape to conductors and list source and circuit number.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed control, signal and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings,

manufacturer's wiring diagrams, and Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power,communications, control and lighting. Install underground-line warning tape for both direct-buried conduits.

F. Warning Labels for Boxes, and Enclosures for Power: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access to equipment.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

a. Controls with external control power connections

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

3. Arc Flash Warning Labels: Provide Arc Flash Warning labels per Section 26 05 73. Install Arc Flash Warning Labels per NFPA 70 for panelboard,disconnect switches, automatic transfer switch: Locate labels so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.

G. Equipment Identification Nameplates: On each unit of equipment, install unique designation nameplate that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply nameplates to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Nameplate Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine nameplate. Unless otherwise indicated, provide a single line of text with 1/2 inch high letters (1/4 inch where space is limited) on 1-1/2 inch high nameplate; where 2 lines of text are required, use nameplates sized 2 inches high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine nameplates sized similar to indoor equipment nameplates.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Install nameplates for equipment including, but not limited to, the following:

a. Electrical enclosures

3. Nameplates shall identify equipment or load controlled and/or function and shall be same as indicated on contract documents. Voltages shall be shown on panelboard nameplates.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Install non-adhesive signs and plastic nameplates parallel to equipment lines; attach with screws and auxiliary hardware appropriate to the location and substrate. Secure to inside surface of door or panelboard that is recessed in finished locations.

F. Operating Instructions: Mount operating procedures on the wall immediately adjacent to the piece of equipment for which the instructions apply. If sufficient wall space is available, mount directly to one of the sheet metal panels of the equipment.

G. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.

H. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.

1. Color shall be factory applied, or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.

2. Colors for 480/277 V Circuits:

a. Phase A (left bus in panelboard): Brown

b. Phase B (center bus in panelboard): Orange

c. Phase C (right bus in panelboard): Yellow

d. Neutral: White

e. Equipment Ground: Green

3. Colors for 208/120 V Circuits:

   a. Phase A (left bus in panelboard): Black

   b. Phase B (center bus in panelboard): Red

   c. Phase C (right bus in panelboard): Blue

   d. Neutral: White

   e. Equipment Ground: Green

4. Direct Current Conductors (Any voltage):

   a. Positive: Black

   b. Negative: White

5. Field-applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two runs of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

I. Aluminum Wraparound Marker Nameplates and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

J. Painted Identification: Prepare surface and apply paint.

-- End of Section --

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS
09/17

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specifications apply to this section

1.02 SUMMARY

A. This Section includes short-circuit and protective device coordination, and arc flash hazard analysis studies for the entire electrical system serving the Groundwater Extraction and Treatment Plant.

B. The studies shall be prepared by a Professional Engineer employed by the Engineering Service Organization whose services are to be retained by the Contractor.

C. Protective devices shall be furnished and set based on results of the protective device coordination study

D. Furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 141	(1993) IEEE Recommended Practice for Electric Power Distribution for Industrial Plants
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE 1584	(2002) IEEE Guide for Performing Arc Flash Hazard Calculations

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70E	(2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only.

When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Professional Engineer Qualifications:; G

SD-03 Product Data

Computer Software Program; G

SD-05 Design Data

Field Data As Required By The Power System Studies; G

Short-Circuit And Protective Device Evaluation Study; G, AE

Protective Device Coordination Study; G, AE

Arc Flash Hazard Analysis; G, AE

Final Reports; G, AE

SD-07 Certificates

Product Certificates for Software; G

SD-11 Closeout Submittals

Arc Flash Training; G

1.05 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Professional Engineer Qualifications: The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Professional Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For computer software program to be used for studies.

B. Final Reports for Review: The short-circuit, protective device coordination and arc flash hazard analysis studies shall be

submitted to the Contracting Officer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Contracting Officer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

C. Qualification Data: For Professional Engineer and the Engineering Service Organization.

D. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

E. Study Reports for use in Construction: The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations.

2. Descriptions, purpose, basis and scope of the study.

3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings.

4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings.

5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout.

6. Incident energy and flash protection boundary calculations.

7. Comments and recommendations for system improvements, where needed.

8. Executive Summary including source of information and assumptions made.

2.02 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.

4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc
6. Or approved equal.

2.03 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 EXECUTION

3.01 STUDIES

A. The coordination study shall begin with the Utility Company's feeder protective device and include all of the electrical protective devices down to power distribution panelboards and all motors. The study shall also include variable frequency drives, transformers and protective devices associated with variable frequency drives.

B. Furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

3.02 DATA COLLECTION

A. Furnish and record all field data as required by the power system studies. The Professional Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Load data utilized may include existing and proposed loads obtained from Contract Documents.

C. Include fault contribution of existing motors in the study. Obtain required existing equipment data, if necessary, to satisfy the

study requirements.

3.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point
2. Distribution panelboard
3. Branch circuit panelboards
4. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
3. Adequacy of transformer windings to withstand short-circuit stresses.
4. Cable and busway sizes for ability to withstand short-circuit heating.
5. Notify Government in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

3.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
3. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
4. Conductor damage curves
5. Ground fault protective devices, as applicable
6. Pertinent motor starting characteristics and motor damage points
7. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each panelboard

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

3.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (distribution and branch circuit panelboards) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480 volt locations and significant locations in 208 volt systems fed from transformers equal to or greater than 30 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2.

3.06 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, number per phase, length, impedance and conduit type
4. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio

B. Short-Circuit Data:

1. Source fault impedance
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Circuit Breakers:

a. Adjustable pickups and time delays (long time, short time, ground).
b. Adjustable time-current characteristic.
c. Adjustable instantaneous pickup.
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

3.07 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the Contractor.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Contracting Officer in writing of any required major

equipment modifications.

3.08 ARC FLASH WARNING LABELS

A. Provide a 3.5 inch by 5 inch thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided

2. For each low voltage switchboard, one arc flash label shall be provided

E. Labels shall be field installed by the Contractor.

3.09 ARC FLASH TRAINING

A. Train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units by the International Association for Continuing Education Training.

-- End of Section --

SECTION 26 05 93

ELECTRICAL SYSTEMS FIRESTOPPING
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions (walls, partitions, floors) including both empty openings and openings containing electrical penetrating items, including but not limited to raceways and cables.

B. RELATED WORK

1. Section 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

2. Section 26 05 33.10 - RACEWAYS

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2015) Fire Tests of Through-Penetration Firestops

1.04 PERFORMANCE REQUIREMENTS

A. Provide firestop system to resist spread of fire, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Firestop systems shall be UL Classified for the application and correspond to those indicated by reference to designations listed by UL Fire Resistance Directory.

C. Conform to applicable Code requirements of Authority Having Jurisdiction.

D. For through-penetration firestop systems exposed to view, traffic,

moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

SD-02 Shop Drawings

Each Through-Penetration Firestop System; G, AE

SD-03 Product Data

Each Type Of Product Indicated; G, AE

Material Safety Data Sheets; G

SD-06 Test Reports

Inspection Reports; G

Firestopping Tests; G

SD-07 Certificates; G

Certification Of Compliance With Building Codes

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G

SD-11 Closeout Submittals

Warranty; G

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.

B. Firestopping tests shall be performed by a qualified testing and inspecting agency, or another agency performing testing and follow-up inspection services for firestop systems acceptable to Authorities Having Jurisdiction.

C. Manufacturer's representative shall be on-site during initial installation of firestop systems to train appropriate Contractor personnel in proper selection and installation procedures.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product, type and manufacturer, and UL Label where applicable.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

C. Handle in accordance with recommended procedures, precautions, or remedies described in material safety data sheets as applicable.

1.08 PROJECT CONDITIONS

A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop systems' manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturers' written instructions by natural means or, where this is inadequate, forced-air circulation.

1.09 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Notify Contracting Officer at least 7 days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by the Government.

1.10 SEQUENCING

A. Sequence work to avoid interferences with building finishes and installation of other products.

1.11 WARRANTY

A. Refer to Division 01 and Section 26 05 02 - BASIC ELECTRICAL REQUIREMENTS for general warranty requirements.

B. Manufacturer shall provide standard 1 year warranty against defects in materials and workmanship for products specified in this Section. Warranty period shall begin on date of substantial completion.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for each type of product indicated.

B. Shop Drawings For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetration items, including documentation of UL certification for firestop systems.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Material Safety Data Sheets provided with product delivered to job site.

E. Certification of compliance with Building Codes of Project location.

F. Inspection reports.

2.02 MANUFACTURERS

A. 3M (Fire Protection Products Division).
B. Hilti Inc.
C. Tremco (Sealant/Weatherproofing Division).
D. Nelson Firestop Products.
E. Specified Technologies Inc.
F. RectorSeal Corporation.
G. Or approved equal.

2.03 MATERIALS

A. Firestop Products: UL 1479, ASTM E814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance; materials shall not contain flammable solvents.

B. Firestop Systems: Produced by the same manufacturer.

C. Accessories: Components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Accessories include the following items:

1. Permanent forming/damming/backing materials

2. Temporary forming materials

3. Substrate primers

4. Collars

5. Steel sleeves

D. Fill Materials: Including the following:

1. Firestop putty, caulk sealant, intumescent wrap strips, intumescent firestop collars, firestop mortars, pillows/bags, or a combination of these products to provide a UL-listed system for each application required for this Project; mineral wool backing where specified in manufacturer's application detail.

E. Mixing

1. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for opening configurations, penetrating items and other conditions affecting performance of firestopping.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean out openings immediately prior to installing through-penetration firestop system to comply with firestop system manufacturer's written instructions.

B. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

C. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

3.03 INSTALLATION

A. Comply with "System Performance Requirements" Article in Part 1

and with firestop system manufacturer's written installation instructions and drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during application as required. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

C. Avoid multiple penetrations of common fire barrier opening. Seal each penetration in accordance with manufacturer's UL installation details. When multiple penetrations are unavoidable, seal openings with appropriate UL Classified firestopping systems.

3.04 IDENTIFICATION

A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning-Through-Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address, and phone number

3. Through-penetration firestop system designation of applicable testing and inspecting agency

4. Date of installation

5. Through-penetration firestop system manufacturer's name

6. Installer's name

3.05 FIELD QUALITY CONTROL

A. Provide certification by Installer that all through-penetration firestop systems have been firestopped in accordance with applicable Building Codes of Project location.

B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with specifications.

3.06 CLEANING

A. Clean surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

-- End of Section --

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 43	(2013) Recommended Practice for Testing Insulation Resistance of Rotating Machinery
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2017; Errata 1 2017) National Electrical Safety Code
IEEE C62.33	(1982; R 2000) Standard for Test Specifications for Varistor Surge-Protective Devices

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 4	Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 70B	(2016) Recommended Practice for Electrical Equipment Maintenance
NFPA 70E	(2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace
NFPA 101	(2015; ERTA 2016) Life Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.7	Definition and Requirements for a

Nationally Recognized Testing Laboratory

Other applicable guidance documents for this Section:

1. Insulated Cable Engineers Association (ICEA).

2. National Institute for Certification in Engineering Technologies (NICET).

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Testing Firm Qualifications; G

SD-05 Design Data

Inspections And Testing Procedures; G

Energization Plan; G

SD-06 Test Reports

Test Or Inspection Reports And Certificates; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

SD-11 Closeout Submittals

Programmable Settings; G, AE

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.

2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.

3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.

4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.

5. Technicians certified by NICET or NETA.

6. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.

7. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.

8. In compliance with OSHA 29 CFR 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment shall be:

1. Scheduled with Government prior to de-energization.

2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Government at least 48 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS

2.01 PRODUCT INFORMATION

Contractor will supply the following information on products and service to be performed under this Section.

A. Inspections and Testing Procedures: Submit the following 30 days prior to performing inspections or tests.

1. Schedule for performing inspection and tests.

2. List of references to be used for each test.

3. Sample copy of equipment and materials inspection form(s).

4. Sample copy of individual device test form.

5. Sample copy of individual system test form.

B. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:

1. Government's representative sign-off form for complete and

accurate arc flash labeling and proper protective device settings for equipment to be energized.

2. Staged sequence of initial energization of electrical equipment.

3. Lock-Out-Tag-Out plan for each stage of the progressive energization.

4. Barricading, signage, and communication plan notifying personnel of newly energized equipment.

C. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:

D. Operation and Maintenance Data:

1. In accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA.

2. After test or inspection reports and certificates have been reviewed by Government and returned, insert a copy of each in Operation and Maintenance Manual.

E. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:

1. Protective relays.

2. Intelligent overload relays.

3. Variable frequency drives.

4. Power metering devices.

5. Uninterruptible power supplies.

6. Electrical communications modules.

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.

2. Installation operates properly.

3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents

and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate circuit breakers power monitoring meters, and other applicable devices in accordance with values established by short circuit, coordination study as specified in Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH HAZARD.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

H. Realign equipment not properly aligned and correct unevenness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Government of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.

2. Vacuum and wipe clean enclosure interior.

3. Remove corrosion found on metal surfaces.

4. Repair or replace, as determined by Government, door and panel sections having dented surfaces.

5. Repair or replace, as determined by Government, poor fitting doors and panel sections.

6. Repair or replace improperly operating latching, locking, or interlocking devices.

7. Replace missing or damaged hardware.

8. Finish:

a. Provide matching paint and touch up scratches and marks.

b. If required because of extensive damage, as determined by Government, refinish entire assembly.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of Utility Company supply system to Project when installation is essentially complete and is in operation.

2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.

3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.

a. Submit Voltage Field Test Report within 5 days of test.

4. Unbalance Corrections:

a. Make written request to Utility Company to correct condition
if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.

b. Obtain written certification from responsible Utility Company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.

2. Make line current check after Utility Company has made final adjustments to supply voltage magnitude or balance.

3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.

2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.

3. Check panelboard mounting, area clearances, and alignment and fit of components.

4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

b. Each phase of each bus section.

c. Phase-to-phase and phase-to-ground for 1 minute.

d. With breakers open.

e. With breakers closed.

f. Control wiring except that connected to solid state components.

g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Ground continuity test ground bus to system ground.

3.04 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.

2. Proper winding connections.

3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.

5. Proper operation of fans, indicators, and auxiliary devices.

6. Removal of shipping brackets, fixtures, or bracing.

7. Free and properly installed resilient mounts.

8. Cleanliness and improper blockage of ventilation passages.

9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.

10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:

1) Winding-to-winding.

2) Winding-to-ground.

b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

c. Results temperature corrected in accordance with NETA ATS, Table 100.14.

d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

e. Insulation resistance test results to compare within 1 percent of adjacent windings.

2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.05 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 6 and larger for:

a. Physical damage.

b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specification.

e. Proper circuit identification.

2. Mechanical Connections For:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.

3. Shielded Instrumentation Cables For:

a. Proper shield grounding.

b. Proper terminations.

c. Proper circuit identification.

4. Control Cables For:

a. Proper termination.

b. Proper circuit identification.

5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:

a. Use 1,000 volt dc megohmmeter for 600 volt insulated conductors and 500 volt dc megohmmeter for 300 volt insulated conductors.

b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.

c. Evaluate ohmic values by comparison with conductors of same length and type.

d. Investigate values less than 50 megohms.

2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.06 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.

2. Proper operation of switch operating handle.

3. Adequate mechanical support for each fuse.

4. Proper contact-to-contact tightness between fuse clip and fuse.

5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.

6. Proper phase barrier material and installation.

7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.

8. Perform mechanical operational test and verify mechanical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each switch blade and fuse holder.

b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.

2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.

4. Cracked casings.

5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.

6. Operate breaker to verify smooth operation.

7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.

8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:

a. Use 1,000 volt dc megohmmeter for 480 volt and 600 volt circuit breakers and 500 volt dc megohmmeter for 240 volt circuit breakers.

b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

d. Test values to comply with NETA ATS, Table 100.1.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each pole.

b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:

a. Long-time minimum pickup and delay.

b. Short-time pickup and delay.

c. Ground fault pickup and delay.

d. Instantaneous pickup by run-up or pulse method.

e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

f. Trip times shall be within limits established by NEMA AB 4, Table 5 3. Alternatively, use NETA ATS, Table 100.7.

g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5 4. Alternatively, use NETA ATS, Table 100.8.

3.08 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:

a. Cracked insulation.

b. Broken leads or defective wiring.

c. Proper connections.

d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically:

a. Grounding and shorting connections have good contact.

b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

B. Electrical Tests:

1. Current Transformer Tests:

    a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.

    b. Polarity test.

2. Potential Transformer Tests:

    a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:

        1) Winding-to-winding.

        2) Winding-to-ground.

    b. Polarity test to verify polarity marks or H1 X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.09 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.

2. Verify meter multipliers.

3. Verify meter types and scales conform to Contract Documents.

4. Check calibration of meters at cardinal points.

5. Check calibration of electrical transducers.

3.10 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center and panelboard assemblies for proper connection and tightness.

2. Ground bus connections in motor control center and panelboard assemblies for proper termination and tightness.

3. Effective transformer core and equipment grounding.

4. Accessible connections to grounding electrodes for proper fit and tightness.

5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:

a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.

b. Main ground electrode system resistance to ground to be no greater than 5 ohm(s).

2. Two-Point Direct Method Test:

a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground

system, equipment frames, and system neutral and derived neutral points.

b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3. Neutral Bus Isolation:

a. Test each neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.

b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.

c. Investigate values less than 50 megohms.

3.11 GROUND FAULT SYSTEMS

A. Inspection and testing limited to:

1. Zero sequence grounding systems.

2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure:

a. Zero sequence sensing system is grounded ahead of neutral disconnect link.

b. Ground strap sensing system is grounded through sensing device.

c. Neutral ground conductor is solidly grounded.

2. Verify control power has adequate capacity for system.

3. Manually operate monitor panels for:

a. Trip test.

b. No trip test.

c. No automatic rest.

4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.

5. Relay check for pickup and time under simulated ground fault conditions.

6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed; minimum 1 megohm.

2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.

3. Test relay timing by injecting 300 percent of pick-up current or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.

4. Test system operation at 55 percent rated control voltage, if applicable.

5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.12 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1 horsepower and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.

2. Shaft alignment.

3. Blockage of ventilating air passageways.

4. Operate motor and check for:

a. Excessive mechanical and electrical noise.

b. Overheating.

c. Correct rotation.

d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.

e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.

5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:

    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:

        1) Motors 200 horsepower and less for 1 minute duration with resistances tabulated at 30 seconds and 60 seconds.

    b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.

2. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.13 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.

2. Proper operation of indicating and monitoring devices.

3. Proper overload protection for each motor.

4. Improper blockage of air-cooling passages.

5. Proper operation of draw out elements.

6. Integrity and contamination of bus insulation system.

7. Check door and device interlocking system by:

    a. Closure attempt of device when door is in OFF or OPEN position.
    b. Opening attempt of door when device is in ON or CLOSED position.

8. Check nameplates for proper identification of:

    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbuttons.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
    g. Indicating meters.

9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.

10. Verify current transformer ratios conform to Contract Documents.

11. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints thermographic survey.

12. Ohmic value to be zero.

    a. Bolt torque level in accordance with NETA ATS Table 100.12, unless otherwise specified by manufacturer.

    b. Thermographic survey temperature gradient of 2 degrees C, or less per NETA ATS, Table 100.18.

13. Check operation and sequencing of electrical and mechanical interlock systems by:

    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.

14. Verify performance of each control device and feature furnished as part of motor control center.

15. Control Wiring:

    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.

16. Exercise active components.

17. Inspect contactors for:

    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.

18. Compare overload heater rating with full-load current for proper size.

19. Compare motor protector and circuit breaker with motor characteristics for proper size.

20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:

    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.

    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.

    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices

open.
e. Test values to comply with NETA ATS, Table 100.1.

2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:

a. Trip time in accordance with manufacturer's published data.
b. Investigate values in excess of 120 seconds.

3. Control Wiring Tests:

a. Apply secondary voltage to control power and potential circuits.

b. Check voltage levels at each point on terminal board and each device terminal.

c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.

4. Operational test by initiating control devices to affect proper operation.

3.14 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.

2. Ground connections to ground bus.

B. Electrical Tests:

1. Varistor Type Arrestors:

a. Clamping voltage test.
b. Rated RMS voltage test.
c. Rated dc voltage test.
d. Varistor arrestor test values in accordance with IEEE C62.33, Section 4.4 and Section 4.9.

3.15 THERMOGRAPHIC SURVEY

A. Provide thermographic survey per NETA ATS Table 100.18 of connections associated with incoming service conductors, bus work, and branch feeder conductors No. 2 and larger at each:

1. Low voltage motor control center.

2. Panelboard.

B. Provide thermographic survey of feeder conductors No. 4 and larger terminating at:

1. Motors rated 15 hp and larger.

2. Low voltage disconnect switches.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading per NFPA 70B, Section 20.17.

E. Do not perform survey on equipment operating at less than 40 percent of rated load. If plant load is insufficient, perform test with supplemental load bank producing rated load on item being measured.

F. Utilize thermographic equipment capable of:

1. Detecting emitted radiation.

2. Converting detected radiation to visual signal.

3. Detecting 1 degree C temperature difference between subject area and reference point of 30 degrees C.

G. Temperature Gradients:

1. 3 degrees C to 7 degrees C indicates possible deficiency that warrants investigation.

2. 7 degrees C to 15 degrees C indicates deficiency that is to be corrected as time permits.

3. 16 degrees C and above indicates deficiency that is to be corrected immediately.

H. Provide written report of:

1. Areas surveyed and the resultant temperature gradients.

2. Locations of areas having temperature gradients of 3 degrees C or greater.

3. Cause of heat rise and actions taken to correct cause of heat rise.

4. Detected phase unbalance.

-- End of Section --

SECTION 26 09 35

TELEPHONE AUTOMATIC DIALER SYSTEM
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. This Section includes telephone automatic dialer system. The system shall be comprised of equipment as specified and it shall operate over voice-grade, dial-up telephone circuits furnished by the Contractor and invoiced to the Owner.

B. Related Section may include but are not limited to the following:

1. Division 26 Electrical

2. Division 27 Communications

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's Technical Data And Application Instructions; G

SD-10 Operation and Maintenance Data

Maintenance Data; G

1.04 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

1.05 COORDINATION

A. Coordinate equipment interface with SCADA system.

B. Unit shall be capable of being upgraded over a phone line to include Modbus RTU protocol support such that it can communicate with SCADA software packages over a phone line, cell phone, radio modem or direct RS-232/RS-485 connection.

PART 2 PRODUCTS

2.01 PRODUCT INFORMATION

A. Product Data: Submit manufacturer's technical data and application instructions.

B. Maintenance Data: For materials and products, include in maintenance manuals specified in Division 01.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Raco Manufacturing.
2. Antx, Inc.
3. Siemens.
4. Honeywell.
5. Or approved equal.

2.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Electronic monitoring system shall interface Groundwater Extraction and Treatment Plant alarms to public telephone system, or cellular phone network.

2. Upon receipt of one or more critical alarm trips, electronic system will automatically dial out onto phone system with preprogrammed messages.

3. System shall continue calling until call completed and acknowledged.

B. Description and Telephone Number Dialing

1. The dialer shall be a solid-state component capable of dialing one to at minimum eight phone numbers, each up to 16 digits in length.

2. Phone numbers shall be user programmable via the system's keypad, locally or remotely connected PC or laptop or Touch Tone Phone.

C. Solid State Voice Message Recording and Playback:

1. The unit shall have two different categories of speech message capability. It shall allow for message recording from a remote telephone as well as from the front panel.

2. User Field Recorded Messages: The user may record and re-record their own voice messages, for each input channel and for the Station ID.

3. Permanent built-in messages shall be included to support user programming operation, to provide supplemental warning messages such as advising that the alarms have been disabled,

and to allow the unit to be fully functional even when the installer has not recorded any messages of their own.

D. Non-Volatile Program Memory Retention

1. User-entered programming shall be kept intact even when all power is removed for up to ten years.

E. Acknowledgment:

1. Acknowledgement of an alarm phone call is to be accomplished by pressing a Touch Tone "9" as the alarm call is being received, locally at the keypad, and/or by returning a phone call after receiving an alarm call.

F. Input Monitoring Function:

1. The unit shall continuously monitor the presence of AC power and the status of contact closure inputs. AC power failure, or any input violation of normal condition shall cause the unit to go into alarm status and begin the dial-out sequence.

G. Alarm Message:

1. Upon initiating an alarm phone call; the system is to "speak" only those channels that are currently in "alarm status."

H. Diagnostics:

1. The unit shall provide a complete verbal report of all programmable functions and their programmed values on command from any remote Touch Tone phone.

2. Each unit shall allow connection via remote PC over a modem connection.

I. Inquiry Message and Function

1. User shall be able to view the current status of the remote unit through the Internet, request an immediate update of the status and set pre-defined times that the status should automatically be transferred and store on the Internet.

J. Power Battery Back-Up

1. Unit shall be provided with a rechargeable battery capable of keeping the product operating, and user programming intact, for a minimum of six continuous hours in the event of power failure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install devices and assemblies in accordance with manufacturer's written instructions and approved submittals.

3.02 CONNECTIONS

A. Wire each device, program test and utility unit to be suitable for operation.

3.03 FIELD QUALITY CONTROL

A. Test device for proper operation.

-- End of Section --

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.91	(2011) Standard Test Code for Dry-Type Distribution and Power Transformers

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1561	(2011; Reprint Jun 2015) Dry-Type General Purpose and Power Transformers

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less:

1. Distribution transformers.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Data For Testing Agency; G

SD-02 Shop Drawings

Wiring Diagrams; G, AE

Equipment Assemblies; G, AE

SD-03 Product Data

Nameplate Data, Capacities, Weights, Dimensions, Minimum Clearances, Installed Devices And Features, And Performance For Each Type And Size Of Transformer; G

SD-06 Test Reports

Source Quality-Control Test Reports; G

Field Quality-Control Test Reports; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.07 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data for testing agency.

D. Source quality-control test reports

E. Field quality-control test reports

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

2.02 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Products.

2. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.

3. General Electric Company.

4. Siemens Energy & Automation, Inc.

5. Square D; Schneider Electric.

6. Or approved equal.

2.03 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.04 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2 for interior installations and NEMA 250, Type 4X for exterior installations.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: ANSI 61 Gray.

E. Taps for Transformers Smaller Than 3 KVA: None.

F. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

2. Include special terminal for grounding the shield.

3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.

c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

G. Wall Brackets: Manufacturer's standard brackets.

H. Fungus Proofing: Permanent fungicidal treatment for coil and core.

I. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

J. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91.

2.05 IDENTIFICATION DEVICES

B. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section 26 05 53"ELECTRICAL SYSTEMS IDENTIFICATION."

2.06 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure and ambient temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.02 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."

3.03 CONNECTIONS

A. Ground equipment according to Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

B. Connect wiring according to Division 26 Section 26 05 05 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES".

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

-- End of Section --

SECTION 26 24 16

PANELBOARDS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction
NECA 407	(2015) Standard for Installing and Maintaining Panelboards

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB1.1	(2013) General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 V or Less
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PB 1	(2011) Panelboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 70E	(2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. Section Includes:

1. Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards.

1.04 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS or SPD: Transient voltage surge suppressor or Surge Suppression Device

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Each Panelboard And Related Equipment; G, AE

SD-03 Product Data

Each Type Of Panelboard, Switching And Overcurrent Protective Device, Accessory, And Component; G, AE

Panelboard Schedules; G, AE

SD-06 Test Reports

Field Quality-Control Reports; G

SD-07 Certificates

Compliance With Test Parameters

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

SD-11 Closeout Submittals

Maintenance Materials; G

Warranty; G

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and

marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.08 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contracting Officer no fewer than two days in advance of proposed interruption of electric service.

2. Do not proceed with interruption of electric service without Contracting Officer's written permission.

3. Comply with NFPA 70E.

1.09 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by

them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace all equipment devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for each type of panelboard, switching and overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings for each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

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

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Submittals

1. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section 01 78 23 "OPERATION AND MAINTENANCE DATA," include the following:

a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

b. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

F. Maintenance Materials Submittals

1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

a. Keys: Two spares for each type of panelboard cabinet lock.

b. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

2.02 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Groundwater Treatment Structure Locations: NEMA 250, Type 4X.
b. Indoor Dry and Clean Locations: NEMA 250, Type 1
c. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
d. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
e. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
f. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 3R.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

6. Finishes:

   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Same finish as panels and trim.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Mechanical type.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Spare Capacity: Provide a minimum of 25 percent spare electrical capacity per panel.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.03 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

5. Or approved equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: As indicated on drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - lectrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: As indicated on the drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturer of the panelboard furnished.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic

trip; and the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time time adjustments.
d. Ground-fault pickup level, time delay, and I2t response.

4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

PART 3 EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install panelboards and accessories according to ANSI/NEMA PB1.1.

B. Mount top of trim 90 inches above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

G. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Government's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated on the drawings.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

-- End of Section --

SECTION 26 24 17

ROLL-UP GENERATOR TERMINATION CABINET
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D2240	(2015) Standard Test Method for Rubber Property - Durometer Hardness

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1773	(2011) Standard for Termination Boxes
UL 1691	(2012) Single Pole Locking-Type Separable Connectors
UL 498	(2017) UL Standard for Safety Attachment Plugs and Receptacles
UL 94	(2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes Roll-Up Generator Termination Cabinets

(RUGTC) for use with AC circuits rated 600 V and less and having termination/lug landings for phase, neutral, and ground conductors for transitioning between portable generator and the building.

B. Related Sections include the following:

1. Division 26 Section 26 05 04"BASIC ELECTRICAL MATERIALS AND METHODS"

2. Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION"

1.04 DEFINITIONS

A. RUGTC: Roll Up Generator Termination Cabinet.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Data For Manufacturer And Testing Agency; G

SD-02 Shop Drawings

Fabrication And Installation Details Of RUGTC; G, AE

SD-03 Product Data; G

Rated Capacities, Weights, Operating Characteristics, Furnished Specialties, And Accessories; G

SD-06 Test Reports; G

Field Quality-Control Reports.; G

Certified Copies Of Factory Test Reports; G

SD-07 Certificates; G

Seismic Qualification Certificates; G

SD-11 Closeout Submittals

Operation And Maintenance Manuals; G

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL, and marked for intended location and application.

B. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to RUGTC. Unpack and dry wet materials before storage.

B. Protect RUGTC from scratching and marring of finish.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for each type of product.

1. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings

1. Show fabrication and installation details of RUGTC, including dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists.

C. Qualification Data for manufacturer and testing agency.

D. Seismic Qualification Certificates: For accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control reports.

F. Operation and Maintenance Data: include operation and maintenance manuals.

2.02 MANUFACTURERS

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

1. Trystar.
2. Square D Co.
3. Powertron.
4. Eaton Corp. Electrical Group.

5. Berthold Electric Company.
6. Or approved equal.

B. General Requirements: UL 1773 listed, marked "Suitable for use on line side of service equipment".

2.03 FUNCTIONAL FEATURES

A. Description: An arrangement of buswork mounted on insulators in a weatherproof, permanently mounted cabinet with terminations for the temporary connection of a portable generator or on the line side and permanent connections on the load side to the electrical distribution of the building.

2.04 LINE (TEMPORARY) TERMINATIONS

A. The RUGTC shall be provided with both mechanical lugs and cam-type receptacle assembly for connection of generator power phases (A, B, C), neutral and grounding conductors. All connections for phases, neutral, ground, etc., shall be clearly marked via labeling.

B. Each single pole cam-type receptacle shall be rated for no less than 200 amps at 90 deg C. Contact material of the receptacle shall be composed of brass.

C. Cam-lock connector shall be UL 498 and UL 1691 listed for attachment plugs and receptacles. Connectors must be suitable for use in outdoor environments. Cam-lock connectors shall be rated for 600 volts, 400 amperes, 60 hertz, single pole, continuous duty operation. Connector shall be male type in-line connectors and shall be designed for terminating on 500 kcmil cables with a crimp-type connection. The connectors shall lock together so that they cannot twist or turn loose unless release mechanism is engaged. The insulated sleeve shall be mechanically secured to the connector contacts to give a minimum of 700 pounds shear force Connectors shall be positive latching ball nose connectors. Insulation and protective caps shall be ethylene propylene thermoplastic rubber (EPTR) colored black phase A, white phase B, and red phase C, conforming to the following:

1. Constant Service Temperature Range: minus 81 degrees F to 275 degrees F

2. Flammability: UL 94 HB Rated

3. Electrical: UL Relative Thermal Index (RTI): 212 degrees F minimum

4. Durometer Hardness: ASTM D2240, 55 - 65A

D. Incoming Mains Access Location: Front.

E. Main Lugs, Incoming: Conductor connectors suitable for use with conductor material and sizes.

1. Main and Neutral Lugs: Mechanical set screw type, CU only.

2.05 LOAD (PERMANENT) TERMINATIONS

A. Outgoing Mains Access Location: Bottom.

B. Main Lugs, outgoing: Conductor connectors suitable for use with conductor material and sizes.

1. Main and Neutral Lugs: Two-hole, long barrel compression type, CU only.

2.06 ENCLOSURES

A. Enclosures: Free-standing stainless steel cabinet, NEMA 250, NEMA 3R to comply with environmental conditions at installed location. Enclosure shall maintain NEMA 3R rating with temporary generator cables installed.

B. Compartments: Access to the wiring compartment is through a full front, sturdy, continuous hinged door with padlock provisions.

C. Wiring Spaces:

1. Access to the line side terminations is through a hinged door in the front of the enclosure. Front door must be opened. Access panel shall have up to ten 3 inch bushed openings with safety caps.

2. The load side access is through a fixed bottom plate for terminating outgoing conduits.

2.07 CHARACTERISTICS AND RATINGS

A. Nominal System Voltage: 480/277 V, three phase, four wire.

B. Assembly Short-Circuit Current Rating: minimum 42,000 kA.

C. Continuous Rating: 200 A.

D. Phase and Neutral Buses: Uniform capacity for entire usable length.

E. Phase and Neutral Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, 1000A/sq.in. current density mounted on insulators.

F. Neutral Buses: 100 percent of the ampacity of phase buses, equipped with compression connectors for outgoing circuit neutral cables and mechanical connectors for incoming circuit neutral cables.

G. Ground Bus: Hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for equipment grounding conductors.

H. Front-Connected, Front-Accessible.

2.08 SOURCE QUALITY

A. Testing: Inspect and test according to requirements in NEMA standard.

B. RUGTC will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, submit to Contracting Officer.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. The RUGTC shall be completely assembled, wired, adjusted, and tested at the factory. After assembly, the complete RUGTC will be tested for operation under simulated service conditions to ensure the accuracy of the wiring and the functioning of all equipment.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 INSTALLATION

A. Install RUGTC on building wall or concrete base. Comply with requirements for concrete base specified in Division 03 Sections.

1. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges shall be chamfered.

2. For supported equipment, install epoxy-coated anchor bolts that anchor into structural concrete pad.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Provide minimum two concrete filled bollards, painted yellow for protection from vehicular traffic.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION" for identification of components and wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label with engraved nameplate.

3. Label with instructional sign.

3.04 WIRING INSTALLATION

A. Install wiring between terminal busses and switchgear. Comply with requirements in Division 26 Section 26 05 05 "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES".

B. Bundle, train, and support wiring in enclosures.

3.05 CONNECTIONS

A. Comply with requirements for installation of conduit in Division 26 Section 26 05 33.10 "RACEWAYS" and Section 26 05 33.20 "BOXES, ENCLOSURES, AND CABINETS". Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

C. Verify tightness and torque all accessible bolted electrical connections to manufacturer's specified values using a calibrated torque wrench.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Inspect wiring, components, connections, and equipment installation.

2. Test insulation resistance for each connecting supply circuit.

3. Test continuity of each circuit.

4. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

-- End of Section --

SECTION 26 24 19

LOW-VOLTAGE MOTOR CONTROL
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2017; Errata 1 2017) National Electrical Safety Code

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 402	Standard for Installing and Maintaining Motor Control Centers.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 2.3	(1995; R 2002; R 2008) Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600 V
NEMA ICS 18	(2001; R 2007)Motor Control Centers

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 845	(2005; Reprint Jul 2011) Motor Control Centers

1.02 DEFINITIONS

A. CT: Current Transformer.

B. LCD: Liquid Crystal Display.

C. MCC: Motor Control Center.

D. N.C.: Normally Closed.

E. N.O.: Normally Open.

F. THD: Total Harmonic Distortion.

G. VT: Voltage Transformer.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Interconnection Diagrams; G, AE

Outline Diagrams; G

Schematic (Elementary) Diagrams; G

One-Line Diagrams; G, AE

Control Diagrams; G

Conduit Entrance Locations; G, AE

Front MCC Elevations; G

Dimensional Drawings; G, AE

SD-03 Product Data

Typed Tabulation Of Equipment Data; G

Descriptive Information; G

Itemized Bill Of Material; G

Bus Data; G, AE

Protective Devices; G, AE

SD-06 Test Reports

Factory Inspection And Test Checklists; G

Factory Test Reports, Certified; G

SD-08 Manufacturer's Instructions

Anchoring Instructions And Details; G

Manufacturer's Installation Instructions; G

SD-10 Operation and Maintenance Data

Operational Description; G

Operation And Maintenance Data; G

1.04 QUALITY ASSURANCE

A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.01 PRODUCT INFORMATION

Contractor will supply the following information on specified products and materials:

1. Descriptive information.

2. Itemized Bill of Material.

3. Dimensional drawings.

4. Front MCC Elevations.

5. Conduit entrance locations.

6. Bus data.
7. Protective Devices: Copies of time-current characteristics.

8. Operational description.

9. Anchoring instructions and details.

10. Typed Tabulation of Equipment Data:

a. Motor name; tag (equipment) numbers as shown on Drawings.
b. Motor horsepower.
c. Nameplate full load current.
d. Measured load current and voltage.
e. Heater model number and relay setting.
f. Protective device trip settings.
g. Manufacturer's solid state starter switch or dip switch or program settings.

h. Attach above typed, tabulated data to a copy of starter manufacturer's solid state overload setting selection tables for starters provided.

11. Control diagrams.

12. One-line diagrams.

13. Schematic (elementary) diagrams.

14. Outline diagrams.

15. Interconnection diagrams.

16. Manufacturer's installation instructions.

17. Factory test reports, certified.

18. Operation and Maintenance Data as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

2.02 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton Electrical/Cutler-Hammer.
2. GE Industrial Systems.
3. Schneider Electric/Square D Services.
4. Allen-Bradley.
5. Or approved equal.

2.03 GENERAL

A. Like Items of Equipment: End product of one manufacturer and same manufacturer as low voltage panelboards for standardization.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120 volt secondary, primary voltage to suit.

2. Two current-limiting fuses for primary circuit.

3. One fuse in secondary circuit.

4. Mount within starter unit.

E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Lifting lugs on equipment and devices weighing over 100 pounds.

G. Anchor Bolts: Galvanized, sized seismically by a licensed

structural engineer registered in the State where equipment is to reside, 1/2 inch minimum diameter, and as specified in Section 05 50 13, METAL FABRICATIONS.

H. Seismic Zone and Importance Factor shall be as specified in Section 01 61 00, COMMON PRODUCT REQUIREMENTS.

I. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.

2. Altitude: 3,000 feet above sea level.

3. Equipment to be fully rated.

J. Enclosures: In accordance with NEMA 250.

K. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.

2. Exterior Color: Manufacturer's standard.

2.04 SEPARATELY MOUNTED MOTOR CONTROL

A. Manually Operated Starter, Fractional Horsepower:

1. Rating: 16 amperes continuous at 277 volts maximum.

2. Single-phase, nonreversing, full voltage with overload protection.

3. Toggle operated.

4. Enclosure: NEMA 250, Type 13.

5. Neon Light: Red.

6. Handle guard/lock-off plate.

2.05 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.

2. Voltage Rating: 480 volts.

3. Short Circuit Rating: 42,000 amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly.

4. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.

5. NEMA ICS 18, Part 3.

a. Class: I.

b. Type: B.

B. Enclosure:

1. Type: NEMA 250 Type 1, indoor gasketed.

2. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:

a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.

b. Alternative width dimensions of 24 inches and 30 inches are acceptable for oversize devices or panels.

3. Construction:

a. Sheet steel reinforced with channel or angle irons.

b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.

c. Removable top cover plates and bottom cover plates.

d. Removable plates on end panels for future bus extension.

4. Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.

5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.

6. Vertical Wiring Compartment:

a. Full height, isolated from unit starters with separate hinged door and tie supports.

b. No terminal blocks allowed in vertical wireway compartment.

7. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.

8. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.

9. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access and energizing at any time by qualified individual.

10. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.

11. Cable Entrance: Main leads enter from control and feeder circuits enter from top and bottom.

12. Horizontal Power Bus:

a. Three-phase tin-plated, copper, entire width of control center, rated as shown.

b. Construct to allow future extension of additional sections.

c. Pressure type solderless lugs for each incoming line cable.

d. Isolated from top horizontal wireway.

e. Provide Belleville washers on bus connection bolts.

13. Vertical Power Bus:

a. Three-phase tin-plated, copper, full height of section, rated 300 amperes.

b. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.

c. Insulated and isolated barrier, complete with shutters.

d. Provide Belleville washers on bus connection bolts.

14. Neutral Bus:

a. 50 percent neutral, entire width of control center.

b. Tin-plated.

c. Provide Belleville washers on bus connection bolts.

15. Ground Bus:

a. Copper, tin-plated, rated 300 amperes, entire width of control center and in each vertical wireway.

b. Provide Belleville washers on bus connection bolts.

16. Bus Bracing: 42,000 amperes rms symmetrical.

C. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, and indicating lights as specified in Section 26 05 04, BASIC ELECTRICAL MATERIALS AND METHODS.

2. Construction:

a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.

b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.

c. Readily interchangeable with starters of similar size.

d. Pull-apart unit control wiring terminal boards capable of accepting up to 2#14 AWG wires minimum on all units.

3. Starters:

a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.

b. Rating: Horsepower rated at 600 volt, UL labeled for 42,000 amperes at 480 volts short circuit capacity with overload protection.

c. Three-phase, nonreversing, unless specified otherwise.

d. Disconnect Type: Motor circuit protector.

e. Combination Full Voltage, Magnetic Starter:

1) Control: As shown on Drawings.

2) Pilot Lights: Red-ON and Green-OFF.

f. Communications: None.

g. Padlockable operating handle when de-energized with up to three-lock capability.

h. Unit door interlocked to prevent opening when disconnect is in closed position.

i. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.

j. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.

4. Disconnecting Device:

a. In each starter, control circuit disconnect to de-energize circuits in unit which are not de energized by starter power disconnect device.

b. Padlockable in OPEN position for up to three locks.

5. Circuit Breaker:

a. Meet requirements of UL 489.

b. Molded case with manufacturer's recommended trip setting for maximum motor protection.

c. Thermal-magnetic trip.

d. Tripping indicated by operating-handle position.

e. Interrupting capacity required for connection to system with short-circuit capacity indicated.

6. Solid State Motor Overload Protection:

a. Inverse-time-limit characteristic.

b. Phase loss, phase unbalance and Class II ground fault protection.

c. Current operated electronic circuitry with adjustable trip.

d. Class 10/20/30 relay trip, switch selectable.

e. One N.O. auxiliary contact for remote monitoring.

f. Manual reset.

g. Provide in each ungrounded phase.

h. Mount within starter unit.

i. Communications: Microprocessor interface capability to computer.

7. Ground Fault Protection: Where indicated and as specified in Paragraph Main Protective Device and Feeder Units, except provide instantaneous operation device.

D. Control Unit:

1. Disconnecting Device: Pull-apart terminal blocks capable of de energizing external source control circuits in unit.

2. Control Devices: As indicated and as specified in Section 26 05 04, BASIC ELECTRICAL MATERIALS AND METHODS.

3. Control Wiring:

a. Copper, 14 AWG, minimum.

b. Permanent sleeve type markers with wire numbers applied to each end of wires.

c. Terminate wires using insulated locking fork or ring type crimp terminals.

d. Terminate current transformer leads on shorting type terminal blocks.

E. Main Protective Device and Feeder Unit:

1. Construction: As specified in Paragraph Motor Controller Unit.

2. Incoming Service Feeder: Cable, as shown.

3. Solid State Trip Circuit Breaker:

a. In accordance with UL 489.

b. Main protective device.

c. UL labeled as suitable for service entrance.

d. Insulated or molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.

e. Solid-state current control with adjustable ampere setting, adjustable long-time delay, adjustable short-time trip and delay band, fixed or adjustable instantaneous trip, and adjustable ground fault trip and delay band.

f. Setting adjustments to be covered by a sealable, tamper-proof, transparent cover (insulated case breakers only) or by compartment door for other breakers.

g. Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in emergency situation.

4. Molded Case Circuit Breaker:

a. In accordance with UL 489.

b. Feeder protective device.

c. Thermal-magnetic trip and interrupting capacity required for connection to system with short circuit capacity indicated.

d. Indicate tripping by operating-handle position.

e. Suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

F. Digital Instruments:

1. Digital Monitoring Panel:

a. Microprocessor-based electronic monitoring package, complete with keypad or entry keys.

b. Alpha numeric, LED or LCD display.

c. Communications: Interface capability to PLC over Ethernet, with built-in web server.

d. Manufacturers and Products:

1) Cutler-Hammer; Central Monitoring Unit.
2) General Electric; Power Leader, Modbus monitor Electro Industries.
3) Or approved equal.

G. SPD: As specified in Section 26 43 00, TRANSIENT VOLTAGE SUPPRESSION.

H. Transformers: As specified in Section 26 22 00, LOW-VOLTAGE TRANSFORMERS.

I. Panelboards: As specified in Section 26 24 16, PANELBOARDS.

J. Nameplates:

1. Laminated plastic; white, engraved to black core.

2. Provide for each motor control center and each unit.

3. Engrave with inscription shown on single-line diagram.

4. Provide blank nameplates on spaces for future units.

5. Attach with stainless steel panhead screws on face of motor control center.

2.06 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NFPA 70, Article 430 Part VIII.

2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.

3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.

4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.

5. Control Circuits and Devices:

a. Energize circuit at rated voltage.

b. Operate control devices.

c. Perform continuity check.

6. Instruments, Meters, Protective Relays, and Equipment:

a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.

b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.

7. Perform dielectric tests on primary circuits and equipment, except potential transformers. Tests shall be made phase-to-phase and phase-to-around with 60 cycle test voltages applied for 1 second at 2,640 volts.

8. Verify equipment passed tests and inspection.

9. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.

2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.

5. Grout mounting channels into floor or mounting pads.

6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.

7. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:

a. Motor served by tag number and equipment name.

b. Nameplate horsepower.

c. Motor code letter.

d. Full load amperes.

e. Service factor.

f. Installed overload relay heater catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

2. Adjust to approximately 11 times motor rated current.

3. Determine motor rated current from motor nameplate following installation.

C. Overload Relay: Select and install overload switch settings after actual nameplate full-load current rating of motor has been determined.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 43 33, MANUFACTURERS' FIELD SERVICES, for the following services at jobsite or classroom as designated by Government, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance, and inspection of installation.

2. 1/2 person-day for functional and performance testing.

3. 1/2 person-day for plant startup.

4. 1/2 person-day for training of Government's personnel.

-- End of Section --

SECTION 26 27 13

ELECTRICITY METERING
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61000-4-30	(2015; ED 3.0; 2016 COR 1)Electromagnetic Compatibility (EMC) - Part 4-30: Testing and Measurement Techniques - Power Quality Measurement Methods
IEC 62053-22	(2003; ED 1.0) Electricity Metering Equipment (a.c.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S)
IEC 62053-23	(2003; ED 1.0) Electricity Metering Equipment (a.c.) - Particular Requirements - Part 23: Static Meters for Reactive Energy (Classes 2 and 3)

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction
NECA 400	(2007) Standard for Installing and Maintaining Switchboards

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.20	(2015) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

PL 109-58	Energy Policy Act of 2005 (EPAct05)

UNDERWRITERS LABORATORIES (UL)

UL 1244	(2000; Rev 4) Standard for Safety Electrical and Electronic Measuring and Testing Equipment

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes equipment for utility company's electricity metering and electricity metering by Owner.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electricity-Metering Equipment; G, AE

SD-03 Product Data

Electricity-Metering Equipment; G, AE

SD-06 Test Reports

Field Quality-Control Test Reports; G, AE

SD-07 Certificates

Manufacturer Seismic Qualification Certification For Electricity-Metering Equipment

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center as specified in NECA 400.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Contracting Officer no fewer than thirty days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contracting Officer's written permission.

1.08 COORDINATION

A. General Requirements for Electricity Metering by owner:

1. Comply with UL 1244.

2. Comply with PL 109-58 Energy Policy Act (EPACT) of 2005.

3. Meters used for billing shall have an accuracy of 1.0 percent of reading, complying with requirements in ANSI C12.20.

4. Enclosure: NEMA 250, Type 1 minimum.

5. Identification: Comply with requirements in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION."

6. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

7. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

B. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power and communication services.

2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for Electricity-metering equipment: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Describe electrical characteristics, features, and operating sequences, both automatic and manual. Include the following:

B. Shop Drawings for Electricity-Metering Equipment :

1. Dimensioned plans and sections or elevation layouts.

2. Wiring Diagrams: Power, signal, and control wiring specific to this Project. Identify terminals and wiring designations and color codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

3. Mounting and anchoring devices recommended by manufacturer to resist seismic forces specified in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."

C. Manufacturer Seismic Qualification Certification for Electricity-Metering Equipment: Submit certification that equipment components and their mounting and anchorage provisions have been designed to remain in place without separation of any parts or loosening of factory-made connections when subjected to the seismic forces defined in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS." Include the following:

1. Basis for Certification: Indicate whether certification is based on actual test of assembled components or on calculations.

2. Detailed description of equipment mounting and anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For electricity-metering equipment to include in emergency, operation, and maintenance manuals.

2.02 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

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. Square D; Schneider Electric.Eaton Electrical Inc.
2. Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Siemens Energy & Automation, Inc.
5. Or approved equal.

B. Current-Transformer Cabinets: Comply with requirements of

electrical power utility company.

C. Meter Sockets: Comply with requirements of electrical power utility company.

D. Kilowatt-Hour/Demand Meters: Electronic three-phase meters, measuring electricity use and demand.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: Digital liquid crystal, indicating accumulative kilowatt hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand.

3. Demand Signal Communication Interface: Match signal to remote building automation system input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

4. Programmable Contact Module: Unit shall have push-button switches and a display for setting the demand level at which an integral set of Form C contacts shall be operated to initiate indicated action.

5. Enclosure: NEMA 250, Type 1, with hasp for padlocking or sealing.

6. Identification: Comply with Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

7. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

8. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

Type: Split core.

9. Meter Accuracy: Nationally recognized testing laboratory certified to comply with ANSI C12.1.

2.03 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

A. Kilowatt-Hour/Demand Meters Electronic three-phase meters, measuring electricity use and demand.

B. 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. Square D; Schneider Electric.Eaton Electrical Inc.
2. Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

4. Siemens Energy & Automation, Inc.
5. Or approved equal.

C. GENERAL PROVISIONS

1. All setup parameters required by the meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.

2. The Meters may be applied in 4-wire wye, 3-wire wye, 3-wire delta, direct delta and single phase systems.

3. The Meters shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400Hz.

4. Identification: Comply with Division 26 Section "ELECTRICAL SYSTEMS IDENTIFICATION."

5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for ratings of circuits indicated for this application.

   a. Type: Split core.

D. COMPONENTS

1. Current/Voltage Inputs

   a. The Meter shall have no less than 4 voltage inputs and 3 current inputs.

   b. The Meter in its standard configuration shall be able to accept 600VLL/347LN without using potential transformers.

   c. The Meter shall be able to withstand 900 VAC RMS continuously without damage.

   d. The Meter shall have nominal current ratings of 5A ac with a current range or 0-10A ac

   e. The Power Meter shall be able to withstand 15A continuous, 50A for 10s/hour and 500A 1s/hour.

2. Measured Values

   a. The Meter shall provide the following, true RMS metered quantities for voltage:

      a) Voltage L-L Per-Phase

      b) Voltage L-L 3-Phase Avg

      c) Voltage L-N Per-Phase

      d) Voltage L-L Min/Max

e) Voltage L-N Min/Max

b. The Meter shall provide the following true RMS metered quantities for current:

a) Current Per-Phase

b) Current, Neutral (calculated)

c) Current 3-Phase Avg

d) Current Min/Max

3. Demand

The Meter shall be able to provide min/max demand, present demand interval, running average demand and predicted demand on multiple demand channels including current demand, power demand and user-defined generic demand channels, which also include demand calculations based on input pulses.

4. Accuracy

a. The Meter shall meet ANSI C12.20 0.5

b. The Meter shall meet IEC 62053-22 class 0.5S (real energy)

c. The Meter shall meet IEC 62053-23 class 2 (reactive energy)

5. Sampling

a. The Meter shall perform zero-blind metering and sample at a minimum of 128 samples per cycle, simultaneously on all voltage and current channels in the meter.

b. The Meter shall provide 1-second updates in registers and on the display.

c. The Meter shall digitally sample at a rate high enough to provide true RMS accuracy to the 31st (9340) harmonic for current and voltage.

6. Logging

a. The Meter shall provide for onboard data logging. The Power Meter shall be able to log data, alarms, events and waveform captures.

1) The Meter shall support 80kb of logging information.

2) The Meter shall support 1 customizable data log capable of capturing up to 96 user-defined or preset quantities based on an alarm event or a time interval.

3) The Meter shall support an alarm log which records date/time stamps and alarm values.

4) The Meter shall support a billing log which records quantities at a user-defined interval.

5) The Meter shall support a Maintenance log which records quantities at a user-defined interval.

6) Basic logging shall will be factory set and will startup when power is applied

7. Alarming

a. The Meter shall have set point driven alarming capability.

b. The Meter shall be able to generate an email on an alarm condition.

c. The Meter shall support over 50 definable alarm conditions based on pick-up, drop-out and delay variables.

d. The Meter shall be able to trigger data log captures on an alarm condition.

e. The Meter shall be able to open or close relays on an alarm condition possibly to perform load-shedding.

f. The Meter shall be able to combine any logical combination of any number of available set point conditions to control any internal or external function or event.

g. The Meter shall have four alarm severity levels for any value.

h. Indication of an alarm condition shall be given on the front display of the meter.

8. Communications

a. The Meter shall be capable of the following communications methods:

a) Wireless Communications

b) Ethernet Communications

9. I/O Options

a. The Meter shall provide as standard 1 digital input and 1 digital solid state output / KY pulse output.

b. The Meter shall be capable of supporting 13 digital inputs.

c. The Meter shall be capable of supporting 5 relay outputs which can be configured for pulse output relay operation for kWh total, kVARh total, kVAh, kWh imported, kVARh imported, kWh exported, kVARh exported.

d. The Meter shall be capable of supporting 2 energy pulse outputs simultaneously.

e. The Meter shall have relay outputs that can be able to be configured for latched mode or timed mode.

10. Display

    a. The Meter shall have a 6-line back lit LCD display which provides 4 simultaneous quantities on-screen.

    b. The Meter shall be capable of having an anti-glare backlit white LCD display, both integrated or in a remote display version.

    c. The Meter shall allow the user to select one of two languages to view on the screen: English and Spanish.

    d. The Meter shall provide local access to the following metered values:

        1) Current, per phase rms and 3-phase average.

        2) Voltage, phase-phase, phase to neutral and 3-phase average.

        3) Real Power, per phase and 3-phase total.

        4) Power factor, 3-phase total and per phase. (PQM Only)

        5) Frequency

11. Reset of the following values shall be allowed from the Power Meter display:

    a. Peak demand current.

    b. Peak demand power (kW) and peak demand apparent power (kVA).

    c. Energy (MWh) and reactive energy (MVARh).

12. Setup requirements shall be allowed at the display. These include:

    a. CT Rating

    b. PT Rating

    c. System Type

    d. Watt-Hour Pulse

    e. Meter ID number

    f. Meter IP Address

13. Power Quality

    a. The Power Meters shall be IEC 61000-4-30 class B compliant.

2.04 METER MONITORING SYSTEM OVERVIEW

A. The Meter Monitoring System (MMS) shall be a web-based monitoring

system that monitors all specified locations in the distribution system without any further configuration or setup required after complete installation by the Contractor. The MMS is defined to include, but not to be limited to, remote devices for monitoring, protection, device communication interface hardware, intercommunication wiring, monitoring stations, software, software configuration, ancillary equipment, startup and training services.

B. The PC Workstation and the hardware listed below shall have a PC based timing input for maintaining a 1ms resolution throughout the facility. The software will show and log event and alarm times out to 1ms in the sequence in which they occurred. Time stamping to occur at the device where the event occurred.

C. The hardware listed below shall have a PC based timing system for maintaining a 1 second resolution throughout the facility as indicated on the points list. The software will show and log event and alarm times out to 1 second in the sequence in which they occurred. Where possible time stamping to occur at the device where the event occurred. All listed equipment shall be time and date stamped to 1 second through the use of PC based timing. Necessary MMS hardware and associated equipment status/alarm contacts shall be provided in order to meet the 1second requirement.

2.05 MMS SERVER (WORKSTATION) AND CLIENT REQUIREMENTS

A. Coordinate with Contracting Officer to use the workstation to be installed at the GETS building. Refer to Contract Drawings for more information. Provide all required software at the selected workstation to perform all required metering functions.

B. In the case that the workstation cannot be used, the Contractor shall provide a separate workstation to support the MMS server. The MMS Server shall include one factory supplied server computer with at least the following features:

1. Minimum of Xeon processors computer with 4GB RAM, 2.5Ghz, two 250 GB hard disk drives configured for on board Raid 5, 1.44 MB 3-1/2 inch diskette drive, 20x speed DVD read/write drive, 17 inch XGA Flat-screen monitor, XGA video card, dual onboard NIC w/ Giga Bit ports, remote access card with modem, full-size 101-key enhanced keyboard, mouse, and dual AC Power supplies.

2. A minimum of one (1) parallel port, two (2) serial ports and two (2) USB ports.

3. Auto-reboot capability upon return from power failure. Necessary programs must then automatically launch without user intervention.

4. 100 percent IBM compatible.

5. 3 year same day (4 Hour) onsite response with parts and labor warranty

C. The MMS Server shall also serve as a workstation for the MMS operator.

2.06 METER MONITORING SOFTWARE

A. The MMS Server software shall be designed on a MICROSOFT WINDOWS-based platform and have on-line full-screen editing to facilitate the programming and monitoring of the system. The Power Management Server and Web Based Client locations will allow the monitoring of vital system parameters and provide a scalable system for future expansions without replacement of the MMS system hardware or software.

B. The MMS screens shall show all parameters which are available from the individual remote devices by device, including but not limited to all metered values, load status, alarm status, energy data, device position and/or status, device data logs, waveform capture, sag/swell events, etc. In addition, the screens shall be capable (if allowed by the Contracting Officer) of providing for suitable tripping, closing, and opening of appropriate remote devices.

C. The MMS software shall provide, as standard, the following software packages to allow for maximum flexibility and expandability.

1. The proposed system will include a MMS system that supports unlimited Web Based clients and the following device point level packages:

a. 100 monitoring points - Server and Client

b. 100 monitoring points - Full Client

D. The MMS software Web Based clients shall require No loading of software to view all the MMS screens and data.

E. The MMS software shall allow unlimited screens and unlimited screen penetration to lower-level detailed screens.

F. The MMS software shall provide the following screens as standard in the software:

1. Real-time device information like line to line and line to neutral voltage and current readings for all power meters in a 3-line diagram format.

2. Event logs

3. Alarm logs

4. Historical trend plots

5. Real-time trend plots

6. Waveform capture display with zoom in/out capability

7. Billing report display in Excel or HTML format

8. Energy report display in Excel or HTML format

9. Network diagram display

10. Access to device logs, including long-term min/max, voltage, current, power, frequency

11. All measured values supported by the given device as selected by the customer

G. Customer shall have the ability to remove any non-essential parameters from the real-time list of each device to minimize searching through non-essential information.

H. All tables shall be customizable by the customer.

I. The base MMS software package shall have as a minimum the following specified features.

1. System/Device Alarm Logging and Reporting: Any changes in any device, or the system itself including log on/off, power on/off at system master computer, shall be identified and alarmed.

2. Time/Event Logging: The time and causes of each event shall be logged directly to the master control unit file and/or a printer. Time stamping capability in seconds shall be provided at the system master computer of device on/off, device alarm, device trip, and device no response.

3. Data Trending: The software shall include the following trending features:
   a. All information monitored by every remote device shall be capable of being communicated and automatically trended.

   b. Trending time interval and amount of information to be trended shall be user-selectable. Trends shall have the ability to combine information from multiple devices. Time interval selection shall be user-selectable in discrete time blocks from 1 second to many hours. Additionally, time intervals shall have the capability of limiting recording to certain time windows of each day or a certain date range. Automatic start and stop day/times shall be available for unattended recording.

J. Password Protection: The following password security protection features shall be provided:

1. The MMS software shall be capable of having an unlimited number of separate user-defined passwords.

2. All actions; i.e., log on/off, alarm acknowledgment, etc. shall be time and date stamped in the event log.

3. Password security access shall provide for flexible functional access. Functions such as alarm acknowledgment, device configuration, etc. shall be individually customized to each user name assigned.

4. The MMS software password security shall be capable of being utilized for both local and remote computers. Individual operator passwords shall be required at every computer

location. Each operator's capability to interface with the system shall be keyed to his/her entered password and his/her associated security level at each designated station.

K. Diagnostics shall be provided to provide information on device or system malfunction, such as devices not communicating, watchdog alarms, stale data indication, etc.

L. The software shall allow the user to set up to ten individual computer alarm levels for all monitored parameters, such as setting low and high alarm levels for voltage, current, motor run time, etc. These alarm levels shall be independent of device built-in alarm levels. The alarm settings shall support signed values (+/-) as well as high and low limits.

M. The software shall support setting multiple limits, providing additional alarm points above or below the initial limit.

N. The software shall display the analog value that caused the alarm on the alarm screen (time and date stamped), and log same information to the event file.

O. The system shall have the capability of being programmed and modified on-line. It shall not be necessary to shut down any part of the system during programming operations.

P. The system shall have a full on-line help system showing all descriptions, tables, and pictures of the operation of the MMS.

Q. Alarm and Data Log Information: The customer shall be able to access the database of alarm/events and electrical data in a query format. This query shall be programmable and set to an icon or button for repeatability (i.e., - last 7 days loading, all critical alarms, UPS alarms, etc.). These icons shall be able to be placed in any graphic screen or table. Unlimited queries shall be possible. The query shall allow the customer to mix, sort, filter and trend the alarm/events and electrical data in any way the customer desires (by date, by device, by priority, etc.) in order to provide the customer with a limited data set to review and analyze. It will be possible for the customer to request a list/table of just the events desired for a particular device, group of devices or particular events (all sags, all trip events, etc.) by clicking on an icon on the screen. A "one button = whole alarm list" for all devices and alarms is not acceptable.

R. Software Licenses to support 10 concurrent users and VDTs, PCs as indicated in the specifications and drawings and as required for a complete system.

S. Vendor shall include a three (3) year Software Service Agreement which provides customer with software upgrades for the software specified above as they are available.

2.07 MMS STANDARD REPORTING/BILLING FEATURES

A. The reporting / billing package shall be built into the MMS software as standard and allow the user to run the following reports without configuration changes.

B. The following reports will be available in a web based software package, accessible by other computers loaded with no special software besides an updated version of Internet Explorer 9.0 or later. Access to the reports must be limited to personnel with appropriate user ID and password, as administered in the MMS On-Line Software package

1. Energy and Demand for the individual departments/tenants monitored by power meters in the system. Energy and Demand should have the capability to support the local utility rate structure. The Energy and Demand reports will include the following features as a minimum:

a. Aggregation of loads from a number of power monitoring devices shall be possible by grouping devices in groups within a report. The reports shall be able to display total consumption, cost, and peak demand of the energy used for a group, sub-group or device, based on any date range.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install equipment for utility company metering. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

3.02 FIELD QUALITY CONTROL

A. Test Government's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.

2. Turn off circuits supplied by metered feeder and secure them in off condition.

3. Run test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use test load placement and setting that ensures continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at test load connection. Record test results.

5. Repair or replace deficient or malfunctioning metering equipment, or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.03 STARTUP SERVICE FOR GOVERNMENT METERING EQUIPMENT

A. Startup service

1. Verify that electrical wiring installation related to Government metering equipment complies with manufacturer's submittal and installation requirements.

2. Complete installation and startup checks according to manufacturer's written instructions.

B. ADJUSTING

1. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

2. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

C. FIELD, STARTUP AND COMMISSIONING SERVICE

1. Project management shall be provided for the entire project through a single source of contact. The end-user shall also provide a single source of contract with authority over the project to make decisions on timely bases.

2. Startup shall consist of complete configuration and in-service testing of the system, to confirm proper operation of the MMS. The number of site visits and number of service representatives shall be as required.

3. MMS Vendor to supply an Onsite Technician to assist in Third Party Commissioning. Third Party Commissioning shall consist of complete verification of the system. The technician should be onsite for a minimum of three weeks for this activity. weeks may not be continuous.

D. TRAINING

1. The bid shall include the cost for the services of a factory authorized service representative to train the Contracting Officer's On-Site Work Force (OSWF) on procedures and schedules for programming, setting of relay, startup, shutdown, troubleshooting, servicing and preventive maintenance of all equipment. The instruction shall include:

a. The instruction shall be dedicated and intensive and shall be provided by competent instructors fully familiar with the equipment.

b. The instructions shall be presented in three sessions. Each session for each of the three shifts shall be three days and eight hours per day.

c. The Contracting Officer will provide a suitable classroom environment on site for the instruction sessions.

d. The cost of the nine day eight hour instruction sessions shall be included in the Base Bid.

e. Record the instruction procedures on a DVD which shall be labeled and protected from erasure.

f. Schedule training with the Contracting Officer through the Contracting Officer with at least seven working days advance notice.

g. Provide both classroom training and hands-on equipment operation covering complete system operation

3.04 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

-- End of Section --

SECTION 26 27 26

WIRING DEVICES
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors
UL 943	(2016) UL Standard for Safety Ground-Fault Circuit-Interrupters

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.03 SUMMARY

A. This Section includes receptacles, sets, switches, finish plates.

B. Related Section may include but are not limited to the following:

1. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."

2. Division 26 Section 26 05 05 "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES."

3. Division 26 Section 26 05 33.10 "RACEWAYS."

4. Division 26 Section 26 05 33.20 "BOXES, ENCLOSURES, AND CABINETS."

1.04 ABBREVIATIONS

A. GFCI: Ground-fault circuit interrupter.

B. SPD or TVSS: Surge Suppression Device or Transient Voltage Surge Suppressor.

C. ABBAS : Architectural Barriers Act Accessibility Standard

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Each Product Required On The Project; G, AE

SD-10 Operation and Maintenance Data

Maintenance Data For Materials And Products; G

SD-11 Closeout Submittals

NPS-CQC Accessibility Inspection Report; G

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL, or by a testing agency acceptable to Authorities Having Jurisdiction.

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

1.07 COORDINATION

A. Receptacles for Contracting Officer-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data for each product required on the project.

B. Maintenance Data for materials and products, include in maintenance manuals specified in Division 01.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:

a. Bryant Electric, Inc.
b. Hubbell, Inc.; Wiring Devices Div.
c. Leviton Manufacturing Co., Inc.
d. Cooper Industries, Wiring Device Products.
e. Pass & Seymour/Legrand; Wiring Devices Div.
f. Or approved equal.

2.03 RECEPTACLES

A. Catalog numbers given in the following paragraphs are Hubbell, (except as indicated). Equivalent devices by one of the manufacturers listed above are acceptable.

B. Straight-Blade, 20 Ampere, Duplex Type: 5-20R series HBL5352.

C. Straight-Blade, 20 Ampere, Feed-Through GFCI, Specification-Grade, Duplex Type compliant with UL 943 Class A: 5-20R series GF5352.

2.04 SWITCHES

A. Catalog numbers given in the following paragraphs are Hubbell, (except as indicated). Equivalent devices by one of the manufacturers listed under "Manufacturers" section above are acceptable.

B. Snap Switches: Heavy-duty, quiet type, 20 ampere, 120/277-V ac.

1. Single-pole single-throw: Series 1221.

2.05 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: Nylon, color to match device(s).

3. Material for Unfinished Spaces: Stainless steel.

B. Exterior Locations: Cover plates shall be metal weatherproof in-use type.

2.06 FINISHES

A. Color: Ivory, unless otherwise indicated or required by Code.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates. Refer to architectural elevations, casework shop drawings and equipment installation drawings for locations of devices. If not shown or noted otherwise mounting heights shall be as indicated in the following paragraph.

F. Mounting Heights: Dimensions given are from finished floor to centerline of outlets. Adjust heights of outlets in masonry walls per Division 26 Section 26 05 33.20 "BOXES, ENCLOSURES, AND CABINETS." Notations on drawings supersede the following:

1. Wall Switches: 4 feet - 0 inches, except over special equipment, etc., where they shall be at a height to prevent interference to service equipment or as noted on the drawings

2. Wall Mounted Occupancy Sensors: 4 feet - 0 inches

3. Convenience Outlets: 1 foot - 6 inches, except over special equipment, etc., where they shall be at a height to prevent interference to service equipment or as noted on the drawings.

4. Communication Outlet marked as Wall: 4 feet - 0 inches

5. Thermostats: As directed by Division 25

G. Protect devices and assemblies during drywall installation and painting.

3.02 IDENTIFICATION

A. Comply with Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

3.03 CONNECTORS

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

B. Tighten electrical connectors and terminals according with manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A-486B.

3.04 INSPECTION

A. Finished work shall be inspected for compliance with ABAAS upon completion. Submit NPS-CQC Accessibility Inspection Report, supported with digital photos, sketches, product literature, and other explanatory items to describe complete work. Confirm compliance with dimensions and notation. Note non-compliance work and other observations in addition. Commence inspection immediately and in coordination with updated, approved construction schedule. Complete report within 24 hours of starting inspection. Submit finished report to contracting Officer with 24

hours of inspection completion.

3.05 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.06 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

-- End of Section --

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA AB 3	(2013) Molded Case Circuit Breakers and Their Application
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 70E	(2015; ERTA 1 2015) Standard for Electrical Safety in the Workplace

UNDERWRITERS LABORATORIES (UL)

UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 98	(2016) UL Standard for Safety Enclosed and Dead-Front Switches
UL 1053	(2015) Standard for Ground-Fault Sensing and Relaying Equipment

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. Section Includes:

1. Fusible switches.

2. Nonfusible switches.

3. Enclosed circuit breakers (MCCBs).

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Enclosed Switches And Circuit Breakers; G, AE

SD-03 Product Data

Enclosed Switch, Circuit Breaker, Accessory, And Component; G, AE

SD-09 Manufacturer's Field Reports

Field Quality-Control Reports; G, AE

SD-10 Operation and Maintenance Data

Time-Current Coordination Curves; G

Written Instructions For Testing And Adjusting; G

Operation And Maintenance Data for Enclosed Switches and Circuit Breakers; G

SD-11 Closeout Submittals

Maintenance Materials (Spare Parts); G

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including

clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contracting Officer no fewer than seven days in advance of proposed interruption of electric service.

2. Indicate method of providing temporary electric service.

3. Do not proceed with interruption of electric service without Contracting Officer's written permission.

4. Comply with NFPA 70E.

1.07 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.

2. Current and voltage ratings.

3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

C. Field quality-control reports.

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section 01 78 23 OPERATION AND MAINTENANCE DATA, include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

E. Maintenance materials submittals: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

2.02 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.
5. Or approved equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. When neutral conductor is present.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

4. Lugs: Mechanical type, suitable for number, size, and conductor material.

5. Service-Rated Switches: Labeled for use as service equipment.

2.03 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or approved equal.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors. When neutral conductors are present.

3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.04 ENCLOSED CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. Or approved equal.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I2t response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

5. All enclosed circuit breakers that are to be used as service entrance disconnects means shall be labeled for use as service equipment.

2.05 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Water Treatment Structure: NEMA 250, Type 4X.

2. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

3. Outdoor Locations: NEMA 250, Type 4X, stainless steel.

4. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

5. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X, stainless steel.

6. Indoor Locations Subject to Dripping Noncorrosive Liquids: NEMA 250, Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

-- End of Section --

SECTION 26 29 13

ENCLOSED CONTROLLERS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.7	Definition and Requirements for a Nationally Recognized Testing Laboratory

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.

2. Reduced-voltage controllers.

3. Multi-speed controllers.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer Qualifications:; G, AE

Testing Agency Qualifications:; G, AE

SD-02 Shop Drawings

Each Enclosed Controller; G, AE

Coordination Drawings; G, AE

Wiring Diagrams; G, AE

SD-03 Product Data

Each Type Of Enclosed Controller; G, AE

SD-06 Test Reports

Field Quality-Control Test Reports; G

SD-07 Certificates

Manufacturer Seismic Qualification Certification; G

SD-08 Manufacturer's Instructions

Written Instructions For Testing And Adjusting Overcurrent Protective Devices; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

SD-11 Closeout Submittals

Extra Materials ; G; G

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Contracting Officer no fewer than seven (7) days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Contracting Officer's written permission.

1.08 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one (1) spare for every five (5) installed, but no fewer than one set of three (3) of each type and rating.

2. Indicating Lights: Two (2) of each type installed.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.

b. Nameplate legends.

c. Short-circuit current rating of integrated unit.

d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Manufacturer Seismic Qualification Certification: Submit certification that enclosed controllers, accessories, and components will withstand seismic forces defined in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS". Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified".

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event".

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Qualification Data: For manufacturer and/or testing agency.

F. Field quality-control test reports.

G. Operation and Maintenance Data for enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "OPERATION AND MAINTENANCE DATA", include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Crouse-Hinds ECM.; Cooper Industries, Inc. Div.

3. Eaton Corporation; Cutler-Hammer Products.
4. General Electrical Company; GE Industrial Systems.
5. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
6. Siemens/Furnas Controls.
7. Square D.
8. Or approved equal.

2.03 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF", "ON", or "TRIPPED".

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, non-fusible switch.

3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

4. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

2.04 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel

2.05 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Phase-Failure and Undervoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable under-voltage setting.

2.06 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, NEC safety clearances, maintenance accessibility, and other conditions affecting performance.

Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".

B. Comply with mounting and anchoring requirements specified in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS".

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section 26 28 16 "ENCLOSED SWITCHES AND CIRCUIT BREAKERS".

D. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and

configuration of pilot device and control circuit affecting controller functions.

E. Select horsepower rating of controllers to suit motor controlled.

F. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

G. Use manual controllers for 3-phase motors up to 5 hp not requiring automatic or remote control.

H. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

I. Hand-Off-Automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

J. Install independently mounted motor-control devices according to manufacturer's written instructions.

K. Location: Locate controllers within sight of motors controlled, unless otherwise indicated.

L. Motor-Controller Fuses: Install indicated fuses in each fusible switch.

3.04 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

3.05 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section 26 05 05 "LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES".

B. Install all control wiring in conduit.

C. Bundle, train, and support wiring in enclosures.

D. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.06 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS."

C. Tighten connectors, terminals, bus joints, and mountings.

D. Tighten field-connected connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.07 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation.

2. Test and adjust controllers, components, and equipment.

3. Assist in field testing of equipment including pre-testing and adjusting of solid-state controllers.

4. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS, section 7.6.1.2. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.08 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section 01 43 33 "MANUFACTURERS' FIELD SERVICES".

-- End of Section --

SECTION 26 29 23

VARIABLE-FREQUENCY MOTOR CONTROLLERS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures

ICC EVALUATION SERVICE, INC. (ICC-ES)

ICC ES AC156	(2010; R 2015) Seismic Certification by Shake-Table Testing of Nonstructural Components

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61800-3	(2017; ED 3.0) Adjustable Speed Electric Power Drive Systems - Part 3: EMC Requirements and Specific Test Methods

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(2014) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IEEE C57.13	(2016) Requirements for Instrument Transformers

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 7	(2014) Adjustable-Speed Drives
NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 5	(2017) Industrial Control and Systems: Control Circuit and Pilot Devices
NEMA ICS 61800-2	(2005) Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements - Rating Specification for Low Voltage Adjustable Frequency AC Power Drive Systems
NEMA MG 1	(2016; SUPP 2016) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.7	Definition and Requirements for a Nationally Recognized Testing Laboratory

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2014; Reprint Mar 2016) UL Standard for Safety Surge Protective Devices
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 508A	(2013; Reprint Jun 2017) UL Standard for Safety Industrial Control Panels

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer Qualifications; G

Testing Agency Qualifications; G

SD-02 Shop Drawings

Each VFD; G, AE

Wiring Diagrams; G, AE

Coordination Drawings; G, AE

SD-03 Product Data

Each Type And Rating Of VFD; G, AE

SD-05 Design Data

Load-Current And List Of Settings Of Adjustable Overload Relays; G, AE

SD-06 Test Reports

Field Quality-Control Reports; G

Harmonic Analysis Report; G, AE

SD-07 Certificates

Manufacturer Seismic Qualification Certification

VFD Product Certificates

SD-10 Operation and Maintenance Data

Written Instructions For Testing And Adjusting; G

Routine Maintenance Requirements For VFDs And All Installed Components; G

Written Instructions For Testing And Adjusting Thermal-Magnetic Circuit Breaker And Motor-Circuit Protector Trip Settings.; G

Written Instructions For Testing, Adjusting, And Reprogramming Microprocessor Control Modules; G

Written Instructions For Setting Field-Adjustable Timers, Controls, And Status And Alarm Points; G

SD-11 Closeout Submittals

Warranty; G

Extra Materials (Spare Parts); G

1.03 RELATED DOCUMENTS

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

1.04 SUMMARY

A. This section includes separately enclosed, preassembled, combination variable frequency motor speed controllers/ drives (VFDs), rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:
1. Division 26 Section 26 05 48 "VIBRATION SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS".

C. Division 26 shall provide all VFDs and line reactors and/or harmonic filters with the specific equipment in accordance with this Section. Locations of VFDs are either integral with the respective equipment and factory mounted/wired or shipped separately for field connections as shown on the respective drawings.

D. Division 26 shall provide VFDs and corresponding line reactors and/or harmonic filters that are not factory mounted on equipment. Provide all wiring, connections and mounting methods in accordance with equipment installation drawings and this section.

1.05 DEFINITIONS

A. CPT: Control power transformer.

B. DDC: Direct digital control.

C. EMI: Electromagnetic interference.

D. LED: Light-emitting diode.

E. NC: Normally closed.

F. NO: Normally open.

G. OCPD: Overcurrent protective device.

H. PID: Control action, proportional plus integral plus derivative.

I. RFI: Radio-frequency interference.

J. VFD: Variable frequency drive or variable frequency motor speed controller.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 300 miles of the Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency

acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70 and UL 508A.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

G. Comply with IEEE 519 for following harmonic distortion limits:

1. Design VFD to limit the harmonic distortion generated by the drive(s) on the electrical distribution system.

2. Individual or simultaneous operation of the VFDs shall not add more than 3 percent total harmonic voltage distortion to the normal bus at the point of common coupling (i.e., common junction, bus or node), nor more than 5 percent at emergency generator while operating from standby generator.

3. Maximum allowable total and individual harmonic current distortion limit for each odd harmonic shall not exceed limits as set forth by IEEE 519.

4. Provide all equipment and accessories required to successfully comply with the above at no additional cost to the Government, even if not specified hereinafter, including, but not limited to:

a. Twelve-pulse, eighteen-pulse or higher order bridge converter (rectifier) drives.
b. Active "front end" design.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service

1.08 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 32 to 104 deg F.

2. Humidity: Less than 90 percent (noncondensing).

3. Altitude: Not exceeding 6,644 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.09 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "CAST-IN-PLACE CONCRETE."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For each type and rating of VFD indicated.

1. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performances, electrical ratings, characteristics and finishes for VFDs.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFD indicated.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Each installed unit's type and details.

   b. Nameplate legends.

   c. Short-circuit current rating of integrated unit.

   d. UL 508A Listed and labeled for rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

2. Include mounting and attachment details.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Wiring Diagrams: Include diagrams for power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

   Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Required working clearances and required area above and around VFDs.

   2. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements.

   3. Show support locations, type of support, and weight on each support.

   4. Indicate field measurements.

D. Qualification Data: For testing agency.

E. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS". Include the following:

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components

or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event".

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

F. Product Certificates: For each VFD from manufacturer.

G. Qualification Data: For manufacturer and testing agency.

H. Field quality-control reports.

I. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section 01 78 23 "OPERATION AND MAINTENANCE DATA", include the following:

1. Routine maintenance requirements for VFDs and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. In addition to items specified in Division 01 Section 01 78 23 "OPERATION AND MAINTENANCE DATA", include the following:

a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
c. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

K. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

1. The VFD manufacturer shall perform a harmonic analysis and include it with the VFD and harmonic filter submittals. The analysis shall be performed assuming all VFDs operating in synchronism except for those identified for standby use. The analysis shall compute at each point of common coupling on the electrical distribution system the percent amplitude and RMS

value of current and voltage of all harmonic orders of zero through 32, percent TVHD, RMS of harmonic voltages and currents, and total RMS voltage and current.

2. A Point of Common Coupling (PCC) shall be any and all of the following electrical locations on the effective system distribution network:

   a. A common junction or node to more than one path of power distribution which is considered to have no impedance between two or more points (e.g., bus of distribution equipment, wire troughs, etc.).

   b. Primary and secondary terminals of a transformer.

   c. Point of service connection to the utility company (PCC1).

   d. Output terminals of an emergency generator.

   e. Automatic transfer switches.

3. IEEE 519 shall be used as a design guideline for the harmonic analysis and the computation of TDD. The TDD shall be included in the VFD submittal. The voltage and current distortion by all the VFDs operating in synchronism, except those identified for standby use, shall not exceed the limits in Table 10.2 and Table 10.3 respectively, of IEEE 519-1992. The values in the General System column in Table 10.2 shall be the maximum allowable THD (voltage) limits for this project.

   Maximum short circuit current, wire sizes and transformer sizes are shown on the electrical single line diagrams. Equipment locations are shown on the electrical plans. Utilize standard manufacturer transformer impedances, unless otherwise shown on the single line diagrams. The maximum demand load current to be used for the TDD calculation shall be 80 percent of the service substation transformers equipment capacity.

4. Source quality-control reports.

L. Maintenance Materials:

Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Recommended spare parts list:

1. One extra of each type of control transformer Fuse per VFD panel type

2. One extra VFD Keypad Control Panel per VFD panel type

3. One extra VFD Internal Cooling Fan per VFD panel type

4. 5-Pack of Filter Screens per panel

5. One extra Light Bulb per Illuminated Lens

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Baldor Electric Company (Graham).
3. Danfoss Inc.; Danfoss Electronic Drives Div.
4. Eaton Corporation; Cutler-Hammer Products.
5. General Electric Company; GE Industrial Systems.
6. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
7. Siemens Energy and Automation; Industrial Products Division.
8. Square D.
9. Toshiba International Corporation.
10. Honeywell Automation and Control Solutions.
11. Yaskawa.
12. Toshiba.
13. Or approved equal.

2.03 VARIABLE FREQUENCY DRIVE

A. General Requirements for VFDs:

1. VFDs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Constant torque and variable torque.

C. VFD Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction. UL 508A Listed and Labeled.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFD input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 5 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.

7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.

8. Humidity Rating: Less than 95 percent (noncondensing).

9. Altitude Rating: Not exceeding 6644 feet.

10. Vibration Withstand: Comply with NEMA ICS 61800-2.

11. Overload Capability: 1.2 times the base load current for 60 seconds.

12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

13. Speed Regulation: Plus or minus 10 percent.

14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 0.1 to 999.9 seconds.

4. Deceleration: 0.1 to 999.9 seconds.

5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.

4. Inverter overcurrent trips.

5. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.

6. Critical frequency rejection, with three selectable, adjustable deadbands.

7. Instantaneous line-to-line and line-to-ground overcurrent trips.

8. Loss-of-phase protection.

9. Reverse-phase protection.

10. Short-circuit protection.

11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bi-directional Autospeed Search" feature is available and engaged.

M. Bi-directional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker and current-limiting fuses with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFD input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFDs shall withstand the effects of earthquake motions determined according to ASCE 7. The designated VFDs shall be tested and certified by an NRTL as meeting the ICC ES AC156 test procedure requirements.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event".

2.05 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.

2. Run.

3. Overvoltage.

4. Line fault.

5. Overcurrent.

6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.

2. Running log of total power versus time.

3. Total run time.

4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).

2. Motor speed (rpm).

3. Motor status (running, stop, fault).

4. Motor current (amperes).

5. Motor torque (percent).

6. Fault or alarming status (code).

7. PID feedback signal (percent).

8. DC-link voltage (V dc).

9. Set point frequency (Hz).

10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: 0- to 10-V dc
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

a. 0- to 10-V dc.

b. 4- to 20-mA dc.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc, which can be configured for any of the following:

a. Output frequency (Hz).

b. Output current (load).

c. DC-link voltage (V dc).

d. Motor torque (percent).

e. Motor speed (rpm).

f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of three programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Set point speed reached.

c. Fault and warning indication (overtemperature or overcurrent).

d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two

G. Interface with Telemetry System Factory-installed hardware and software shall interface with Telemetry System to monitor, control, display, and record data for use in processing reports. VFD settings shall be retained within VFD's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status

b. Control: On-off operation

2. Communication Interface: Communication shall interface with Telemetry system to remotely control VFD from Telemetry system. Control features and monitoring points displayed locally at VFD panel control panel shall be available at the Telemetry System.

2.06 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning/ Output Filtering: Based on the manufacturer's harmonic analysis study and report, provide input and output filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.07 ADDITIONAL REQUIRED FEATURES

A. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFD resumes normal operation.
B. Remote Indicating Circuit Terminals: Mode selection, controller

status, and controller fault.

C. Remote digital operator kit.

D. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.08 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.

2. Outdoor Locations: Type 4X.

3. Wash-Down Areas: Type 4X, stainless steel.

4. Other Wet or Damp Indoor Locations: Type 4X

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.09 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices where required: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons: Shielded.

2. Pilot Lights: Push to test.

3. Selector Switches: Rotary type.

4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied has arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Spare control-wiring terminal blocks; unwired.

E. Standard Displays:

1. Output frequency (Hz).

2. Set-point frequency (Hz).

3. Motor current (amperes).

4. DC-link voltage (VDC).

5. Motor torque (percent).

6. Motor speed (rpm).

7. Motor output voltage (V).

8. Harmonic trap filter display - power on, trap functioning, trap failure.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with stainless-steel intake and exhaust grills and filters; 120V AC; obtained from integral CP

I. Historical Logging Information and Displays:

1. Real-time clock with current time and date.

2. Running log of total power versus time.

3. Total run time.

4. Fault log, maintaining last four faults with time and date stamp for each.

J. Historical Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

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

3.02 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.03 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".

B. Floor-Mounting Controllers and equipment: Install controllers and equipment on 8-inches nominal thickness concrete base. Coordinate with structural concrete specification section for additional information.

1. 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 concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper

attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Division 26 Section 26 05 48 " VIBRATION SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS".

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.04 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section 26 24 19 "LOW VOLTAGE MOTOR CONTROLS".

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

D. Provide interlock wiring for each VFD motor circuit disconnect and coordinate with the VFD manufacturer for proper connections at the disconnect switch and wiring knockout location on the VFD. Allow enough wiring in the VFD to make final connections. The Licensed electrician will make final connections at the VFD and perform testing and certification for the electric interlock. Provide two 12 AWG in 3/4 inch EMT raceway.

3.05 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFD with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.06 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Acceptance Testing Preparation:

1. Complete installation and startup checks according to manufacturer's written instructions. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit Test continuity of each circuit.

2. Complete installation and startup checks according to manufacturer's written instructions. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.

E. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Contracting Officer before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA ATS Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFD. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional

follow-up infrared scan of each VFD 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFDs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.07 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

Complete installation and startup checks according to manufacturer's written instructions.

3.08 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. VFD shall employ adjustable current limit control that will override the speed reference command and decrease the drive's output frequency while maintaining the optimum volts per hertz ratio whenever the output current level exceeds the current limit set-point. Current limit shall automatically extend the acceleration ramp to prevent motor overload during acceleration and automatically extend deceleration ramp to prevent over-voltage tripping due to motor regeneration during deceleration.

D. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY AND ARC FLASH ANALYSIS".

E. Set field-adjustable pressure switches.

3.09 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFDs whose interiors have been exposed to water or other

liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

-- End of Section --

SECTION 26 36 00

NON-AUTOMATIC TRANSFER SWITCHES
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9001	(2008; Corr 1 2009) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2016; SUPP 2016) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1008	(2014) Transfer Switch Equipment
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Non-automatic transfer switches

2. Remote annunciation systems

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer And Supplier Qualification Data; G

SD-02 Shop Drawings

Dimensioned Outline Drawings; G, AE

Installation And Mounting Instructions; G, AE

Interconnection Wiring Diagrams; G, AE

Internal Electrical Wiring And Control Drawings; G, AE

Single-Line Diagram; G, AE

SD-03 Product Data

Transfer Switch Mechanism; G, AE

Control System; G, AE

Protective Devices; G, AE

Cabinet; G, AE

SD-07 Certificates

Manufacturer Seismic Qualification Certification

SD-10 Operation and Maintenance Data

Each Type Of Product To Include In Emergency, Operation, And Maintenance Manuals; G

1.05 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

B. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch generator sets and remote monitoring equipment (if applicable) at the site within a response period of less than eight hours from time of notification.

1. The transfer switch shall be serviced by technicians employed

by, and specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.

3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

D. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of one (1) year from registered commissioning and start-up, or eighteen (18) months from date of shipment.

E. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.

1.06 COORDINATION

A. Size and location of concrete equipment bases and anchor bolt inserts shall be coordinated. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See para 3.1 for additional information on installation

B. If Project calls for bypass switch(es) mounted on a concrete base, the base must be designed to accommodate the requirements of the drawout mechanism (extension rails and/or wheeled carriage) of the bypass switch.

PART 2 PRODUCTS

2.01 PRODUCT INFORMATION

Contractor shall provide the following information for all products and services specified in this Section.

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

1. Technical data on all major components of all transfer switches and other products described in this section. Product Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady

state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.

2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.

2. Internal electrical wiring and control drawings.

3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.

4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.

C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS." Include the following:

1. Seismic certification, as required for site conditions. Seismic certifications shall be third-party certified, and based on testing. Certification based on calculations does not meet this requirement.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational both during and after the seismic event".

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section 01 78 23 OPERATION AND MAINTENANCE DATA, include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

F. Warranty documents demonstrating compliance with the project's contract requirements.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cummins Power Generation.
2. Russelectric.
3. ASCO.
4. Or approved equal.

B. Equipment specifications for this Project are based on non-automatic transfer switches manufactured by Cummins Power Generation. Switches manufactured by Russelectric or ASCO that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.

C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.03 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Provide transfer switches in the number and ratings that are shown on the Contract Drawings. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

B. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.

C. Solid-State Controls: All settings should be accurate to plus or minus 2 percent or better over an operating temperature range of minus 40 to plus 140 degrees F.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches).

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.

2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.

3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.

5. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for the purpose of load shedding from the generator set.

6. The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.

7. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.

8. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG 1.

   a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality

9. Transfer switches designated on the drawings as "4-pole" shall be provided with a switched neutral pole switched which is switched simultaneously with phase poles.

10. Transfer switches designated on the drawings as "3-pole" shall have a full current-rated neutral bar with lugs.

11. Transfer switches designated on the drawings as "non-automatic" switches shall meet the requirements of section 2.4 of this specification.

12. Transfer switches designated on the drawings as "closed transition" switches shall meet the requirements of section 2.5 of this specification.

G. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism

H. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Terminal arrangement and cabinet space must be such that feeder conductors can enter from the top, side or bottom of the switch, at the installer's discretion. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.

I. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:

1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA 70, regardless of the direction from which the conduit enters the enclosure.

2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.

3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.

a. Transfer switches that are installed outdoors or in any other uncontrolled environment shall be supplied with NEMA Type 4 or 4X (stainless steel) enclosures (IEC IP65).

2.04 NON-AUTOMATIC TRANSFER SWITCHES

A. Operation: Electrically actuated by pushbuttons labeled "Normal Source" and "Alternate Source". The switch shall be capable of transferring the load to either source, as long as the oncoming source is energized.

B. Transfer switch shall be field-configurable for operating speed.

C. Non-automatic switches shall have pilot lights to indicate which load is connected.

D. Transfer switch shall have unassigned auxiliary contacts consisting of one set of normally closed contacts for each switch position, rated 10 amps at 240 VAC.

2.05 REMOTE ANNUNCIATOR SYSTEM

A. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches. Annunciation shall include the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation.

D. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation. The remote annunciation system shall not prevent transfer to the alternate source when the primary power source fails, nor prevent return to the primary source if the alternate source fails

PART 3 EXECUTION

3.01 INSTALLATION

A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS."

B. Floor-Mounting Switch: Anchor to floor by bolting.

1. Floor-mounted transfer switches (except drawout switches supported by wheeled carriages, which must be rolled out at floor level) shall be mounted on concrete bases complying with the following requirements:

a. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions

beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".

C. Annunciator Mounting: Flush in wall, unless otherwise indicated.

D. Identify components according to Division 26 Section 26 05 53 ELECTRICAL SYSTEMS IDENTIFICATION.

E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Government if necessary to accommodate required wiring.

B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.

C. Transfer switch shall be provided with CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

D. Ground equipment according to Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

E. Connect wiring according to Division 26 Section 26 05 05 "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES".

3.03 SOURCE QUALITY CONTROL

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer's representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.

1. Perform recommended installation tests as recommended in manufacturer's installation and service manuals.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.

   a. Verify that the transfer switch is accurately metering AC voltage and current (when provided).

3. Ground-Fault Tests (if integral to transfer switch): Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.

2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.06 SERVICE AND SUPPORT

A. The manufacturer shall supply the Government with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and

capabilities:

1. The software shall be 32 bit and shall be Windows XP and Vista compatible.

2. The software shall use Windows Explorer format, for easy use and commonality with other software in use at the facility.

-- End of Section --

SECTION 26 41 00

LIGHTNING PROTECTION
09/17

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes lightning protection for buildings and or building site components as indicated.

B. Related Sections may include but are not limited to the following:

1. Division 03 Section 03 30 00.00 "CAST-IN-PLACE CONCRETE".

2. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.03 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 780	(2017) Standard for the Installation of Lightning Protection Systems

UNDERWRITERS LABORATORIES (UL)

UL 96A	(2016) Standard for Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

Manufacturer Qualifications; G

SD-02 Shop Drawings

Lightning Protection System; G, AE

SD-03 Product Data

Air Terminals; G, AE

Conductors; G, AE

Mounting Accessories; G, AE

SD-06 Test Reports

Field Inspection Reports; G

SD-07 Certificates

Roof Adhesive Approval for Application; G

1.05 SYSTEM DESCRIPTION

A. System shall be Class 1, UL 96A Master labeled, and shall consist of air terminals on roof, bonding of structure and metal objects, grounding electrodes, interconnection conductors, and if required protection of roof-mounted mechanical equipment.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer with three years of documented experience, who is a factory authorized installer of the system and certified by the Lightning Protection Institute.

B. Manufacturer Qualifications: A firm with three years of documented experience in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance. Manufacturer shall also be a member of the Lightning Protection Institute.

C. Listing and Labeling: As defined in NFPA 780, Article 2-2, "Definitions".

D. Provide UL Master Certificate.

1.07 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, photovoltaic system and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and installer.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For air terminals, conductors, and mounting accessories required on the project.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association.

D. Certification: Signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the roofing material.

E. Field inspection reports indicating compliance with requirements as specified in Part 3.

2.02 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. A-C Lightning Security, Inc.
2. Independent Protection Company, Inc.
3. Thompson Lightning Protection, Inc.
4. Lightning and Grounding Systems, Inc.
5. Or approved equal.

2.03 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96A.

B. Roof-Mounting Air Terminals: Solid copper, 24 inches long, by 5/8 inches diameter, unless otherwise indicated.

C. Ground Rods: Chemical Rod, 10 feet long by 3/4 inch diameter.

D. Conductors: Copper, 17 gauge wires, 59,500 cm, 187-1 2 lbs per 1000 feet.

E. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install lightning protection components and systems according to UL 96A.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends greater than 90 degrees and maintain minimum 8 inch radius bends.

C. Conceal the following conductors:

1. Down conductors.
   a. One down conductor shall have accessible disconnect clamp for testing purposes.

2. Notify Contracting Officer at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices except on roofs. On roofs use approved mechanical connection. Protect adjacent construction elements and finishes from damage.

E. Use approved mastic, DO NOT penetrate roof membrane without permission from the Contracting Officer.

3.02 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

C. Use bimetallic connectors when connecting dissimilar metals.

3.03 FIELD QUALITY CONTROL

A. UL Inspection: Apply for inspection by UL as required to obtain a UL Master Label for system.

B. Obtain UL Master Label and attach to building at location directed by the Contracting Officer.

-- End of Section --

SECTION 26 43 00

TRANSIENT VOLTAGE SUPPRESSION
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. This Section includes transient voltage surge suppressors used to protect AC electrical distribution equipment from the effects of lightning, utility switching events, noise, and impulses generated internally within a facility.

B. Related Sections may include but are not limited to the following:

1. Division 26 Section 26 05 53 ELECTRICAL SYSTEMS IDENTIFICATION.

2. Division 26 Section 26 05 33.20 BOXES, ENCLOSURES, AND CABINETS.

3. Division 26 Section 26 24 16 PANELBOARDS.

1.03 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.1	(1981) Standard for Surge Arresters for AC Power Circuits
IEEE C62.11	(2012) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IEEE C62.45	(1992; R 2002) Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V or less) AC Power Circuits

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2017) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

FIPS Pub. 94	(1983) Guideline on Electrical Power for ADP Installations

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2014; Reprint Mar 2016) UL Standard for Safety Surge Protective Devices
UL 248-1	(2011) Low Voltage Fuses - Part 1: General Requirements
UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors
UL 489	(2016) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Materials And Procedures Specified; G, AE

SD-03 Product Data

For Each Type Of Product Required; G, AE

SD-06 Test Reports

Field Test Reports; G, AE

SD-07 Certificates

Test Data Product Certificates; G

SD-10 Operation and Maintenance Data

Maintenance Data; G

SD-11 Closeout Submittals

Warranty; G

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL; by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use; and acceptable for purpose specified by the specified testing firm.

B. ANSI/IEEE Compliance: Comply with IEEE C62.41, IEEE C62.45, IEEE C62.1, and IEEE C62.11.

C. UL Compliance: Comply with UL 248-1, UL 489, UL 1283, and UL 1449 second edition.

D. Federal Information Processing Standards: Comply with Publication 94 (FIPS Pub. 94).

1.06 PROJECT CONDITIONS

A. Placing into Service: Do not energize or connect service entrance equipment to their sources until the surge protective devices are installed and connected.

B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage, but no more than 130 percent. Test certification shall be as outlined in UL 1449 and IEEE C62.11.

2. Operating Temperature: 30 to 120 deg F.

3. Humidity: 0 to 85 percent, noncondensing.

4. Altitude: Less than 15,000 feet above sea level.

5. Unit Operation Voltage: As indicated on the drawings.

1.07 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance and to allow for lead lengths a maximum of 18 inches long with minimum bends.

1.08 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Contracting Officer of other rights Contracting Officer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract

Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship within seven years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

Contractor shall supply the following information for materials and procedures specified in this Section:

A. Product Data: For each type of product required on the project. Include manufacturer's data/ cut sheets detailing exact model number, specification features and options, and rated capacities.

B. Test Data Product Certificates: Signed by manufacturers of transient voltage suppression devices, certifying that products furnished comply with the following testing and labeling requirements:

1. UL 1449 second edition listing and classification.
2. Clamping values (to include rating of internal disconnects if applicable).
3. Surge current fuse testing.
4. Independent test lab single pulse surge current capacity testing.
5. Minimum repetitive surge current capacity testing.

C. Shop Drawings: For materials and procedures specified; include detail on unit dimensions, weights, field connections, and mounting provisions.

D. Field Test Reports: Written reports of tests specified in Part 3 of this section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For transient voltage suppression devices, include in maintenance manuals specified in Division 01

2.02 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.03 SERVICE ENTRANCE EQUIPMENT SUPPRESSORS

A. Manufacturers:

1. Current Technology, Inc.
2. Liebert Corp.
3. Innovative Technology's Vanguard.
4. Or approved equal.

B. Suppression System: Suppression system shall incorporate a hybrid design of metal oxide varistor (MOV) arrays and filtering capacitors. These components shall optimally share surge currents to ensure maximum performance of long-term reliability. The system shall NOT utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

C. Surge Protective Device Description: Modular design with bolted modules and the following features and accessories:

1. Installation: Provide as an integral part of equipment or installed on the front face or side of equipment.

2. Disconnect Switch with Fuses: A low impedance, integral and safety interlocked disconnect switch with externally mounted manual operator shall be provided. The switch shall disconnect all ungrounded circuit conductors from the distribution to enable testing and maintenance without interruption of power to the facility. The disconnect shall be capable of withstanding the rated single pulse surge current rating of the filter without failure or damage.

   a. If disconnect switch with fuses is not integral to equipment, provide a fused disconnecting means ahead of unit.

3. Fault Current Protection: Integral fusing shall be provided to protect from dangerous failures of the TVSS devices. Minimum fault current protection shall exceed available fault current values shown on the Drawings. The fusing shall also be coordinated with each TVSS device to allow surge currents (with IEEE C62.41 8x20 waveform) within each device's surge current rating to pass without opening the fuses.

4. Internal Fusing: Every current carrying conductor associated with internal components shall be fused to ensure that every fault is isolated at the point of the fault or at the component level.

5. Noise Filter: High Frequency Extended Range Filter. EMI-RFI noise rejection/ attenuation (per UL 1449 and IEEE C62.11 and 50 ohm insertion loss methodology) shall be as follows, or as close as possible, provide actual data.

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	47	41	31	35	53

For installations that install multiple filters, the filters

shall be coordinated to provide minimum noise rejection/ attenuation as follows:

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	85	83	68	67	84

NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

6. Excessive MCOV Withstand (overvoltage rating): The unit shall be capable of withstanding temporary overvoltage events that may be encountered within the distribution system without damaging any of the components within the TVSS, especially MOV's and other non-MOV parallel connected elements, in accordance with UL 1449 and IEEE C62.11.

7. Arrangement with connections to phase buses, neutral bus, and ground bus.

   a. Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick disconnect terminals shall be used in the surge current-carrying paths.

8. LED indicator lights for power and protection status, plus audible alarm, with battery-powered silencing switch, to indicate when protection has failed. The alarm shall indicate single or multiple phase failure of the MOV.

9. Two sets of dry contacts rated at 5-A and 250-V ac, one NO and one NC for remote monitoring of protection status. Coordinate with building power monitoring and control system.

D. Rated Single Pulse Surge Current Capacity. Calculations for single pulse surge current capacity shall use the component manufacturer's individual component rating multiplied by the respective number of per mode components. Documentation shall be provided with submittals on the Attachment 1 TVSS Submittal Compliance Form located at the end of this section. Component manufacturer's ratings shall be derived using the ANSI/IEEE C62.41 Category C1 8x20, 3000A current waveform. The per mode single pulse surge current rating shall be calculated based upon the component manufacturer's catalog rating for each device. The minimum rated single pulse surge current capacity per mode shall be as follows:

Rated Single Pulse Surge Current Capacity				
TVSS Amps Per Phase	L-N (A)	L-G (A)	N-G (A)	L-L (A)
200,000	100,000	100,000	100,000	100,000

E. Tested Single Pulse Surge Current Capacity. The suppression filter system shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. Units with surge current capacities of 200,000 amps or less shall be tested as a unit, not individual modules. Due to industry test equipment limitations, units with surge current capacities greater than 200,000 amps shall be tested as a unit to 200,000 amps; and certified for surge current ratings above 200,000 amps by testing individual components or sub-assemblies with a mode. Units that sustain any component or overcurrent device failure are unacceptable.

F. Minimum Repetitive Surge Current Capacity. Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45, every mode of the suppression filter system shall be designed to survive multiple Category C3, 20 KV, and 10 KA impulses. Test documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.

Repetitive Surge Current Capacity - Number of Impulses				
TVSS Amps Per Phase	L-N (A)	L-G (A)	N-G (A)	L-L (A)
TVSS Amps Per Phase	> 4,500	> 4,500	> 4,500	> 4,500

G. Suppression Voltage Rating. In compliance with procedures outlined in UL 1449 and IEEE C62.11, the maximum suppression voltage rating (with integral fused disconnect) shall be as follows:

System Voltage	Mode	B3 Ringwave	B3/C1 Comb. Wave	C3 Comb. Wave	UL 1449
120/240 120/208	L-N	325/375	425/450	650/775	400/400
	L-G	400/450	425/450	650/825	500/500
	N-G	350/350	475/475	750/750	500/500
	L-L	400/500	775/850	950/1250	700/700
277/480	L-N	550/600	875/900	1125/1125	800/800
	L-G	850/875	850/900	1075/1125	1000/1000
	N-G	700/700	900/900	1225/1225	800/900
	L-L	650/750	1650/1725	1950/2200	800/900

2.04 ENCLOSURES

A. NEMA 250, or as indicated on plans with type matching the enclosure of panel or device being protected.

PART 3 EXECUTION

3.01 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed 18 inches in length. Do not bond neutral and ground.

C. Conductor size shall be a minimum of #6 AWG copper.

3.02 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.03 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer's installation requirements.

3.04 SUPPLEMENTS

The supplements listed below, prior to "End of Section", are part of this Specification.

1. TVSS Submittal Compliance/Approval Form

-- End of Section --

TVSS SUBMITTAL COMPLIANCE/APPROVAL FORM

Performance/Feature	**Specification Requirement**	**Proposed Model:** _____
Single Pulse Surge Rating Per Mode	_____ L-N _____ L-G _____ N-G	_____ L-N _____ L-G _____ N-G
Single Pulse Surge Rating Per Phase	_____ L-N + L-G	_____ L-N + L-G
Number of Components Used For Above Rating (Attach Component Manufacturer's Product Data Sheet)	Number of MOV's/Mode L-N _____ L-G _____ N-G _____	Number of MOV's/Mode L-N _____ L-G _____ N-G _____
Warranty for Damage to TVSS Due to Lightning		
Dispatch Location For Local Support And Start-Up		
MCOV For <u>All</u> Components	_____ Volts	_____ Volts
Individually Fused Elements Individual Fuse – Surge Current Rating	Required? ___No <u>X</u> Yes _____ Transient Amps	Provided? ___No ___Yes _____ Transient Amps
Protection Modes Provided		
Cat. C3 Repetitive Surge Current Cap.	_____ Hits/Mode	_____ Hits/Mode
High Frequency Noise Filtering Attenuation	100 KHz _____ dB 1 MHZ _____ dB 10 MHZ _____ dB 100 MHZ _____ dB	100 KHz _____ dB 1 MHZ _____ dB 10 MHZ _____ dB 100 MHZ _____ dB
Internal Surge Current Path	Copper Bus Bar	
Low Impedance Internal Disconnect	Required? ___No ___Yes	Provided? ___No ___Yes
Disturbance Counter	Required? ___No ___Yes	Provided? ___No ___Yes
Electrical Equipment Overcurrent Protection Required	___No ___Yes Size: _____ AMPS	___No ___Yes Size: _____ Amps
INDEPENDENT LAB TESTING		LAB NAME:_____

Note: Provide copies of Independent Laboratory's qualifications and complete test results for proposed product.

SECTION 26 50 00

INTERIOR LIGHTING
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

This Section includes the following:

1. Interior lighting fixtures.
2. Emergency lighting units.
3. Lighting fixture supports.

1.03 DEFINITIONS

BF: Ballast factor.
CRI: Color-rendering index.
CU: Coefficient of utilization.
LER: Luminaire efficacy rating.
LED: Light Emitting Diode.
Luminaire: Complete lighting fixture, including ballast housing if provided.

1.04 REFERENCES

ASTM INTERNATIONAL (ASTM)

ASTM A641/A641M	(2009a; R 2014) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

Illuminating Engineering Society of North America

IESNA LM-79	IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products
IESNA LM-80	Measiromg Lumen Maintenance of LED Light Sources

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.7	Definition and Requirements for a Nationally Recognized Testing Laboratory

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors
UL 924	(2016; Reprint Mar 2017) UL Standard for Safety Emergency Lighting and Power Equipment

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Testing Laboratory Qualifications (Manufactures); G

Testing Laboratory Qualifications (Independent); G

SD-02 Shop Drawings

Wiring Diagrams; G, AE

Coordination Drawings; G, AE

SD-03 Product Data

Physical Description Of Lighting Fixture Including Dimensions; G, AE

Emergency Lighting Units Including Battery And Charger; G, AE

Energy-Efficiency Data; G, AE

Photometric Data; G, AE

SD-04 Samples

Interior Lighting Fixtures; G, AE

SD-06 Test Reports

Field Quality-Control Test Reports; G

SD-07 Certificates

Product Certificates; G

SD-10 Operation and Maintenance Data`

Operation And Maintenance Data; G

SD-11 Closeout Submittals

Warranties; G

Extra Materials (Spare Parts); G

1.06 QUALITY ASSURANCE

Luminaire Photometric Data Testing Laboratory Qualifications (Manufactures): Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

Luminaire Photometric Data Testing Laboratory Qualifications (Independent): Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

Comply with NFPA 70.

FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.07 COORDINATION

Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.08 WARRANTY

Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

Special Warranty for LED Fixtures: Manufacturer's standard form, made out to Owner and signed by fixture manufacturer agreeing to replace fixtures that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year(s) from date of Substantial Completion.

1.09 EXTRA MATERIALS

Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 1 for every 10 of each type and rating installed.

Furnish at least one of each type.

2. Plastic Diffusers and Lenses: 1 for every 10 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Product Data

Provide for each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.

3. Energy-efficiency data.

4. Life, output, and energy-efficiency data for lamps.

5. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.

b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

c. For all alternate or substituted fixtures submit a complete floor layout with lighting calculations of each space showing max, min, and average illuminance in space and proof that submitted fixture meets the Government's illuminance requirements within the space.

B. Shop Drawings

1. Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.

a. Wiring Diagrams: Power and control wiring.

2. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

a. Lighting fixtures.

b. Suspended ceiling components.
c. Structural members to which suspension systems for lighting fixtures will be attached.
d. Other items in finished ceiling including the following:

1) Air outlets and inlets.
2) Speakers.
3) Sprinklers.
4) Smoke and fire detectors.
5) Access panels.

C. Samples for Verification

1. Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

a. Lamps: Specified units installed.
b. Accessories: Cords and plugs.

D. Product Certificates

For each type of ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.

E. Qualification Data

For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data

For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

H. Warranties

Special warranties specified in this Section.

2.02 MANUFACTURERS

In Lighting Fixture Schedule on Construction Documents where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Basis-of-Design Product: The design for each lighting fixture is based on the lighting fixture's type and calculated foot candle obtained in each area. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

a. Lithonia Lighting.
b. Acuity Brands, Juno Lighting.
c. Holophane Leader in Lighting Solutions.
d. Acuity Brands, Winona Lighting.
e. Hubbell Lighting.
f. Acuity Brands, Peerless Lighting.
g. Cooper Lighting.

h. GE Lighting.
i. Or approved equal.

2.03 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

D. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

E. Plastic Diffusers and Covers:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless different thickness is indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.04 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body. Comply with UL 924.

1. Emergency Connection: Operate 1 LED lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night-Light Connection: Operate one LED lamp continuously.

3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

b. Indicator Light: LED indicates normal power on. Normal

glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.

5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.05 LED LUMINAIRES

A. LED luminaires shall provide a continuous and controllable light source. Lamp output and dimensions shall be in accordance with Contract Drawings and Specifications.

B. LED Luminaires shall include but not limited to, light source luminaire, power supply and control interface with added components as needed for complete and functioning system.

C. LED luminaire lumen output will be in accordance with specifications and shall not depreciate more than 20 percent after 10,000 hours of use. Rated lumen output for LED specifications and shall not depreciate more than 20 percent after 10,000 hours of use.

D. Rated lumen output for LED luminaires to operate in ambient temperature of minus 4°F -20°C to 122°F +50°C. Luminaires to have minimum life of 50,000 hours.

E. LED fixture shall comply with ANSI chromaticity standards for classifications and color temperature.

F. All LEDs used in the LED luminaires will be of high brightness and proven quality. All LEDs shall be driven digitally with pulse width modulation control to prolong life and maintain consistency of lumen output.

G. All connections to luminaires will be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

H. Fuse Protections: All power supply outputs will be either fuse protected or PTC-protected as per Class 2 UL listing. All luminaires will have built-in fuse protection. All power supplies will provide for knockouts for conduit connections or clamp-style connection for the low-voltage wiring.

I. LED fixture shall be UL listed and labeled.

J. Luminaire testing shall be per IESNA LM-79 and IESNA LM-80 procedures.

K. LED Lamp life for white LEDs shall be 50,000 plus hours with lamp failure occurring only after LED had produces 70 percent of initial rated lumens.

L. Lamp life for colored LEDs shall be 30,000 plus hours with lamp failure occurring only after LED had produces 50 percent of initial rated lumens.

M. Provide shop drawings, with LED systems based on lumens output at 70 percent lumen depreciation for white LEDs and 50 percent lumen depreciation for color LEDs.

N. LED Drivers: reverse polarity protection, open circuit protection, require no minimum load. Minimum 90 percent efficiency. Class A noise rating.

O. Dimming: LED system capable of full and continuous dimming

P. LED light source manufacturers : Nichia, Cree, Osram Sylvani, GE Lumination or approved equal.

Q. Special types as indicated in luminaire schedule.

2.06 LED DRIVERS (POWR SUPPLIES)

All LED drivers to be compatible with LEDs. All LED luminaires and drivers (power supplies) shall be furnished by single manufacture to insure compatibility.

A. Electric Characteristics (at 77°F ambient temperature)

1. Input Voltage Range - 120V to 277V

2. Efficiency Minimum - 80%

3. Output Current Regulation Range (+/-) 5%A

4. Total Harmonic Distortion (THD) - 20% maximum

5. Power Factor - 0.9 minimum

6. Crest Factor (LED Current) - 1.5 maximum

7. FCC Class B for Conducted EMI

8. FCC Class A for Radiated EMI

9. Drivers life - 50,000 hours minimum

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm) Coordinate first paragraph below with Drawings to identify humid spaces.

D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated,

threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.01 INSTALLATION

A. Luminaires: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each luminaire.

1. Do not support luminaires to the work of other trades unless otherwise specified or noted.

2. All luminaires shall be independently supported from structure. Provide all necessary additional supports and hangers to securely fasten and support all luminaires to structure.

B. Suspended Luminaire Support: As follows:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers.

3. Continuous Rows: Use supports specified, installed according to luminaire manufacturer's written instructions and details.

C. Surface-Mounted Luminaire Support:

1. Luminaires containing ballasts shall be mounted with a minimum of 1-1/2 inch spacers where mounted on combustible materials, unless specifically approved for the application.

D. Lighting fixtures in equipment rooms shall not be installed until after all piping and ductwork is in place. Lighting fixture layout shown on the drawings is typical layout for bid purposes, but shall be modified to provide adequate lighting of the equipment space according to final construction conditions. Any relocation of fixtures due to duct or piping interference shall be as directed by the Contracting Officer at no expense to the Contracting Officer.

E. Fixtures located on exterior of the building shall be installed so as to maintain a weatherproof installation.

F. Direct connected recessed fixtures in removable ceilings shall be connected to the branch circuit wiring from an accessible junction box.

G. Lighting fixtures shall not be installed where finished coat or paint has been applied to surface until paint is thoroughly dry.

3.02 CONNECTIONS

A. Luminaire outlet boxes shall be grounded to the grounding system.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.03 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Provide instruments to make and record test results.

C. Tests: As follows:

1. Verify normal operation of each luminaire after installation.

2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

3. Verify normal transfer to battery source and retransfer to normal.

4. Check excessively noisy LED fixtures.

5. Report results in writing.

D. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
E. Corroded Luminaires: Replace during warranty period.

F. Whenever luminaires are used for work lights during construction they shall be relamped with the Project specified lamp just prior to turnover of the project to the Contracting Officer.

3.04 CLEANING AND ADJUSTING

A. Clean luminaires internally and externally after installation. Use methods and materials recommended by manufacturer.

-- End of Section --

SECTION 26 90 30

PROGRAMMABLE LOGIC CONTROLLERS
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 ABBREVIATIONS

A. PLC: Programmable Logic Controller.

B. RTU: Remote Terminal Unit.

C. HMI: Human Machine Interface.

1.03 REFERENCES

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 1131-1	Programmable Controllers - Part 1: General Information
IEC 1131-2	Programmable Controllers Part 2: Equipment Requirements and tests
IEC 1131-3	Programmable Controllers - Part 3: Programming Languages.
IEC 1131-4	Programmable Controllers - Part 4: User Guidelines
IEC 1131-5	Programmable Controllers - Part 5: Communications
IEC 60529	Classification of Degrees of Protection Provided by Enclosures

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA 1	(2015) Standard for Good Workmanship in Electrical Construction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers,

	Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment
UL 508A	(2013; Reprint Jun 2017) UL Standard for Safety Industrial Control Panels

1.04 SUMMARY

A. This Section includes the following:

1. This Specification covers the PLC which operates the GETS facility, and covers the remote PLCs which control specific components of the plant and which must interface with the plant PLC. If deviations from these specifications are needed, submit in writing to the Contracting Officer for review and approval before changes are made.

2. The PLCs shall be Modbus and Ethernet Compatible to communicate with other RTU/PLC equipment, and other peripheral equipment. The communication protocol shall be Ethernet using Modbus Ethernet TCP/IP.

3. All Components shall be designed for operation within a temperature range of 30 degrees F to 100 degrees F in 20% to 95% relative humidity. The processors shall perform self-diagnosis and diagnosis of other components which are part of the system process, and upon detection of malfunction or other trouble, an alarm output shall be given, identifying the failed component.

4. The PLC shall be programmable through the operator's computer or through a laptop computer through either a USB port or Ethernet port and shall be able to tie to the computer system through either a USB port or Ethernet port. The Computer shall tie to the Plant System for operator interface and for data transfer through an Ethernet tie.

5. Modification of the operating program or changing of any setpoints shall be possible only through the Computer at the PLC, or by input from a Laptop plugged into the PLC directly. Changing the operation program shall be password protected.

6. Some functions processed by one PLC will rely upon data received through another PLC and some operations commanded by one PLC will be carried out through another PLC.

7. One (1) PLC units shall be interfaced for complete control of the plant:

   a. One (1) PLC unit at the GETS facility for control and operation and process and instrumentations at the entire facility.

6. Operator control of all PLCs shall be possible through either Computer inside the office space at the GETS facility or by user interface through a Human Machine Interface to be located on the at the PLC enclosure at the GETS facility.

1.05 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:

   1. Division 25 Section 25 01 00 MASTER CONTROL SYSTEM.

B. Provide materials, equipment, programming and services as required to install programmable logic controllers with memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

C. Provide and Install programmable logic controller systems with I/O as scheduled on the Contract Drawings.

D. Software Configuration Rights:

   1. The software configuration files shall become the property of the Contracting Officer. Identify all protection methods and turn over all keys and passwords to the Contracting Officer.

   2. System supplier shall draft an agreement with the Contracting Officer, to be reviewed by the Engineer, identifying any consequences arising from modifications to the configuration files not authorized in writing by the system supplier during the specified warranty period. This agreement will be signed by the Contracting Officer and supplier and copies of the document distributed to all parties. Unauthorized modifications to software configuration during the warranty period will result in a void warranty.

1.06 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

For the Equipment Specified; G

SD-03 Product Data

Software Configuration; G

Coordination Requirements; G, AE

Software Installation Media; G

Software Documentation; G

SD-06 Test Reports

Record Of Tests And Inspections; G, AE

SD-05 Design Data

Substantiating Battery Calculations For Supervisory And Alarm Power Requirements; G, AE

SD-07 Certificates

Software License Certificates; G

SD-11 Closeout Submittals

Operation & Maintenance Manuals And Instructions; G

Extra Materials(Spare Parts); G

Instructional Videotape; G

1.07 FACTORY TESTING

A. Refer to the requirements of Section 25 01 00 MASTER CONTROL SYSTEM.

1.08 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under Section 25 01 00 MASTER CONTROL SYSTEM.

C. Submit the following information specifically for programmable logic controllers:

1. As-built printout of all software configuration including data tables, ladder logic, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.

2. Electronic documentation shall include fully annotated electronic copies of all PLC programs . As-built documentation shall include all changes made during the first year of

operation.

3. Software configuration files shall be included in the manual in two forms:

   a. CD ROM.
   b. Paper.

D. Submit software license certificates, manufacturer provided software documentation, and software installation media.

1.09 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused from current manufacturer.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:

   a. NFPA 70 - National Electrical Code and state amendments thereto.

   b. IEEE C37.90 - IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

2. International Electrotechnical Commission (IEC), Specifications and Standards, current edition:

   a. IEC 1131-1. Programmable Controllers Part 1: General Information.

   b. IEC 1131-2. Programmable Controllers Part 2: Equipment Requirements and tests.

   c. IEC 1131-3. Programmable Controllers - Part 3: Programming Languages.

   d. IEC 1131-4. Programmable Controllers - Part 4: User Guidelines.

   e. IEC 1131-5. Programmable Controllers - Part 5: Communications.

f. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures

3. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:

a. NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.

b. NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

c. NFPA 70 - National Electrical Code

4. National Underwriters Laboratories, Inc. (UL), Specifications and Standards, current edition:

a. UL 508 - Industrial Control Equipment.

b. UL 508A - Industrial Control Panels.

c. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.10 WARRANTY

A. See Division 01 for additional requirements.

1.11 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Supply one spare 120VAC discrete input/output module of each type supplied for this project.

C. Supply one spare 24VDC analog input/output module of each type supplied for this project.

D. Supply one spare processor of each type supplied for this project

PART 2 PRODUCTS

2.01 PROJECTS REQUIREMENTS

Contractor shall submit the following information for all specified materials and services provided.

A. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation and control system and in accordance with the requirements specified under the process specifications.

B. Submit the following information specifically for programmable logic controllers:

1. Software configuration consisting of data tables, ladder logic, and other parameters.

2. Identify coordination requirements with other sections.

2.02 MANUFACTURERS

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

1. Allen-Bradley/Rockwell Automation.
2. Siemens Automation.
3. Motorola.
4. Or approved equal.

2.03 GENERAL SYSTEM REQUIREMENTS

A. Common Hardware Specifications

1. Environmental

a. Ambient Temperature Rating

1) Operating: 0 to 60 degrees C
2) Storage: -40 to 85 degrees C

b. Humidity: 5 to 95 percent non-condensing
c. Shock:

1) Operating: 30 Gs (3 pulses, 11 mS)
2) Non-operating: 50.0 Gs (3 pulses, 11 mS)

d. Vibration:

1) Vibration Operating: 1.0 G at 5 to 2000 Hz
2) Non-operating: 2.5 Gs at 5 to 2000 Hz

e. Free Fall (drop test):

1) Portable, 2.268 kg (5 lbs) or less at 0.762m (six drops)
2) Portable, 2.268 kg (5 lbs) or more at 0.1016m (three flat drops)

f. Electromagnetic Compatibility:

1) Showering Arc: 1.5 kV Per NEMA ICS 2/NEMA ICS 3
2) Surge Withstand Capability: 3 kV per ANSI/IEEE C37.90
3) Fast Transient Burst (impulse): 2 kV for power supplies, 1 kV for I/O and communication lines over 10m, 5 nS rise time
4) Electrostatic Discharge: 15 kV, 100 pF/1.5 kohm model
5) Radiated Electromagnetic Susceptibility: 5W walkie-talkie at 464.5 MHz and 153.05 MHz.
6) Noise Immunity: NEMA Standard ICS 2

2. Safety:

a. Dielectric Withstand: 1500VAC per UL 508
b. Isolation between communication circuits: 500 VDC
c. Isolation between backplane and I/O: 1500 VAC

d. Flammability and Electrical Ignition: UL 94 V-0

e. Certification:

1) UL listed
2) CSA certified
3) CUL listed
4) Class 1, Groups A, B, C or D, Division 2
5) CE compliant for all applicable directives

B. Configuration

1. The programmable controller, associated I/O, chassis, and power supplies shall be of a modular design. The programmable controller and I/O modules shall mount into the chassis

2. Processor Systems shall include processor, power supply, input/output modules, communication modules, and remote interface modules as required to meet system requirements.

3. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.

4. Modules are to be supplied as specified unless system requirements dictate the use of alternative modules.

C. Selection

1. The programmable controller shall be selected from a family of programmable controllers with memory capability ranging up to 7.5Mbytes.

2. All system and signal power to the controller and support modules shall be distributed on a single motherboard or backplane.

3. All system modules including the processor shall be removable from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.

4. All system modules and chassis shall be designed to provide for free airflow convection cooling.
5. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to insure that the physical module is consistent with what was configured for the corresponding slot.

D. Programming:

1. Minimum Programming Instruction Set:

a. Language Characteristics: Ladder diagram
b. Logic Operations: AND, OR, XOR, NOT

c. Register Operations: Store, recall
d. Math Operations: Addition, subtraction, multiplication, division, square root, matrix operations
e. Process Control: Proportional-Integral-Derivative

2.04 PLC SYSTEM

A. Processor Unit:

1. Processor Memory:

a. Program memory of 1.5 Mbytes as dictated by the application. Compact flash memory card shall provide 64 Mbytes non-volatile memory.
b. All user memory in the processor not used for program storage shall be for the purpose of data storage.

2. Performance:

a. Capability of controlling up to (30) I/O modules
b. Typical Throughput Time of 0.08 ms/K based upon a 1K ladder logic program consisting of simple ladder logic and communications servicing
c. Bit Execution Time of less than 0.51 microseconds
d. Proportional Integral Derivative Control with up to 451 microsecond execution time
e. Online programming including runtime editing

3. Features:

a. Standard RAM Memory Back-up provided through minimum two year lithium battery
b. LED indicators for: POWER, RUN, CPU Fault, Forced I/O, Battery Low, DH485, RS-232
c. One RS-232 port that supports RS-232 DF1 full-duplex or DF1 half-duplex slave, DH-485, Modbus RTU Slave and ASCII protocols
d. One Ethernet/IP port
e. Real Time Clock
f. Key Switch Positions for Remote, Program and Run

B. Discrete AC Input and Output Modules:

1. Manufacturer:

a. 16-Point, 120VAC Input Module:
b. 16-Point, 120VAC Output Module:
c. 16-Point, Contact Output Module:

2. 16-Point, 120VAC Input Module:

a. Operating voltage of 79 to 132VAC
b. Sixteen non-isolated Inputs
c. Removable terminal block

1) Terminal identification diagram one each module
2) Terminal blocks to have barriers on 3 sides
3) Optical isolation between digital and field circuits
4) Wiring terminals with self-lifting pressure plates to

secure two No.14 AWG wires

d. LEDs to indicate the status of each I/O point
e. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

3. 16-Point, 120VAC Output Module:

a. Quantity of sixteen outputs
b. Output Voltage Range of 85-265VAC
c. Output Current Rating:

1) Per Point: 0.5A maximum at 30 degrees C; 0.25A maximum at 60 degrees C; Linear Derating
2) Per Module: 8A maximum at 30 degrees C; 4A maximum at 60 degrees C; Linear Derating

d. Surge Current per Point of 20A for 43ms each, repeatable every 2s at 60 degrees C
e. Minimum Load Current of 10mA per point
f. Maximum On-State Voltage Drop of 1.5V peak at 2.0A and 6V peak at load less than 50mA
g. Maximum Off-State Leakage of 3mA per point

4. 16-Point, Contact Output Module:

5. Voltage rating of 5 to 265VAC

6. Sixteen individually isolated relay outputs

7. Continuous current rating per point: 2.5A ac not to exceed 1440 VA for the module

8. Continuous current rating per module: 16 A ac, 2.5A / common

9. Removable terminal block:

a. Configuration

1) Terminal identification diagram on each module
2) Terminal blocks to have barriers on 3 sides
3) Optical isolation between digital and field circuits
4) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

b. LEDs to indicate the status of each I/O point
c. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

C. Analog Input and Output Modules:

1. Differential Analog Input Module:

a. Eight input channels per module
b. Ratings:

1) Current Rating of 0 to 20mA, 4 to 20mA
2) Voltage Rating of Plus/Minus 10VDC, 0 to 10VDC, 0 to 5VDC, 1 to 5VDC
3) Current Terminal Impedance:

(a) Current Rating of 250 Ohms
(b) Voltage Rating of 220 Kohm

4) Resolution of 14 bits

c. Overall Accuracy:

1) Current Terminal Rating of Plus or Minus 0.35 percent full scale at 25 degrees C
2) Voltage Terminal Rating of Plus or Minus 0.2 percent full scale at 25 degrees C
3) Non-linearity of plus or minus 0.03 percent of full scale
4) Repeatability of plus or minus 0.03 percent

d. Input channel configuration via configuration software screen or the user program
e. Input Group to Bus Isolation of 500VAC for (1) minute
f. Removable terminal block:

1) Terminal identification diagram one each module
2) Terminal blocks to have barriers on 3 sides
3) Wiring terminals with self-lifting pressure plates to secure two No.14AWG wires

g. LEDs to indicate the status of each I/O point
h. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

2. Isolated Analog Output Module:

a. Four output channels per module, isolated
b. Ratings:

1) Current Rating of 0 to 20mA, 4 to 20mA
2) Voltage Rating of Plus/Minus 10VDC, 0 to 10VDC, 0 to 5VDC, 1 to 5VDC

c. Loading:

1) Inductive load of 0.1mH maximum for current outputs
2) Resistive load of 0 to 500 Ohm on current output
3) Capacitive load of 1 degree F maximum for voltage outputs
4) Current load of 10mA maximum on voltage output
5) Load range of greater than 1kOhm at 10VDC

d. Resolution of 14 bits
e. Non-linearity (in percent of full scale) of plus or minus 0.05 percent
f. Repeatability (in percent of full scale) of plus or minus 0.05 percent
g. Overall accuracy:

1) Plus or minus 0.35 percent full scale at 25 degrees C for current terminal
2) Plus or minus 0.5 percent full scale at 25 degrees C for voltage terminal

h. Open and short-circuit protection:

1) Output voltage protection
2) Input Group to Bus Isolation of 500VAC for (1) minute

i. Removable terminal block:

1) Terminal identification diagram one each module
2) Terminal blocks to have barriers on 3 sides
3) Wiring terminals with self-lifting pressure plates to secure two No.14 AWG wires

j. LEDs to indicate the status of each I/O point
k. No tools shall be required to install or remove modules. Modules shall have upper and lower panel mounting tabs as well as latches for DIN rail mounting.

D. Power Supplies (Non-Redundant):

1. Selection Requirements:

a. Select capacity of power supply for each rack based upon requirements of modules installed in rack with 20 percent of power supply capacity reserved for future.

2. Features:

a. Line Voltage rating of 85 to 265VAC
b. User Power Capacity of 250mA at 24VDC
c. Short circuit protection via front access fuse with cover
d. 5V and 24V overvoltage protection
e. Line loss ride through of 10ms (minimum) to 10 seconds (maximum)
f. LED to indicate that input power is available
g. Provide terminal blocks with barriers on three sides of each terminal and finger-safe covers.
h. Allows for bank of I/O to be connected to the processor bank I/O via expansion cable.
i. Capability of mounting the expansion bank of I/O either vertically or horizontally in relation to the processor bank of I/O.

2.05 BATTERY BACKUP

A. The PLC System shall be provided with a battery backup power. The battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

B. Storage batteries

1. Submit substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery

recharging period shall be included. Provide storage batteries which are 24 Vdc sealed, lead-calcium type requiring no additional water with ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the PLC system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Locate batteries at the bottom of the telemetry system enclosure panel. Provide batteries with overcurrent protection. Separate battery cabinets shall have a lockable, hinged cover similar to the telemetry system enclosure. The lock shall be keyed the same as the telemetry system enclosure panel.

C. Battery Charger

1. Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Locate charger in control panel cabinet or in a separate battery cabinet.

2.06 HMI TOUCHSCREEN DISPLAY

A. Each PLC system shall be furnished with a HMI (Human Machine Interface) panel capable of displaying parameters from the PLC and allowing control of the PLC via touch screen commands. Panel shall be fully compatible with the PLC furnished and have Ethernet support. Mount panel on the dead front panel of the telemetry enclosure as shown on the drawings. Minimum requirements shall be:

1. Screen size: 7 inches minimum

2. Type: Color Active Matrix TFT

3. Resolution: 64k colors, 800x800 pixel SVGA

4. Touchscreen : Analog Resistive.

5. Keypad: Poly or stainless steel domes membrane

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

1. Siemens Comfort Panel.
2. C-More Industrial.
3. Vartech Systems.
4. Schneider.
5. Rockwell Automation.
6. Motorola.
7. Or approved equal.

C. Agency approvals:

1. C-UL certified
2. UL listed
3. CE marked
4. Class I Div 2, Groups A, B, C, D

D. Environmental:

1. Temperature:

a. Operating: 32 to 131 degrees F
b. Storage: -13 to 158 degrees F

2. Relative Humidity: 5 to 95 percent non-condensing
3. Shock:

a. Operating: 15 g at 11 ms
b. Non-Operating: 30 g at 11 ms

4. Vibration:

a. 0.012 in p-p, 10 to 57 Hz
b. 2 g peak, 57 to 500 Hz

5. Ratings: NEMA Type 12, 13, 4X, IP54, IP65

E. Electrical

1. Input voltage :

a. 85 to 264VAC
b. 47 to 63 Hz

2. Power Consumption: 160 VA maximum

F. Memory:

1. Real-time Clock Battery-backed clock timestamps critical data
2. Application Memory: 64 MB Flash/64 MB RAM or 128 MB Flash/128 MB RAM
3. as needed by application

G. Communications Ports: Ethernet, RS-232, 2 USB

1. Provide USB printer support.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Anchor equipment to building structural elements and support according to requirements in Division 26 "Seismic Controls for Electrical Systems."

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.02 GROUNDING

A. AC Power: Comply with division 26 "Grounding and Bonding for Electronic Systems" for materials and installation requirements.

3.03 WIRE AND CABLE INSTALLATION

A. Low-Voltage Analog Circuits: Install wiring as specified in Division 26 "Low Voltage Electrical Power Conductors and Cables".

B. Connections: Make connections according to manufacturer's wiring diagrams, unless otherwise indicated.

C. Wiring Method: Install wire and cable in metal raceway except where another wiring method is indicated.

3.04 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 ELECTRICAL SYSTEM IDENTIFICATION.

B. Label each monitoring and control module and equipment unit with a unique designation that is consistent with wiring diagrams and schedules in operation and maintenance manual. Label conductors and cables at each end and where exposed within troughs and pull-and-junction boxes.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

2. Electrical Tests: Use caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

a. Continuity tests of circuits.

b. Operational Tests: Set and operate controls at each control panel and at each monitored and controlled device to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Record response to each test command and operation, including logging and printout of events. Record time intervals between initiation of alarm conditions and registration of alarms at control (panel), and between initiation of commands and execution at controlled equipment.

1) Simulate malfunctions to verify protective features and appropriate alarm indications.

3. Seismic-restraint tests and inspections shall include the following:

a. Type, size, quantity, arrangement, and proper installation of mounting or anchorage devices.
b. Test mounting and anchorage devices according to requirements in Section 26 05 48 "VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS".

4. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

5. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

6. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, retests, and inspections. Include printout of testing event log, annotated to provide a machine record of testing that corresponds to written test records.

D. Prepare test and inspection reports.

3.06 DEMONSTRATION

A. Train Government's maintenance personnel to adjust, operate, and maintain systems.

B. Video Training: Provide an instructional videotape covering features, capabilities, and operation of installed control panels. Illustrate actual equipment and related functions. Illustrate adjustment of system set-points. Show cause-and-effect sequences during operation. Cross-reference instruction manuals throughout. Follow same order of presentation as instruction manual. Include the following:

1. Control Panel Operation:

a. Describe and demonstrate indications, controls, and features.

b. Demonstrate responses to all indications.
c. Demonstrate setup of control panels and related equipment.
d. Describe and demonstrate safety and security precautions.
e. Show how to get help.

2. System and Equipment Maintenance:

a. Describe and demonstrate safety and security precautions.
b. Demonstrate basic maintenance; need for qualified technician for internal maintenance; basic maintenance schedule; techniques for keeping terminals properly tightened, filter screens clean, and overheat sensors checked; and techniques for performing other required servicing.
c. Demonstrate adjustment of controls. Describe warranty and show how to get help.

3. System Troubleshooting:

a. Demonstrate troubleshooting procedure for common software, programming, control panel, communications, and field device problems.

-- End of Section --

DIVISION 27 – COMMUNICATIONS

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2)
National Electrical Code

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.03 SUMMARY

A. This Section includes conduit, cabinets, terminal backboards and outlets to form empty raceway systems, for installation of data communication system.

B. Service entrance wiring and premises wiring by Contracting Officer.

C. Equipment by Contracting Officer.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having Jurisdiction.

B. Related Sections include the following:

1. Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".
2. Division 26 Section 26 05 29 "HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS".
3. Division 26 Section 26 05 33.10 "RACEWAYS".

PART 2 PRODUCTS

2.01 COMPONENTS

A. Cabinets: Size as indicated on the drawings, comply with Division 27 Section 27 10 00 "COMMUNICATIONS AND SECURITY GENERAL REQUIREMENTS". Furnish cabinets with backboards.

B. Conduit: Comply with Division 26 Section 26 05 33.10 "RACEWAYS."

C. Pull Boxes, Junction Boxes and Outlet Boxes: Comply with Division 26 Section 26 05 33.20 "BOXES, ENCLOSURES AND CABINETS".

PART 3 EXECUTION

3.01 INSTALLATION

A. Install outlet boxes and conduit.

B. Maintain 12 inches separation between power and telephone service conduits.

C. Provide pull boxes in conduit runs as required in Division 26 Section 26 05 33.20 "BOXES, ENCLOSURES, AND CABINETS".

D. Provide a minimum of one duplex receptacle on a dedicated circuit in each equipment room.

E. Install termination backboards plumb and attach securely at each corner.

3.02 CONNECTIONS

A. Ground equipment.
   1. Install ground terminal at local exchange carrier service location and connect according to Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

3.03 IDENTIFICATION

A. Identify components and circuits according to Division 26 Section 26 05 53 "ELECTRICAL SYSTEMS IDENTIFICATION".

B. Identify communication system backboards and cabinets with the legend "Telephone", "Data", "TV", etc. as appropriate for the installation.

C. Identify telecommunications outlet boxes and pull-and-junction boxes with approved designations.

-- End of Section --

SECTION 27 10 00

COMMUNICATIONS AND SECURITY GENERAL REQUIREMENTS
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Division 26 Electrical

1.02 WORK INCLUDED

A. The Telecommunications Contractor (TC) shall provide all labor, materials and equipment for the complete installation of work called for in the Contract Documents unless otherwise noted.

1.03 REFERENCES

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials

BUILDING INDUSTRY CONSULTING SERVICES INTERNATIONAL (BICSI)

BICSI MANUAL	(2014)Telecommunications Distribution Methods Manual, 13th Edition

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 1000-5-2	Electromagnetic Compatibility (EMC) - Part 5-2: Earthing and Cabling Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-569	(2015d) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-606	(2012b; Add 1 2015) Administration Standard for the Telecommunications Infrastructure
TIA-607	(2011b) Generic Telecommunications Bonding

	and Grounding (Earthing) for Customer Premises
TIA-526-14	(2015c) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

Testing Agency Qualifications; G

SD-03 Product Data

For Each Type Of Product; G, AE

Surface-Burning Characteristics; G, AE

SD-06 Test Reports

Field Quality-Control Reports; G, AE

Source Quality Control Test Results; G, AE

SD-11 Closeout Submittals

Warranty; G

1.05 QUALITY ASSURANCE

A. All communications and security cable and related components shall be installed in a neat and workmanlike manner by a contractor trained in the installation, termination and testing of Category 6 cabling systems.

B. Equipment and materials shall be of the quality and Manufacturer indicated.

C. Where "approved equal" is stated, the equipment shall be equivalent in every way to that of the equipment specified, subject to approval by the Contracting Officer.

D. Communication grounding and bonding shall be in accordance with applicable codes and regulations. The requirements of IEC 1000-5-2 and TIA-607 shall be observed throughout the entire cabling system.

E. Materials and work specified herein shall comply with all applicable requirements of the following codes and standards. All codes and standards are to be construed as current, latest, as amended or as adopted:

1. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
2. TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
3. TIA-606 Administration Standard for the Telecommunications Infrastructure
4. TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
5. NFPA 70 - National Electric Code
6. Building Industry Consulting Services International Standards Manual (BICSI MANUAL) - Telecommunications Distribution Methods Manual

1.06 WARRANTY

A. The TC shall provide to the Contracting Officer a (1) one year warranty on all cable and components installed under this section including labor unless otherwise noted. The warranty shall commence from the date of acceptance by the Contracting Officer.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

The following information will be submitted on all products and services supplied by the Contractor:

A. Product data for each type of product indicated.

B. Performance Requirements:

1. General Performance: Communication cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

2. Field quality-control reports.

3. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

4. Testing Agency Qualifications: An NRTL.

a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

5. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings

of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

6. 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.

7. Telecommunications Pathways and Spaces: Comply with TIA-569.

8. Grounding: Comply with TIA-607.

PART 3 EXECUTION

3.01 TELECOMMUNICATIONS HORIZONTAL CABLE

A. All material and equipment shall be installed in a neat and workmanlike manner.

B. All material and equipment shall be installed per manufacturer's specifications, using methods and tools approved by the manufacturer.

C. Installation and configuration shall conform to the requirements of the current revision levels of TIA-568-C.1 & TIA-569, NFPA 70, applicable local codes, and to the manufacturer's installation instructions.

D. Install horizontal voice and data cables from the Telecommunications Room (TR) to the telecommunications outlet. Support cables via TC provided cable wireways and/or EC provided conduits. The maximum distance from the telecommunications outlet to the horizontal cross-connect within the telecommunications rooms shall be 295 feet.

E. Install horizontal voice and data cables from the Telecommunications Room (TR) to the telecommunications outlet. Support cables via TC provided cable wireways and/or EC provided conduits. The maximum distance from the telecommunications outlet to the horizontal cross-connect within the telecommunications rooms shall be 295 feet.

F. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

G. Install cables without damaging conductors, shield, or jacket. Cables that are damaged or kinked must be replaced. Damaged cables will not be accepted.

H. Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.

I. Label both ends of each horizontal cable with the cable number within 6 inches of terminations.

3.02 GROUNDING

A. Ground all racks, cabinets, frames and ladder racks in accordance with TIA-607 using approved methods and materials.

B. Ground all racks, cabinets, frames and ladder racks to the room grounding bus bar using a minimum #6 AWG conductor.

C. Use 2-hole, long-barrel lugs where ground bonds are fastened to equipment racks, cabinets, frames, ladder racks and busbars. Lugs shall have compression type fittings and be designed for the purpose of bonding equipment to ground. Use factory made bonding conductors where possible. Use proper crimping tools and dies when field installing lugs. Mechanical lugs with screw connections are not permitted. Scrape paint or power coat from equipment racks and ladder racks to bare metal before attaching lugs.

3.03 LABELING

A. Label all cables. Label horizontal cables using Contracting Officer approved labeling scheme. Label horizontal cables at the outlet and patch panel within 12 inches of termination. Label backbone cables to show origination and destination. Affix labels in a visible location. All labels must be machine made and permanently attached.

B. Label all data and voice patch panels per Contracting Officer approved labeling scheme.

C. Label racks, frames and cabinets per Contracting Officer direction.

D. Label network faceplates to match labeling in patch panels in IT cabinet enclosure.

3.04 TESTING

A. The TC shall test 100 percent of all cables installed. Telecommunications cables shall meet or exceed the current TIA-568-C.1 specifications for Category 6 cable. All test reports shall be printed and included in the final record documentation package.

B. UPT Copper Cable

1. The TC shall be responsible for recording all test data.

2. Copies of all test results are to be submitted to the Contracting Officer or authorized representative for review as part of the final record documentation package and remain with the Contracting Officer for their records.

3. Category 6 cabling systems shall be performance verified using an automated test set. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA-568-C.1 standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results

shall include all tests performed, the expected test result and the actual test result achieved.

4. The test shall be a permanent link test, unless otherwise specified by the manufacturer.

5. Provide written results of successful testing of CAT 6 cable runs.

3.05 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

3.06 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test UTP cables according to TIA-568-C.1.

D. Factory test multimode optical fiber cables according to TIA-526-14 and TIA-568-C.1.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy

(Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI MANUAL TDMM, or transferred from instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Prepare test and inspection reports.

-- End of Section --

SECTION 27 13 23

FIBER OPTIC CABLE DISTRIBUTION SYSTEM
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Division 26 Electrical

1.02 WORK INCLUDED

A. The Contractor shall provide all labor, materials and equipment for the complete installation of work called for in the Contract Documents unless otherwise noted.

B. Section includes requirements for fiber optic cable and associated passive components to provide a complete fiber optic cable installation.

C. Active components such as media converters and network switches are specified in Sections related to individual communications subsystems.

D. Contractor shall add new fiber optic cable to ensure connectivity between all facilities as required in this project.

1.03 DEFINITIONS

A. OTDR : Optical Time Domain Reflectometer

1.04 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

All work will conform to the IEC: Electromagnetic Compatibility Standards

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-87-640	(2016) Optical Fiber Outside Plant Communications Cable; 4th Edition

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU G.652	(2009; R 2016) Characteristics of a Single-Mode Optical Fibre and Cable

ASTM INTERNATIONAL (ASTM)

ASTM D1248	(2012) Standard Specification for

	Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM E814	(2013a; R 2017) Standard Test Method for Fire Tests of Penetration Firestop Systems

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

7 CFR 1755.900	(2003) RUS Specification for Filled Fiber Optic Cables

BUILDING INDUSTRY CONSULTING SERVICES INTERNATIONAL (BICSI)

BICSI MANUAL	(2014)Telecommunications Distribution Methods Manual, 13th Edition

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 1000-5-2	Electromagnetic Compatibility (EMC) - Part 5-2: Earthing and Cabling Requirements
IEC 60793-2-50	(2015; ED 5.0) Optical Fibres, Part 2-50: Product specifications – Sectional Specification for Class B Single-Mode Fibres

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

TELCORDIA TECHNOLOGIES, INC. / BELLCORE (TTI)

TTI GR-20-CORE	(2013; Issue 04) Generic Requirements for Optical Fiber and Optical Fiber Cable

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA/EIA-455	(1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
TIA/EIA-598	(2014d) Optical Fiber Cable Color Coding
TIA/EIA-604-12	(2000) FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ
TIA/EIA-604-2	(2004b; R 2014) FOCIS 2 Fiber Optic Connector Intermateability Standard
TIA/EIA-604-3	(2004b; R 2014) Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3
TIA-455-78	(2002b) FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Test Procedures - Attenuation

TIA-455-133	(2003a, R 2013) FOTP-133 - IEC 60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures - Lenth Measurement
TIA-526-7	(2015a) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-568-C.0	(2009; Add 1 2010; Add 2 2012) Generic Telecommunications Cabling for Customer Premises
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-568-C.3	(2008; Add 1 2011) Optical Fiber Cabling Components Standard
TIA-569	(2015d) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA-606	(2012b; Add 1 2015) Administration Standard for the Telecommunications Infrastructure
TIA-607	(2011b) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

UNDERWRITERS LABORATORIES (UL)

UL 94	(2013; Reprint Mar 2016) UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Schedule; G

Fiber Optic Cable Installer Qualifications; G

Splicer Qualifications; G

Manufacturer Qualifications; G

Installer Qualifications; G

Testing Agency Qualifications; G

SD-02 Shop Drawings

Equipment Placement; G, AE

SD-03 Product Data

Product Information In Sufficient Detail To Indicate That Components Meet These Specifications; G, AE

Calculations For Each Fiber Optic Cable Span; G, AE

Cable Running Lists Per Subsystem; G, AE

SD-06 Test Reports

Field Quality-Control Reports; G

Source Quality Control Test Results; G, AE

SD-11 Closeout Submittals

Warranty; G

1.06 QUALITY ASSURANCE

A. All fiber optic cable components and associated componets shall be installed in a neat and workmanlike manner by a contractor trained in the installation, termination and testing of fiber optic cabling systems.

B. Equipment and materials shall be of the quality and Manufacturer indicated.

C. Where "approved equal" is stated, the equipment shall be equivalent in every way to that of the equipment specified, subject to approval by the Contracting Officer.

D. Communication grounding and bonding shall be in accordance with applicable codes and regulations. The requirements of IEC 1000-5-2 and TIA-607 shall be observed throughout the entire cabling system.

E. Materials and work specified herein shall comply with all applicable requirements of the following codes and standards. All codes and standards are to be construed as current, latest, as amended or as adopted:

1. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
2. TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
3. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. TIA-607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises,
5. NFPA 70 National Electric Code
6. BICSI MANUAL Telecommunications Distribution Methods Manual,

1.07 QUALITY CONTROL

A. Fiber Optic Cable Installer and Splicer Qualifications: Provide technicians installing fiber optic cables media, splices and performing system tests who are certified and trained in accordance with an approved manufacturers training program, with a minimum of 3 years experience in installing equivalent Fiber Optic systems. Submit data for approval to the Contracting Officer. Submit technician qualifications for approval 30 days before splices are to be made on the cable. Certification includes the training, and experience of the individual on specific type and classification of Fiber Optic media to be provided under this contract.

1.08 DELIVER, HANDLING AND STORAGE

A. Packing: Ship cable on non-returnable wooden reels. The diameter of the drum shall be at least 20 times the diameter of the cable. Ship cable shall be shipped on reels substantial to withstand reasonable handling and shall be so designed that the inner end of the cable be accessible, but protected from injury. All ends of the cable shall be sealed to prevent entrance of moisture and securely fastened to prevent them from becoming loose during transit.

B. Marking: Label each reel on the outside flange with the following information:

1. Manufacturer's name
2. Contract name and number
3. Cable identification number
4. Cable length
5. Date of manufacture
6. Copy of the factory test results.

1.09 FIELD CONDITIONS

A. Do not install cables that are wet, moisture damaged, or mold damaged.

1. Indications that cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver fiber optic cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period

1.10 WARRANTY

A. The Contractor shall provide to the Contracting Officer a one (1) year warranty on all cables and components installed under this section including labor unless otherwise noted. The warranty shall commence from the date of acceptance by the Contracting Officer.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

The following information will be submitted on all products and services supplied by the Contractor:

A. The Contractor shall provide to the Contracting Officer a (1) one year warranty on all cable and components installed under this section including labor unless otherwise noted. The warranty shall commence from the date of acceptance by the Contracting Officer

B. Product data for each type of product indicated.

1. Submit Product Data Sheets with product information in sufficient detail to indicate that components meet these Specifications. The product model shall be indicated explicitly with arrow or underline on the product sheet submitted.

2. Submit calculations for each fiber optic cable span showing link margin and system gain.

3. Schedule: Submit schedule including identification and description of all major system cutover events or integration activities describing techniques, methods, duration and procedures.

4. Submit cable running lists per subsystem. Lists shall identify the size and type of cable, and identify the termination points of both cable ends. Include cable termination assignments by fiber strand. Specify cable labeling (tags) for each cable per end.

5. Submit drawings showing equipment placement. Include floor or wall profiles showing the location of equipment cabinets. Include vertical cabinet profiles showing the assigned placement of equipment within the cabinet. Depict all equipment within a cabinet, whether said equipment is new or existing.

6. Manufacturer Qualifications: Submit manufacturer's qualifications. Include cable manufacturer's ISO 9001 Certification Number

C. Performance Requirements:

1. General Performance: Communication cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

2. Field quality-control reports.

3. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

a. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.

b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

4. Testing Agency Qualifications: An NRTL.

a. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

2.02 FIBER OPTIC CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AMP Netconnect; a brand of Tyco Electronics Corporation.
2. Belden Inc.
3. CSI Technologies Inc.
4. Or approved equal

B. General Fiber Optic Cable Specifications:

1. All fibers in the cable shall be usable and meet required specifications.
2. The life expectancy of the cable shall be minimum 25 years.
3. The cable shall be designed for installation in underground conduit, wet or dry environments, including alternating wet and dry conditions.
4. All fiber optic cable run in conduits or duct banks shall be an accepted product of the USDA Rural Utilities Service (RUS) 7 CFR 1755.900 and meet the requirements of ICEA S-87-640.

C. Enhanced Single-mode Optical Fiber for Telecommunications Applications:

1. The single-mode fiber utilized in the optical fiber cable shall meet International Telecommunication Union (ITU) recommendation ITU G.652 Table 2 G.652.D;

a. International Electrotechnical Commission (IEC) Standard IEC 60793-2-50 type B.1/G.655-G.655A).3;
b. TTI GR-20-CORE; ICEA S-87-640;
c. RUS 7 CFR 1755.900.

2. Geometry Standards:

a. Cladding Diameter (µm) = 125.0 ± 0.7
b. Core-to-Cladding Concentricity (µm) less than or equal to 0.5
c. Cladding Non-Circularity less than or equal to 0.7 percent
d. Mode Field Diameter @ 1550 nm (µm) = 10.3 ± 0.5
e. Effective Area, Aeff (Characterized): (µm2) = 72
f. Coating Diameter (µm) = 245 ± 5
g. Colored Fiber Nominal Diameter (µm) = 242 ± 7
h. Fiber Curl radius of curvature (m) greater than 4.0 m

3. Optical Standards:

   a. Cabled Fiber Attenuation @ 1310 nm (dB/km) less than or equal to 0.35
   b. Cabled Fiber Attenuation @ 1550 nm (dB/km) less than or equal to 0.25
   c. Point discontinuity @ 1550 nm (dB) less than or equal to 0.25
   d. Cable Cutoff Wavelength (?ccf) (nm) less than or equal to 1480
   e. Total Dispersion (ps/(nmokm))

      1300 nm: < or = 3.0
      1530 - 1565 nm: less than or equal to 18.0
      1565 - 1625 nm: less than or equal to 22.0

   f. Cabled Polarization Mode Dispersion (ps/km) less than or equal to 0.1 max
   g. Water Peak Attenuation @1383+/- 3 nm; less than or equal to 2.1 dB/km

4. Environmental and Mechanical Specifications:

   a. Temperature Cycling -60°C to +85°C
   b. Temperature-Humidity Cycling -10°C to +75°C, 98 percent RH
   c. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m2).
   d. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
   e. Crush Resistance = 10 kN/m (685 Ib/ft) length of cable.
   f. Cable Outside Diameter equal or less than 0.65 inch.
   g. Weight per 1000 linear foot less than or equal to 160lbs

5. Cable Construction (Jacketed and Armored, Duct or Burial):

   a. The cable shall meet the specifications set forth in TTI GR-20-CORE. Cable shall be listed by RUS to ICEA S-87-640 - ISO 9001 - 14001 - TL 9000 and shall be approved for use by RUS.

   b. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be either 2.5 mm or 3.0 mm. Each buffer tube shall contain up to 12 fibers. The fibers shall not adhere to the inside of the buffer tube. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink-back requirements of USDA RUS 7 CFR 1755.900.

   c. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598. The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598. Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1.0 mm. In buffer tubes containing multiple fibers, the colors shall be stable across the specified

storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

d. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fillers shall be placed so that they do not interrupt the consecutive positioning of the buffer tubes. In dual layer cables, any filler shall be placed in the inner layer. Fillers shall be nominally 2.5 mm or 3.0 mm in outer diameter.

e. The central member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to provide tensile strength and prevent buckling. The central member shall be over coated with a thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.

f. Each buffer tube shall be filled with a non-hygroscopic, nonnutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

g. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation, or "S-Z", stranding process. Water wellable yarn(s) shall be applied longitudinally along the central member during stranding.

h. Two polyester yarn binders shall be applied contra-helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage.

i. For single layer cables, a water swellable tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter.

j. Cables shall contain two ripcords under the steel armor for easy armor removal. Additionally, armored cables that have an inner sheath shall also contain one ripcord under the inner sheath.

k. Tensile strength shall be provided by the central member, and additional dielectric yams as required. The dielectric yams shall be helically stranded evenly around the cable core.

l. Cables shall have an inner sheath of Medium Density Polyethylene (MDPE). The minimum nominal jacket thickness of the inner sheath shall be 1.0 mm. The inner jacket shall be applied directly over the tensile strength members (as required) and water swellable tape. A water swellable tape shall be applied longitudinally around the outside of the inner jacket.

m. The armor shall be a corrugated steel tape, plastic-coated on both sides for corrosion resistance, and shall be applied around the outside of the water blocking tape with an overlapping seam with the corrugations in register. The outer jacket shall be applied over the corrugated steel tape armor. The outer jacket shall be a MDPE with a minimum nominal jacket thickness of 1.4 mm. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

n. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class C, Category 4 and Grades J4, E7 and E8. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness.

o. The outer surface of the jacket of each shipping length of cable shall be permanently identified by printing (in a contrasting color) descriptive information on the outer surface of the jacket at intervals of 1500 mm (5 feet) or less. The information shall include identification (Caltrain Communications System), count of fibers, fiber type, date of manufacturing (month and year), manufacturer's part number, manufacturer's name, sequential meter or foot markings, a telecommunication handset symbol as required by National Electrical Safety Code (NESC) Section 350G, fiber count, and fiber type. The actual length of the cable shall be within -0/+1 percent of the length markings. The print color shall be white, with the exception that cable jackets containing one or more co-extruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5mm.

p. If the initial marking fails to meet the specified requirements, i.e., improper text statement, color, legibility, or print interval, the cable may be remarked using a contrasting alternate color. The numbering sequence shall differ from the previous numbering sequence, and a tag shall be attached to both the outside end of the cable and to the reel to indicate the sequence of remarking. The preferred remarking color shall be yellow, with the secondary choice being blue.

2.03 OPTICAL-FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. AMP Netconnect; a brand of Tyco Electronics Corporation.

2. Belden Inc.
3. CSI Technologies Inc.
4. Or approved equal.

B. Rack Mountable:

1. All rack-mounted hardware shall be mountable in an EIA compatible 19 inch rack. One EIA rack space is defined as being 1-3/4 inch in height with mounting holes on each side of the rack and center to center hole spacing. The center to center distance of the bottom hole in a rack space to the top hole in the next lower rack space is 1/2 inch. A wall mounting kit shall be provided when wall mounting is required.

2. The connector housing shall be single cabinet construction and combine splicing and terminations in one unit.

3. The unit shall be mounted with a nominal 4-1/4 inch frontal projection.

4. There shall be full access to the front and rear of the housing.

5. The rack-mounted housings shall meet the requirements of TIA-568-C.1 and UL 94V-0.

6. Housings shall be manufactured using 16 gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. All fasteners shall be black chromated to match the housing. The housing shall have a durable, polycarbonate-tinted front door for viewing patch cords.

7. The housing shall have multiple grommeted cable entry and grommeted patch cord exit locations.

8. The housing shall support single mode and multimode applications.

9. The housing shall have provisions for a clamshell type cable clamping mechanism to provide cable strain relief.

10. The housing shall have locations available for locking the front and/or rear door.

11. Front and rear doors of the connector housings shall be hinged and removable to ease installation. Front and rear doors shall utilize a slam latch to provide quick access and closing.

12. The connector panel housings shall use a strain relief bracket which shall allow the user to install up to two clamshell type cable strain relief on the side of the housing.

13. The connector housings shall have a labeling scheme that complies with TIA-606.

C. Jumper Management Panels: The rack mount hardware shall incorporate In-rack and vertical jumper management techniques. In-rack management panels shall be available to provide jumper

routing to the connector housings and electronic hubs.

1. In-Rack jumper management panels shall be available in 1-RMS, 2-RMS and 3-RMS sizes and shall have removable front covers to conceal and protect the jumpers when installation is complete. The front of the jumper management panel cover shall be flush with the front door of the connector housing.

2. Jumper management panels shall be designed to maintain a 1-1/2 inch minimum bend radius when transitioning between routing panels and frame verticals or connector housings and shall be finished with a wrinkled black powder coat for durability. All fasteners shall be black chromated to match the housing.

3. The vertical jumper routing area shall have vertically adjustable cable retaining rings. The adjustable routing rings shall include a swing out door for ease in jumper routing. The sides of the rings shall have radius guides to provide minimum bend radius control. The rear side of the vertical routing area shall also provide cable retaining rings that hold data cables close to the rack to eliminate accidental snags from maintenance personnel.

4. Slack storage spools shall be provided when jumper slack storage is required in-rack.

5. Slack storage shall be available using both In-Frame and vertical storage.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

F. Cable Connecting Hardware:

1. Comply with Optical-Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3, and TIA/EIA-604-12. Comply with TIA-568-C.3.

2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss of not more than 0.75 dB.

3. Type SFF connectors may be used in termination racks, panels, and equipment package

2.04 WIRE PULLING LUBRICANT

A. Wire Pulling Lubricant shall have the following characteristics:

1. Polymer-based.

2. Average Coefficient of Friction: less than or equal to 0.055.

3. Temperature Range: -28 degrees F -180 degrees F.

4. Compatible with all cable types.

2.05 SOURCE QUALITY CONTROL

A. Factory tests shall be performed in accordance with TIA/EIA-455.

B. Cable shall be tested on-reel prior to shipment.

C. End to end loss shall be recorded for each fiber at 1,310 nm, 1,550 nm and 1,625 nm (for Single-mode).

D. End to end loss shall be recorded for each multi-mode fiber at 850nm and 1,300 nm.

E. OTDR with hardcopy record shall be provided for each single mode fiber at 1,300 nm, 1,550 nm and 1,625 nm.

F. OTDR with hardcopy record shall be provided for each multi-mode fiber at 850 nm and 1,300 nm. G. Polarized Modal Dispersion (PMD) for each single mode fiber shall be measured using a PMD analyzer and polarized light source.

G. Chromatic optical dispersion shall be tested for each single mode fiber.

H. Certified copies of tests results shall be submitted to the Contracting Officer as described in these specifications 14 days after completion of each test.

PART 3 EXECUTION

3.01 INSTALLATION:

A. All fiber optic cable installation shall be accomplished in accordance with the Contract Documents.

B. All fiber optic cable shall be installed in inner-duct. OSP fiber optic cable shall be installed in inner-duct as indicated on the construction drawings through existing handholes, existing duct bank conduits. All duct bank four inch communications conduits serving fiber optic cable shall contain a minimum of four 1 inch inner-ducts each. No more than one OSP fiber optic cable shall be installed in a single inner-duct. The inner-duct shall be installed without coils or twists.

C. Pull locations shall be selected to protect the cable on the reel and in slack loops. Contractor shall be responsible for protecting cable after working hours where cable installation is not completed during a single shift. Cables damaged due to Contractor's negligence while installing cable shall be replaced by the Contractor.

D. Pull lengths shall be designed to allow a 20 percent margin in cable tensile strength. Do not exceed the lesser of 80 percent of the cable's maximum tensile rating or 600 lbs during installation. No residual tension shall remain on the cable after installation

except that due to the cable's weight in the vertical rise. Wire pulling lubricant shall be used to reduce tension on the cable during the installation process.

E. If a winch or pulling machine is used during installation, a dynamometer shall be used to monitor the tension on the cable. The dynamometer shall be certified as calibrated and shall hold the peak value of the cable pull. The peak value shall be recorded and submitted as part of the installation test data submittals.

F. The maximum vertical rise shall be defined as the distance over which the cable is self-supporting. Cable strain relief shall be used at the top of each vertical rise and no less than every time that 80 percent of vertical rise rating of the cable is exceeded.

G. Do not exceed the cable's minimum bend radius for cable under tension or long term installation/storage.

H. Continuity of cable shall be maintained between termination or splice locations shown on the drawings. Additional splices shall not be allowed without the prior written design change approval.

I. Notify the Contracting Officer in writing at least 48 hours in advance of installation of each section of fiber optic cable.

J. All cable entrance openings in equipment enclosures and junction boxes shall be sealed with either a compression type fitting or pliable sealing compound after the cable is in place. Sealing compounds for rooms, houses, walls, or other partitions shall be fire retardant per ASTM E814. Sealing compound shall be used to seal the area around cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed or plugged in accordance and compliance with these Technical Specifications.

K. Lubricant: Use pulling lubricant to minimize pulling tension and prevent sheath damage when pulling cables into ducts and conduits. Apply lubricant to the cable sheath with a lubricator. When pulling has been completed, wipe the exposed cable ends clean of lubricant.

1. Ensure lubricants are compatible with and intended for use with plastic-sheathed cables. Do not allow soap and grease type lubricants.

2. Check all equipment and the pulling set to minimize interruptions once pulling begins. Pull cable without stopping until the required amount of the cable has been placed. When the pulling operation is halted before the pull is completed, do not release the tension of the pulling line. When pulling is resumed, overcome the inertia of the cable by increasing the tension in small steps a few seconds apart until the cable is in motion. Feed the cable from the top of the reel by rotating the reel in the feed direction at the rate of pull. Do not strip cable off the reel by pulling.

L. Seal: Seal ducts or innerduct in which cable is placed with urethane foam duct seal. Insert this material between the cable and the duct or innerduct of which it is in, between the innerduct

and the duct, and in all unused innerduct, in order to prevent damage to the cable sheath and to prevent the entrance of dirt or water into the handhole, manhole or vault. Provide cables in continuous lengths as required to accomplish the required installation without splices from termination to termination, except where

3.02 TERMINATIONS

A. Slack in Fiber Slack Enclosures (FSE's) shall be carefully coiled in order to avoid violating the short and long term minimum bend radius. Supply a minimum of 150 feet of slack at each termination of the cable inside the FSE.

B. Slack in Fiber Distribution Panels (FDP's) shall be restrained and shall be sufficient for strain relief.

C. The central strength member of cable shall be attached to the FDP. The outer jacket of cable shall be attached to the FDP with a cable clamp. D

D. All fiber optic splices shall be fusion splices. Perform splicing at fiber slack enclosures only for the purposes of passing an optical connection through a Communications House. Fusion splicing shall be performed by qualified personnel utilizing a splicer equipped with Local Injection and Detection (LID) to optimize splices. The loss across each spliced fiber shall be less than or equal to 0.04 db.

E. All fiber optical terminations at communications houses and wayside facilities shall be field or factory terminated.

F. Notify the Contracting Officer in writing at least one week in advance of terminating each section of optical cable.

G. Where armored cable is utilized, the armor shall be grounded to the communications room ground bus at one termination location.

3.03 FIELD QUALITY CONTROL

A. Cable Factory Tests: See Source Quality Control herein.

B. Cable Plant Field Tests:

1. Tests shall be performed after installation is complete.

2. One week advance notice shall be provided in writing to the Contracting Officer.

3. Optical attenuation from FDP to FDP shall be recorded.

4. Every fiber optic cabling link shall be tested in accordance with the field test specifications defined by the TIA-568-C.3 (or by the required network application standards) whichever is more demanding.

5. TIA-568-C.3 shall be used to define the passive cabling network, to include cable, connectors, and splices (if present), between two optical fiber patch panels (connecting

hardware). This TIA document shall be used to describe all applicable link segments. Tests shall include the representative connector performance at the connecting hardware associated with the mating of patch cords but not the performance of the connector at the interface with the test equipment.

6. All of the cabling links installed shall be tested and shall pass the requirements of the standards mentioned in above. Any failing link shall be diagnosed and corrected prior to the system acceptance. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Cable Plant Test Result Documentation paragraph specified below.

7. Field test instruments for single mode fiber cabling shall meet the requirements of TIA-526-7.

8. The test instrument calibration date shall be within the calibration period recommended by the vendor in order to achieve the vendor specified measurement accuracy.

9. The fiber optic launch cables and adapters shall be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the test instrument interface adapters.

10. The Pass or Fail condition for the link-under test shall determine by the results of the required individual tests.

C. Cable Plant Performance Test Parameters:

1. In compliance to TIA-568-C.0, the single performance parameter for field testing of fiber optic links shall be link attenuation (insertion loss).

2. The link attenuation shall be calculated by the following formulas specified inTIA-568-C.0:

   a. Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation
   b. Cable Attenuation (db) = Attenuation Coefficient (db/km) x Length (km)
   c. Connector Attenuation (db) = number of connector pairs x connector loss (db). Maximum allowable connector loss = 0.75 db
   d. Splice Attenuation (dB) = number of splices (S) times Splice loss (db). Maximum allowable splice loss = 0.3 db
   e. The values for the Attenuation Coefficient are listed below:

      1) Single mode (outside plant), 1310nm: 0.5 db/km
      2) Single mode (outside plant), 1550nm: 0.5 db/km
      3) Multimode, 850 nm: 3.5 db/km
      4) Multimode, 1300 nm: 1.5 db/km

   f. Link attenuation shall not include any active devices or

passive devices other than cable, connectors, and splices, i.e., link attenuation shall not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

g. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.

3. The above link test limits attenuation is based on the use of the One Reference Jumper Method specified by TIA-526-7, Method A.1 or the equivalent method. The Contractor shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

4. Single-mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with TIA-526-7, Method A.1, One Reference Jumper or the equivalent method. All single-mode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.

D. Optical Time Domain Reflectometer (OTDR) Testing:

1. All cables shall be OTDR tested at 1310 nm and 1550 nm for Single mode operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

2. OTDR tests shall be performed utilizing a pulse suppressor such that the FDP termination shall be shown.

3. All OTDR testing procedures and field test instruments shall comply with applicable requirements of:

   a. TIA-455-78
   b. TIA-455-133

4. Each fiber link and channel shall be tested in one direction.

5. A launch cable shall be installed between the OTDR and the first link connection.

6. A receive cable shall be installed after the last link connection.

7. Optical Return Loss (ORL) for each link shall be measured.

8. Fiber Length shall be measured

9. Test Results:

   a. Reflective events shall not exceed -40 dB
   b. Connections shall not exceed 0.75 dB of attenuation
   c. Non-reflective events (splices) shall not exceed 0.3 db
   d. Point discontinuities shall not exceed 0.1 db
   e. ORL shall be less than -30 dB

10. OTDR Test results shall include OTDR link and channel traces and event tables at the required wavelength(s) and the length for each optical fiber as calculated by the OTDR.

11. An Optical Spectrum scan of each link shall be performed using an optical spectrum analyzer and optical switch to examine fiber nonlinear effects including but limited to Brillouin scattering and four wave mixing across the fiber's usable light spectrum.

12. Polarized Modal Dispersion (PMD) for each link shall be measured using a PMD analyzer and polarized light source. Total PMD for each link shall be less than 10 ps.

E. Cable Plant Test Result Documentation:

1. The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.

2. The test result records saved by the test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test. The popular 'csv' format (comma separated, value format) does not provide adequate protection and shall not be acceptable.

3. The database records of all fiber shall be stored and delivered on CDROM; this CDROM shall include the software tools required to view, inspect, and print any selection of test reports.

4. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information.

    a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
    b. The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
    c. The date and time the test results were saved in the memory of the tester.

5. General Information to be provided in the electronic data base containing the test result information for each link:

    a. The identification of site
    b. The overall Pass/Fail evaluation of the link-under-test
    c. The name of the standard selected to execute the stored test results
    d. The cable type and the value of the 'index of refraction' used for length calculations
    e. The date and time the test results were saved in the memory of the tester
    f. The brand name, model and serial number and calibration data of the tester
    g. The revision of the tester software and the revision of the test standards database in the tester

6. The detailed test results data to be provided in the electronic database for each tested optical fiber shall contain the following information.

    a. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.

    b. The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength and the margin (difference between the measured attenuation and the test limit value).

    c. The link length shall be reported for each optical fiber for which the test limit was calculated based on the formulas specified herein under Cable Plant Performance Test Parameter Paragraphs.

-- End of Section --

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 16 11

INTRUSION DETECTION SYSTEM
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 00 Procurement and Contracting Requirements and Division 01 General Requirements, apply to this Section.

1.02 SUMMARY

A. Provide and install a complete Intrusion Detection System, hereinafter referred to as IDS, as specified in this section. This section includes the following:

1. Provide the IDS with hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Related Sections may include but are not limited to the following:

1. Division 26 Section 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

2. Division 27 Section 27 10 00 COMMUNICATIONS AND SECURITY GENERAL REQUIREMENTS.

1.03 DEFINITIONS

A. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

B. IDS : Intrusion Detection System

C. I/O: Input/Output.

D. Intrusion Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.

E. LED: Light-emitting diode.

F. NEC: National Electric Code

G. NEMA: National Electrical Manufacturers Association

H. NRTL: Nationally Recognized Testing Laboratory.

I. SMS: Security Management System - A SMS is software that incorporates multiple security subsystems (e.g., physical access control, intrusion detection, closed circuit television, intercom)

into a single platform and graphical user interface.

J. PIR: Passive infrared.

K. RF: Radio frequency.

L. Standard Intruder: A person who weighs 45 kg (100 lb.) or less and whose height is 1525 mm (60 in) or less; dressed in a long-sleeved shirt, slacks, and shoes.

M. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

N. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

O. UPS: Uninterruptible Power Supply

1.04 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/SIA CP-01	Control Panel Standards-Features for False Alarm Reduction

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 72	(2016) National Fire Alarm and Signaling Code

UNDERWRITERS LABORATORIES (UL)

UL 634	(2007; Reprint Mar 2015) Connectors and Switches for Use with Burglar-Alarm Systems
UL 639	(2007; Reprint May 2012) Standard for Intrusion Detection Units

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Riser Drawing For Each Applicable Security Subsystem; G, AE

System Drawing For Each Applicable Security System; G, AE

Detail And Elevation Drawings For All Devices; G, AE

SD-03 Product Data

Manufacturer Security System Product Cut-Sheets; G, AE

SD-03 Product Data

Schedule For All Of The Applicable Security Subsystems; G, AE

SD-07 Certificates

Certificates Of Compliance; G

Manufacture's Certification Of Underwriters Laboratories, Inc. (Ul) Listing; G

SD-10 Operation and Maintenance Data

Maintenance And Operating Manuals; G

SD-11 Closeout Submittals

As-Built Packages; G

1.06 COORDINATION

A. Coordinate arrangement, mounting, and support of intrusion detection system equipment: To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

1. To provide for ease of disconnecting the equipment with minimum interference to other installations.

2. To allow right of way for piping and conduit installed at required slope.

3. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in Cast-in-Place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed.

1.07 EQUIPMENT AND MATERIALS

A. General

1. All equipment associated within the IDS shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

2. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.

3. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.

4. All equipment and materials for the system will be compatible to ensure functional operation in accordance with requirements.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

The following information will be submitted on all products and services supplied by the Contractor:

A. Provide certificates of compliance meeting the requirements indicated in the specification.

B. Provide a shop drawing and as-built design package in both electronic format and on paper, minimum size 1220 x 1220 millimeters (48 x 48 inches); drawing submittals shall be per the established project schedule.

C. Shop drawing and as-built packages shall include, but not be limited to:

1. Index Sheet that shall:

a. Define each page of the design package to include facility name, building name, floor, and sheet number.
b. Provide a list of all security abbreviations and symbols.
c. Reference all general notes that are utilized within the design package.
d. Specification and scope of work pages for all security systems that are applicable to the design package that will:

1) Outline all general and job specific work required within the design package.
2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.

2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:

a. Include a title block as defined above.
b. Define the drawings scale in both standard and metric measurements.
c. Provide device identification and location.
d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
e. Identify all pull box and conduit locations, sizes, and fill capacities.
f. Address all general and drawing specific notes for a particular drawing sheet.

3. A riser drawing for each applicable security subsystem shall:

a. Indicate the sequence of operation.
b. Relationship of integrated components on one diagram.
c. Include the number, size, identification, and maximum lengths of interconnecting wires.
d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.

4. A system drawing for each applicable security system shall:

a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
b. Provide full detail of all system components wiring from point-to-point.
c. Identify wire types utilized for connection, interconnection with associate security subsystems.
d. Show device locations that correspond to the floor plans.
e. All general and drawing specific notes shall be included with the system drawings.

5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:

a. Device ID.
b. Device Location (e.g., site, building, floor, room number, location, and description).
c. Mounting type (e.g., flush, wall, surface, etc.).
d. Power supply or circuit breaker and power panel number.
e. In addition, for the IDS, provide the sensor ID, sensor type and housing model number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

D. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

E. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified.

F. Provide all maintenance and operating manuals.

2.02 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at central-station control unit and actuate audible and visual alarm devices.

2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or controller failure.

3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or controller.

B. System Control: Central-station control unit shall directly monitor intrusion detection units and connecting wiring.

C. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

D. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.

2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.

3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.

4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.

5. Protected Zone Test: Initiate operational test of a specific protected zone.

6. System Test: Initiate system-wide operational test.

E. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly;

specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

F. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.03 SYSTEM COMPONENT REQUIREMENT

A. Compatibility: Detection devices and their communication features, connecting wiring, and central-station control unit shall be selected and configured with accessories for full compatibility with the following equipment:

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More.

2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements.

C. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHz.

D. Tamper Protection: Tamper switches on detection devices, controllers, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Central-station control-unit alarm display shall identify tamper alarms and indicate locations.

2.04 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, stainless steel.

D. Corrosion Resistant: NEMA 250, Type 4X, stainless steel.

2.05 EQUIPMENT ITEMS

A. General: All requirements listed below are the minimum specifications that need to be met in order to comply with the IDS.

1. All IDS sensors shall conform to UL 639, Intrusion Detection Standard.

2. The IDS provided shall not limit the expansion and growth capability to a single manufacturer and shall allow modular

expansion with minimal equipment modifications.

B. IDS Components: The IDS shall consist of, but not be limited to, the following components:

1. Control Panel

2. Exterior Detection Devices (Sensors)

3. Interior Detection Devices (Sensors)

4. Power Supply

5. Enclosures

2.06 CONTROL PANEL

A. The control panel shall be the main point of programming, monitoring, accessing, securing, and troubleshooting the IDS. Refer to American National Standards Institute (ANSI) ANSI/SIA CP-01 Control Panel Standard-Features for False Alarm Reduction.

B. The Control Panel shall provide a means of reporting alarms to an Physical Access Control System and Database Management via a computer interface or direct connection to an alarm control monitoring panel.

C. The Control panel shall utilize a Multifunctional Keypad, Input and Output Modules for programming, monitoring and controlling the IDS.

D. The Control panel shall meet or exceed the following minimum functional requirements for programming outputs, system response, and user interface:

1. Programming Outputs:

a. 2 Amps alarm power at 12 VDC
b. 1.4 Amps auxiliary power at 12 VDC
c. Four alarm output patterns
d. Programmable bell test
e. Programmable bell shut-off timer

2. System Response:

a. Selectable point response time
b. Cross point capability
c. Alarm verification
d. Watch mode
e. Scheduled events arm, disarm, bypass and un-bypass points, control relays, and control authority levels

3. User Interface:

a. Supervises up to eight command points (e.g., Up to 16 unsupervised keypads can be used)
b. Provides custom keypad text
c. Addresses full function command menu including custom

functions
d. Allows user authority by defined area and 16-character name
e. Provides for 14 custom authority control levels allowing user's authority to change, add, delete pass codes, disarm, bypass points, and start system tests.

4. The Control panel shall meet or exceed the following technical characteristics:

Input Voltage via 110 VAC or 220 VAC Step-down Transformer	16 or 18 VAC
Operating Voltage	12 VDC
Output Voltage	12 VDC @ 2 A max
Direct Hardwire Zones	7
Partitions	8
Multifunctional Keypads	16 (2 per partition)
Communications Port	RJ-11

E. A multifunctional keypad shall be utilized as a user interface for arming, disarming, monitoring, troubleshooting, and programming the alarm control panel.

F. Keypads shall have the following features:

1. Multiple function keypads suitable for remote mounting, no greater than 4000 ft, shall be provided from the control panel and have a light emitting diode (LED) readout of alarm and trouble conditions by zone.

2. An alphanumeric English language display, with keypad programmability, and EE-PROM memory, shall also be provided.

3. Trouble alarm indicators shall be distinguishable from intrusion alarms.

4. A minimum of four (4) zones selectable as entry and exit with programmable time delay.

5. Complete system test activated capability at the keypad.

6. Capability for opening and closing reports to a remote monitoring location.

7. Adjustable entry and exit delay times.

8. Capability for a minimum of two (2) multiple function keypads.

9. Capability to shunt or bypass selected interior zones while arming perimeter protection and remaining interior zones.

10. Capability for a minimum of seven assignable pass-codes that are keypad programmable from a suppressed master code.

11. The control panel shall have a communications port that will allow for communications with a computer for programming, monitoring, and troubleshooting purposes. The communications port will be, at a minimum, and RJ-11 or better.

12. The control panel will have a systems success probability of 95 percent or better, and shall include the following success considerations:

    a. False Alarm: Shall not exceed one (1) false alarm per 30 days per sensor zone.

    b. Nuisance Alarm: Shall not exceed a rate of one (1) alarm per seven (7) days per zone within the first 60 days after installation and acceptance. Sensor adjustments will be made and then shall not exceed one (1) alarm per 30 days.

13. The Control Panel will be able to detect either a line fault or power loss for all supervised data cables.

    a. Line Fault Detection: Communication links of the IDS shall have an active mode for line fault detection. Fault isolation at the systems level shall have the same geographic resolutions as provided for intrusion detection. The line fault alarm shall be clearly distinguishable from other alarms.
    b. Power Loss Detection: Provide the capability to detect when critical components experience temporary or permanent loss of power and annunciate to clearly identify the component experiencing power loss.

2.07 POWER SUPPLY

A. A power supply shall only be utilized if the control panel is unable to support the load requirements of the IDS system.

B. All power supplies shall be UL rated and able to adequately power two entry control devices on a continuous base without failure.

C. Power supplies shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ 2 amp
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC) Filtered and Regulated
BATTERY	Dependent on Output Voltage shall provide up to 12VDC, 7Ah, rechargeable
OUTPUT CURRENT	4 amp max. @ 13.8 VDC 3 amp max. @ 27.6 VDC
BATTERY FUSE SIZE	3.5 A @ 250 VAC
CHARGING CIRCUIT	Built-in standard

2.08 KEYPADS

A. Keypads shall meet or exceed the following technical characteristics:

Connections	4-wire flying lead for data and power
Operating Temperature	0C to +50C (+32F to +122F)
Display Window	8-point LED
Indicators: Illuminated keys	Armed Status-LED
	Point Status-LED
	Command Mode-LED
	Power-LED
Voltage	Nominal 12 VDC

2.09 INPUT MODULE

A. An input module shall be utilized to connect additional detection devices to the control panel. This module will meet or exceed the following technical characteristics

Operating Voltage	8.5 to 14.5 VDC Nominal
Zone Inputs	Style A (Class B) Supervised
Operating Temperature	0 to 40 degrees C (32 to 140 degrees F)

2.10 OUTPUT MODULE

A. An output module shall be utilized to interface the control panel with other security subsystems. The output module shall meet or exceed the following technical characteristics:

Operating Voltage	8.5 to 14.5 VDC Nominal
Output Relays	"Form C" Dry Relay Contracts
Relay Contact Rating	4A @ 24 VDC
	4A @ 24 VAC
	1A @ 70 VAC

Operating Voltage	8.5 to 14.5 VDC Nominal
Operating Temperature	0 to 40 degrees C 32 to 140 degrees F

2.11 AUDIBLE AND VISUAL ALARM DEVICES

A. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet from central-station control unit.

1. Enclosure: Corrosion Resistant, steel box with tamper switches on cover and on back of box.

2.12 INTERIOR AND EXTERIOR DETECTION DEVICES (SENSORS)

A. The IDS shall consist of interior, exterior, and other detection devices that are capable of:

1. Locating intrusions at individually protected asset areas or at an individual portal.

2. Locating intrusions within a specific area of coverage.

3. Locating failures or tampering of individual sensors or components.

B. Provide and adjust for devices so that coverage is maximized in the space or area it is installed in. For large rooms where multiple devices are required, ensure device coverage is overlapping.

C. Detection sensitivity shall be set up to ensure maximum coverage of the secure area is obtained while at the same time limiting excessive false alarms due to the environment and impact of small animals. All detection devices shall be anti-masking with exception of video motion detection.

D. Dual sensor technology shall be used when possible. Sensor technology shall not be of the same type that is easily defeated by a single method. This will reduce the amount of false alarms.

E. Interior Environmental Conditions: Systems shall be able to operate in environmentally protected interior areas and shall meet operational performance requirements for the following ambient conditions:

1. If components are installed in unheated areas they shall be able to operate in temperatures as low as -17 C (0 F).

2. Interior Sensor Environmental Characteristics:

Temperatures	0 to 50 C 32 to 120 F
Pressure	Sea Level to 15,000 ft. above sea level

Humidity	5% - 95%
Fungus	Components of non-fungus nutrient materials
Acoustical Noise	Suitable for high noise environments above 100db

F. Balanced Magnetic Switches (BMS)

1. BMS switches shall be surface or recessed mounted according to manufacturer's instructions. Recessed mounted is the preferred method to reduce tampering or defeating of the system. Switches shall activate when a disturbance in the balanced magnetic field occurs.

2. Switches shall have a minimum of two (2) encapsulated reed switches.

3. Contractor shall provide each BMS with a current protective device, rated to limit current to 80% of the switch capacity.

4. Surface Mounted BMS: For exterior application, components shall be housed in weatherproof enclosures.

5. BMS field adjustments in the fixed space between magnet and switch housing shall not be possible. Attempts to adjust or disturb the magnetic field shall cause a tamper alarm.
6. BMS Technical Characteristics:

Maximum current	.25 amperes
Maximum voltage	30 VDC
Maximum power	3.0 W (without internal terminating resistors). 1.0 W (with internal terminating resistors).
Components	Three (3) pre-adjusted reed switches Three (3) pre-adjusted magnets
Output contacts	Transfer type SPDT
Contact rating	0.5 amperes, 28 VDC
Switch mechanism	Internally adjustable 1/4- 1/2 inches (6-13 mm)
Wiring	Two (2) wires #22 American Wire Gauge (AWG), three (3) or 11 foot attached cable
Activation lifetime	1,000,000 activations
Enclosure	Nonferrous materials

Maximum current	.25 amperes
Tamper alarm activation	Cover opened 3 mm (1/8 inches) and inaccessible until actuated

PART 3 EXECUTION

3.01 INSTALLATION

A. IDS installation shall be in accordance with UL 639 Standards for Intrusion Detection Units and UL 634 Standards for Connectors with Burglar Alarm Systems, and appropriate manufacture's installation manuals for each type of IDS.

B. Install all work as shown, in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified.

C. The Contractor shall install all system components and appurtenances in accordance with the manufacturer's instructions and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system

D. The IDS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or designed as a computer network.

E. The IDS shall be able to be integrated with other security subsystems. Integration with these security subsystems shall be achieved by computer programming and the direct hardwiring of the systems. Determination for methodology shall be outlined when the system(s) is/are being designed and engineered. For installation purposes, the IDS shall utilize an output module for integration with other security subsystems. The Contractor will ensure all connections are per the OEM and that any and all software upgrades required to integrate the systems are installed prior to system start-up.

F. For programming purposes, the Contractor shall refer to the manufacturer's requirements and Contracting Officer instructions for correct system operations. This includes ensuring computers being utilized for system integration meet or exceeds the minimum system requirements outlined in the IDS software packages.

G. At a minimum, the Contractor shall install primary detection devices, such as three electrode gas-type surge arresters, and secondary protectors to reduce dangerous voltages to levels that will cause no damage. Fuses shall not be permitted as protection devices.

H. Contractor shall provide fail-safe gas tube type surge arresters on exposed IDS data circuits. In addition, transient protection shall protect against spikes up to 1000 volts peak voltage with a one-microsecond rise time and 100-microsecond decay time, without

causing false alarms. The protective device shall be automatic and self-restoring. Also, circuits shall be designed or selected assuming a maximum of 25 ohms to ground.

I. Product Delivery, Storage and Handling:

1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name, equipment model and serial identification numbers, and UL logo. The Contracting Officer may inventory the IDS equipment at the time of delivery and reject items that do not conform to this requirement.

2. Storage and Handling: Store and protect equipment in a manner that will preclude damage as directed by the Contracting Officer.

J. Cleaning and Adjustments:

1. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.

2. Prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or synchronization. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.

3.02 WIRING INSTALLATION

A. Wiring Method: Install wiring in conduit. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wires and Cables

1. 120-V Power Wiring: Install according to Division 26 Section 26 05 05 "LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES", unless otherwise indicated.

2. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Install power supplies and other auxiliary components for detection devices at controllers, unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

F. Identify components with engraved, laminated-plastic or metal nameplate for central-station control unit and each terminal cabinet, mounted with corrosion-resistant screws.

3.03 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5 ohm ground. Measure, record, and report ground resistance.

C. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Division 26 Section 26 05 26 "GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS".

-- End of Section --

SECTION 28 23 00

VIDEO SURVEILLANCE SYSTEM
10/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

ANSI C2	(2017) National Electric Safety Code (NESC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-606	(2012b; Add 1 2015) Administration Standard for the Telecommunications Infrastructure

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	Radio Frequency Devices
47 CFR 17	Construction, Marking, and Lighting of Antenna Structures
47 CFR 76	Multichannel Video and Cable Television Service

UNDERWRITERS LABORATORIES (UL)

UL 486A-486B	(2013; Reprint Jan 2016) Wire Connectors
UL 1449	(2014; Reprint Mar 2016) UL Standard for Safety Surge Protective Devices

1.03 DEFINITIONS

CCTV: Closed-circuit television.

DVR: Digital video recorder.

NVR: Network video recorder.

VMC: Virtual matrix controller.

VI: Video intelligence.

SMS: Security management/access control system.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

SD-02 Shop Drawings

Wiring Diagrams; G

Plan And Elevation Views Of Components And Enclosures; G, AE

Details Of Control Panels; G, AE

Preliminary (Draft) Record Drawings; G, AE

SD-03 Product Data

Manufacturer's Specifications For Each Component; G, AE

SD-04 Samples

Completion Matrix; G

SD-05 Design Data

Structural Analysis For Installed Products; G

Letter of Final Acceptance; G

SD-06 Test Reports

Functional Tests; G, AE

Burn-In Tests; G, AE

Field Quality Control Test and Inspection Results; G, AE

Video Surveillance System Performance Results and Report; G

SD-07 Certificates

Written Certification of Functionality; G

SD-10 Operation and Maintenance Data

Operating Instructions; G, AE

Routine maintenance requirements for system components; G, AE

Lists Of Spare Parts And Replacement Components; G

SD-11 Closeout Submittals

Warranty; G

Extra Materials (Spare Parts); G

Coordination Drawings; G, AE

Checklist ; G, AE

Final As-Built Drawings; G, AE

1.05 QUALITY ASSURANCE

A. Installer Qualifications

1. The Video Surveillance System Installer shall be licensed and shall meet all applicable regulations. The Contractor shall be a firm normally employed in the low voltage and video cabling industry.

2. The Installer must be certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels.

3. The Installer shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein. Each Installer shall furnish with their submittal, a letter from the manufacturer indicating they are a dealer in good standing.

4. The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and testing of video surveillance distribution systems and have personnel who are adequately trained in the use of such tools and equipment. A resume of qualifications shall be submitted with the Installers's proposal indicating the following:

a. A list of five recently completed projects using the product pro-posed of similar type and size with contact names and telephone numbers for each.
b. A list of test equipment proposed for use in verifying the installed integrity of metallic cable systems on this project.
c. A technical resume of experience for the Contractor's Project Manager and on-site installation supervisor who shall be assigned to this project.
d. A list of technical product training attended by the Installer's personnel that shall install the video

surveillance system shall be submitted.

e. Any subcontractor who shall assist the video surveillance Installer in performance of this work shall have the same training and certification as the video surveillance Installer.

B. Product Options

Drawings indicate size, profiles, and dimensional requirements of television equipment and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section 01 61 00 COMMON PRODUCT REQUIREMENTS. Systems that are manufactured and installed by a factory office and are not available through multiple distribution channels will not be accepted.

C. Electrical Components, Devices, and Accessories

Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Compliance

1. Comply with NFPA 70.
2. Comply with 47 CFR 15, 47 CFR 17, and 47 CFR 76.

1.06 PROJECT CONDITIONS

A. Service Conditions for Outdoor Equipment

Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:

1. Temperature: -22° F (30° C) to 122° F (50° C).

2. Relative Humidity: 5 to 100 percent.

3. Weather: Enclosure housings to prevent entry of moisture due to melting ice build-up or driven rain or snow.

B. Service Conditions for Indoor Equipment

Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:

1. Temperature: 32° F (0° C) to 122° F (50° C).

2. Relative Humidity: 0 to 95 percent.

1.07 COORDINATION

A. Coordinate layout and installation of video surveillance equipment and suspension system components with other construction that penetrates building structures or is supported by them, including partition assemblies.

B. Contractor is responsible for all electrical work required on this

project for connection of DVR, cameras, conduit, and power supplies. Contractor shall provide a complete turnkey solution to the Government and be responsible for the complete installation of all security cameras.

1.08 WARRANTY

A. Special warranty specified in this paragraph shall not deprive Government of other rights Government may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1. Written warranty, signed by manufacturer and installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship for a period of three (3) years following date of substantial completion. This warranty shall be in addition to, and not limiting, other rights Government may have under other provisions of the Contract Documents.

2. Warranty shall include all parts and components of the Video Surveillance System.

1.09 EXTRA MATERIALS

Furnish extra materials as described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide not less than one of each item listed below. Deliver extra materials to Government.

1. Fuses: One for every 10; each type and rating.

2. Cameras: One for every 10; each type and focal length installed.

3. DVR/NVR Video Storage Hard Disk Drive; One for every 5; each type installed.

4. RAID Storage Hard Disk Drive; One for every 5; each type installed.

5. DVR Factory System Restore CDs; One for each type installed.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

The following information will be submitted on all products and services supplied by the Contractor.

A. DESIGN CALCULATIONS AND SHOP DRAWINGS

1. Calculate requirements and perform structural analysis for installed products including selection of seismic restraints, signed and sealed by the qualified professional engineer responsible for their preparation.

2. Include dimensioned plan and elevation views of components

and enclosures and details of control panels. Show access and workspace requirements.

3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.:

B. PRODUCT DATA

1. Include detailed manufacturer's specifications for each component specified. Include data on features, ratings, and performance

C. OPERATION AND MAINTENANCE DATA

1. Provide operating instructions covering operation under both normal and abnormal conditions.

2. Routine maintenance requirements for system components.

3. Provide lists of spare parts and replacement components recommended to be stored at the site for ready access.

D. CLOSEOUT SUBMITTALS

1. Coordination Drawings: Plans drawn to scale and coordinating locations of television equipment. Show the following:

a. Ceiling suspension assembly members.
b. Method of attaching hangers to building structure.
c. Location of items requiring installation coordination, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and other architectural features.

2.02 GENERAL

A. The cabling shall be installed per requirements of the manufacturer and the Project Documents, utilizing material meeting all applicable standards. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the specifications.

C. Testing: All installed cabling shall be tested 100 percent at specified performance after installation by the Contractor.

D. All equipment and materials used shall be standard components, regularly manufactured, regularly utilized in the manufacturer's system.

E. All systems and components shall have been thoroughly tested and proven in actual use.

F. Digital Video Recording Software shall be from an original

equipment manufacturer with extensive experience in the Analog and Digital Video Surveillance.

G. All systems and components shall be provided with the availability of a toll free 24-hour technical support phone number from the manufacturer. The phone number shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.

H. All systems and components shall be provided with an explicit manufacturer warranty.

2.03 DATA CLOSET TERMINATION HARDWARE

A. Security Contractor shall provide one 2-post, open rack at building headend closet location to receive video management system.

B. Security Contractor is responsible to coordinate with Government's technology department on acquiring network connections as well as any network configuration information such as IP numbers that will be required to connect NVR/DVR servers to the IP network.

C. Video Surveillance System should depend on Government's IP network. Security Contractor shall provide Government's IP network switch sufficient size and capability to support DVRs, NVRs, Workstations, new IP Cameras, or other video surveillance components.

D. Security Contractor is responsible to provide network cabling connection, either fiber or Category 6, to Government provided network equipment. This connection allows VMC to be connected to Government's local area network.

E. Contractor shall provide and install one infrastructure protection camera in the utility area where Video Surveillance System equipment is installed. Infrastructure protection cameras shall be provided even if not identified on plans.

1. In Analog DVR only installations, Contractor shall install specified analog mini dome camera to open input on Analog DVR.

2. In NVR only or Hybrid DVR installations, Contractor shall install specified IP mini-dome camera.

3. Infrastructure protection cameras shall be programmed to record when motion is sensed and with 30 seconds of pre-alarm recording.

4. Infrastructure protection cameras shall be programmed to allow only users as part of the IT Users Group to view live or playback video of these cameras.

2.04 CABLE AND INSTALLATION

A. The Contractor shall provide and install all low-voltage plenum-rated power cable to camera locations from headend power supply(s). Contractor shall field coordinate location requirements

with the Contracting Officer.

B. Provide and install all plenum-rated fiber optics or cat6 cables from the DVR to each camera location. Contractor shall field coordinate location requirements with the Contracting Officer. Coax shall meet the following minimum criteria:

1. Each run will be installed using appropriate fiber with transmitters to support carrying the video signal from the camera to the DVR. Fiber transmitters shall be by Bosch or approved equal.

C. All pole mounted exterior cameras shall use multimode fiber transmission for video and PTZ data.

D. All exterior Building-mounted cameras shall use surge/spike suppression on all copper video and PTZ data lines to protect headend equipment. Protectors shall include protection for video, 24 volt power and data signal for Pan, Tilt, and Zoom systems. Protectors shall protect all modes herein mentioned and shall contain all modes in a single unit system. Protectors shall meet the following criteria:

1. Camera Power:

a. Surge capacity 3000 Amps (8X20µsec).
b. Screw terminal connection.
c. Screw terminal connection.
d. MCOV 30VAC.

2. Video and Data:

a. Surge capacity 100 amp per conductor.
b. "BNC" connection (Fiber).
c. Protection modes L-G (all).
d. Band pass 0-2gHZ.
e. Insertion Loss <0.3db.

E. Provide all penetrations and all conduits as necessary for installation of CCTV installation.

F. All exterior penetrations require necessary weatherproofing to avoid moisture penetration.

G. All outdoor cable runs underground shall be rated for underground use.

H. Provide all power circuits required for camera power supplies.

I. All cabling for entire project shall be installed at 5'-0" intervals in dedicated support systems using supports such as J-hooks, D-rings, or U support systems. Cable supports will be securely attached directly to building and bridge structures. Do not attach cabling or supports to foreign piping, hangers, conduit, or equipment.

J. For power to all PTZ cameras, Contractor shall install the basic cable for all cameras within 600 ft of DVR. If distance is greater than 600 ft, Contractor shall install oversize conductor

up to 900 ft. For distances greater than 900', Contractor shall also install oversize conductor for camera power.

K. Refer to the drawings for all conductor's sizes and coordinate conductor sizing with the camera's representative.

L. Provide 20'-0" service loops for pole mounted cameras or cameras mounted on the building structure. Support service loops from proper cable support system.

M. Acceptable Manufacturers:

1. Video Surge Protection

a. Bosch 500i Series for PTZ Cameras, or approved equal.

2.05 CAMERAS

A. Camera Mounting Brackets and Hardware

Contractor shall provide all mounting hardware and brackets appropriate to mount cameras, and camera support equipment. Where plans indicate type, Contractor shall provide indicated type. Where not indicated, Contractor shall provide mount that is physically and aesthetically appropriate. All camera mounts shall be provided from camera manufacturer to match finish and style of attached camera.

B. Pan/Tilt/Zoom Cameras

The system shall provide the capability of controlling and viewing pan-tilt-zoom cameras over the network as well as allowing on site viewing and control. The system shall allow this control via "up the coax" signaling so that LAN, WAN, or Internet control is possible.

1. Tamper resistant with all movable parts enclosed behind a protective cover.

2. Integrated dome.

3. 24 VAC operation.

4. Operating temperature range -29° F (-34° C) to 165° F (74° C).

5. 540 TVL 36X day/Night.

6. 128X wide dynamic range.

7. Auto Tracking II Motion Detection.

8. Video motion detection.

9. Coax, UTP, Fiber and IP versions of all camera type shall be available.

a. Provide as directed in plans.

10. Acceptable Manufacturers:

a. Bosch Series, or approved equal.

C. Field-of-View

Determination by the Contractor as necessary for camera locations shall be performed at no additional cost to provide the view desired by the Government. Contractor shall coordinate all final camera views and locations with Contracting Officer for final approval.

2.06 CAMERA POWER SUPPLIES

A. All cameras shall be powered by multi-tap power supplies located in the headend/Utility area.

B. Each camera shall be individually fused at the power supply so a short in one power cable will not affect other cameras.

C. The power supply will be UL listed in an approved enclosure.

D. Contractor shall provide power supplies as required to handle the full load of cameras, taking into consideration number and type of cameras, cable gauge and voltage drop over cabling distance. Camera power supplies shall be installed with no more than 80% total load from attached cameras.

E. Multi-tap camera power supplies shall convert 120 VAC to 24 or 28 VAC at 600 Watts.

F. Acceptable Manufacturers:

1. Bosch RT2440SL, or approved equal
2. Bosch TC1334, or approved equal

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cable. Check raceways, underground path, bridge path, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine walls, building structures, equipment bases, and building supports for suitable conditions where CCTV cameras are to be installed.

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

3.02 INSTALLATION

A. Outdoor Installation

Comply with ANSI C2, "National Electrical Safety Code."

B. Surge Protection

Install surge suppressors where AC-power-operated devices are not protected against voltage transients by integral surge suppressors specified in UL 1449. Install surge suppressors at the devices' power-line terminals. Comply with Division 16 Section "Transient Voltage Suppression."

C. Wiring Method

1. Install cables in raceways, except in accessible indoor ceiling spaces and attics, in hollow gypsum board partitions, and as otherwise indicated. Conceal raceways and wiring except in unfinished spaces.

2. In suspended ceiling and raised floor areas where duct, cable trays or conduit are not available, the Contractor shall bundle, in bundles of 25 cables or less, with cable ties snug, but not deforming the cable geometry. Cable bundles shall be supported via "J" hooks attached to the existing building structure and framework at a maximum of five (5) foot intervals. Plenum rated cable ties shall be used in all appropriate areas. The Contractor shall adhere to the manufacturer's requirements for bending radius and pulling tension of all cables.

3. Cables shall not be attached to lift out structural supports or laid directly on the bridge structure.

D. Fire Wall Penetrations

The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

E. Wall Penetrations

Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant. Provide three sided pre-finished metal hood and seal to wall where conduit penetrates exterior wall.

F. Equipment Hanging

1. Install new conduit on portable pipe supports - (low profile type), as manufactured by Portable Pipe Hangers or Advanced Support Products. Provide protection pads under each support. Coordinate location and routing with design engineer prior to rough-in or installation of system.

2. Ensure CCTV cameras are mounted into the building structure and properly supported.

G. Wiring within Enclosures

Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution

spools.

H. Pulling Cable

Do not exceed manufacturer's recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

I. Exposed Cable

Install parallel to building lines, follow surface contours, and support the cable according to manufacturer's written instructions. Do not run adjacent and parallel to power or data cables.

J. Splices, Taps, and Terminations

For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

K. Grounding

Provide independent signal circuit grounding recommended by manufacturer.

3.03 WIRING INSTALLATION

A. General

1. Cabling between headend and camera locations shall be made as individual home runs. No intermediate splices may be installed or utilized between the headend and the camera location.

2. All cable must be handled with care during installation so as not to change performance specifications.

B. Placement

All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Government's efficient use of their full capacity.

C. Cable Routes

All cabling must be in conduit. Cable supports shall be permanently anchored to building and structure or substrates. Provide attachment hardware and anchors designed for the structure to which attached and that are suitably sized to carry the weight of the cables to be supported. Attaching cable to pipes or other mechanical items is not permitted.

3.04 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras at final locations defined by camera location tests. Install cameras with 84-inch (2134-mm) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance. Contractor shall coordinate with Contracting Officer if this minimum clearance cannot be achieved in location identified on plans.

B. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera.

C. Install power supplies and other auxiliary components at control stations. Do not install such items near the devices they serve, unless otherwise indicated.

D. Install tamper switches arranged to detect unauthorized entry into system component enclosures and mount in self-protected, inconspicuous positions.

E. Camera Adjustment and Analog Video Signal Testing:

1. Contractor shall use the following adjustment and testing procedures to avoid noise that the DVR will interpret as motion and reduce overall recording duration.

2. At the DVR, test each video cable to ensure Sync and Color Burst levels are within 144 mV (20 IRE) to 360mV (50 IRE).

3. At each camera location, eliminate or minimize camera vibration caused by either wind in outdoor settings or by general vibration at the camera.

4. AGC shall be used sparingly to avoid generating noise that the DVR will interpret as motion.

5. Equalizing Video Signals: Where system performance may be degraded in certain operating modes, revise component connections and install video distribution amplifiers and attenuators as required to provide a balanced signal across the system.

3.05 COORDINATION

A. The Contracting Officer shall assist in establishing procedural guidelines and in defining terminology and conditions unique to the Government's operation.

B. Determine Government's priority of camera importance to alternate high priority cameras and normal priority cameras on different multi-tap power supplies and DVRs, encoders and/or NVR.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 16 Section 26 05 53 ELECTRICAL SYSTEMS IDENTIFICATION.

B. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Government. Label patch

panels in the wiring closet to match those on corresponding camera locations. The font shall be at least one-eighth inch (1/8") in height, block. All labels shall correspond to as-builts and to final test reports.

C. Contractor shall ensure complete typed labeling of all cameras with numbers that correspond to locations on video server. Labeling system shall correspond to the Government's labeling system. Verify with Contracting Officer. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.

D. All cables shall be labeled at both ends with a machine label and all terminations shall be stenciled with a typed label for quick circuit identification. Labeling shall conform to TIA-606 and include interconnect cable identification numbers.

E. A floor plan, clearly labeled with all numbered camera locations, shall be included in the as-built plans.

3.07 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of television equipment.

B. Inspection

Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

C. Test Schedule

Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

3.08 SYSTEM STARTUP

A. Work shall be complete and ready to operate prior to final acceptance.

B. Program initial user groups and users.

C. Video Surveillance System shall be programmed to include the cameras are located, the exact camera locations and name of cameras. Field verification of camera names are required to complete this task.

D. Video Surveillance System shall be programmed to include Government's logical camera groupings.

3.09 SYSTEM ACCEPTANCE

A. Final acceptance testing of the Work will be conducted by the

Government.

B. Prior to any final acceptance testing, the Contractor shall submit two sets of preliminary (draft) Record Drawings to the Engineer. The preliminary Record Drawings are to be used by the Engineer to conduct the system final test.

C. Submit a paragraph by paragraph completion matrix indicating completion or delinquency for each item included in the Specification and all subsequent addenda and bulletins as part of the Work. Indicate completion of the requirement by the word "Completed" following each paragraph number. Indicate delinquency for the requirement by the words "To Be Completed" following the applicable paragraph number. Should work on any item be under way, but not yet fully complete, indicate the extent (or lack thereof) of completion to date, and the proposed date of completion.

D. Conduct a complete test of the entire Video Surveillance System and provide the Contracting Officer with a written report on the results of that test.

E. Fully complete the checklist (included as Appendix "E") prior to the burn-in test of the Video Surveillance System. The checklist shall accompany the written certification to the Contracting Officer that the installed complete Video Surveillance System has been calibrated, tested, and is fully functional as specified herein.

F. Following completion of the initial testing and correction of any noted deficiencies, conduct a five day burn-in test. The intent of the burn-in test shall be to prove the Video Surveillance System by placing it in near real operating conditions. During this period the Video Surveillance System shall be fully functional and programmed such that all points, interfaces, controls, reports, messages, prompts, etc. can be exercised and validated. Record and correct any system anomaly, deficiency, or failure noted during this period. Scheduling of the final acceptance test shall be based on a review of the results of this burn-in test.

G. Deliver a report describing the results of functional tests, burn-in tests, diagnostics, calibrations, corrections, and repairs, including written certification, to the Contracting Officer that the installed complete Security System has been calibrated, tested, and is fully functional as specified herein.

H. Prior to the final acceptance test, coordinate with the Government for security related construction clean up and patch work requirements. Security equipment closets and similar areas should be free of accumulation of waste materials or rubbish caused by operations under the Contract. At completion of the Work, remove all waste materials, rubbish, the Contractor's and it's subcontractors' tools, construction equipment, machinery and all surplus materials.

I. Upon written notification from the Contractor that the Video Surveillance System is completely installed, integrated and operational, and the burn-in testing completed, the Government will conduct a final acceptance test of the entire system.

J. During the course of the final acceptance test by the Government, the Contractor shall be responsible for demonstrating that, without exception, the completed and integrated system complies with the contract requirements. All physical and functional requirements of the project shall be demonstrated and shown. This demonstration will begin by comparing "as built" conditions of the Video Surveillance System to requirements outlined in the Specification, item by item. Following the Specification compliance review, all Video Surveillance System headend equipment will be evaluated.

K. In order to sufficiently demonstrate the Security Camera System's functionality, the operator on duty and his/her superior may be requested to perform certain daily operations inherent to the Security Camera System. These operations may include, but not be limited to the following:

1. Responding to alarms.

2. CCTV camera call-up on various monitors.

3. Manipulation of PTZ cameras.

L. As all of these operations depend heavily on the training outlined within the Specification, the Contractor shall have completed all of the required training prior to initiation of the final acceptance test.

M. Following the Video Surveillance System headend equipment and console review, the installation of all field devices will be inspected. This field inspection will weigh heavily on the general neatness and quality of installation, complete functionality of each individual device, and mounting, backbox and conduit requirements compliance.

N. All equipment shall be on and fully operational during any and all testing procedures. Provide all personnel, equipment, and supplies necessary to perform all site testing. A manufacturer's representative may be present on site to answer any questions that may be beyond the technical capability of the Contractor's employees, if the Contractor so elects or by specific request of the Contracting Officer, at no charge to theGovernment.

O. Upon successful completion of the final acceptance test (or subsequent punch list retest) the Contracting Officer will issue a letter of final acceptance/ and the Contractor shall submit final As-Built Drawings.

P. The Government retains the right to suspend and/or terminate testing at any time when the system fails to perform as specified. In the event that it becomes necessary to suspend the test, all of the Government's fees and expenses related to the suspended test will be deducted from the Contractor's retainage. Furthermore, in the event it becomes necessary to suspend the test, the Contractor shall work diligently to complete/repair all outstanding items to the condition specified in the Specification and as indicated on the security drawings. The Contractor shall supply the Contracting Officer with a detailed completion schedule outlining phase by phase completion dates and a tentative date for a subsequent punch

list retest. During the final acceptance test, no adjustments, repairs or modifications to the system will be conducted without the permission of the Architect.

3.10 CLEANING

Clean CCTV system components, including camera-housing windows, lenses, and monitor screens, using methods and materials recommended by manufacturer.

3.11 END-USER TRAINING

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain television equipment.

1. Train Government's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.

2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Review data in maintenance manuals. Refer to Division 1 Section 01 78 00 CLOSEOUT SUBMITTALS.

4. Schedule training with Government, through Contracting Officer, with at least seven days advance notice.

5. Conduct a minimum of six hours training as specified in instructions to Government's employees in Division 1 Section 01 78 00 CLOSEOUT SUBMITTALS.

3.12 ON-SITE ASSISTANCE

Occupancy Adjustments: When requested by Government within one year of date of Substantial Completion, provide on-site assistance in tuning and adjusting the system to suit actual occupied conditions and to optimize performance. Provide up to two adjustments at Project site forthis purpose, without additional cost.

-- End of Section --

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This work includes designing digital /addressable fire alarm system as described herein and on the Contract Drawings. The system shall include wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide systems complete and ready for operation. Equipment, materials, installation, workmanship, inspection, and testing shall be in strict accordance with the required and advisory provisions of NFPA 72 except as modified herein. The system layout, on drawings, shows the intent of coverage and is shown in suggested locations. Final quantity, layout, and coordination are the responsibility of the Contractor.

B. Section Includes:

1. Fire-alarm control unit.

2. Manual fire-alarm boxes.

3. System smoke detectors.

4. Notification appliances.

5. Remote annunciator.

6. Addressable interface device.

7. Digital alarm communicator transmitter.

1.03 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.04 SYSTEM DESCRIPTION

A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.05 REFERENCES

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S1.4	Specifications for Sound Level Meters

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1100	(2005) Emerald Book IEEE Recommended Practice for Powering and Grounding Electronic Equipment

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2014) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 25	(2017; TIA 17-1) Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
NFPA 70	(2017; ERTA 1-2 2017; TIA 17-1; TIA 17-2) National Electrical Code
NFPA 72	(2016) National Fire Alarm and Signaling Code
NFPA 90A	(2015) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 268A	(2008; Reprint Oct 2014) Smoke Detectors for Duct Application
UL 38	(2008; Reprint Nov 2013) Manual Signaling Boxes for Fire Alarm Systems
UL 268	(2016; Reprint Jul 2016) UL Standard for Safety Smoke Detectors for Fire Alarm Systems
UL 632	Standard for Safety Electrically-Actuated Transmitters
UL 864	(2014) Standard for Control Units and Accessories for Fire Alarm Systems

1.06 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installer Qualifications; G

SD-02 Shop Drawings

Plans, Elevations, Sections, Details, And Attachments; G, AE

Plan View Drawing Showing Device Locations, Terminal Cabinet Locations, Junction Boxes, Other Related Equipment, Conduit Routing, Wire Counts, Circuit Identification In Each Conduit, And Circuit Layouts; G, AE

Riser Diagrams; G, AE

Wiring Diagram; G, AE

Coordinating Drawings for Duct Smoke Detectors; G, AE

Voice/Alarm Signaling-Service Equipment Rack Or Console Layout; G, AE

SD-03 Product Data

For Each Type Of Product Indicated.; G, AE

System Operation Matrix; G, AE

Annotated Catalog Data; G, AE

Performance Parameters For Each Detector; G, AE

Final Acceptance Testing Procedures; G, AE

SD-05 Design Data

Voltage Drop Calculations; G, AE

Battery-Size Calculations; G, AE

Amplifiers Design Data; G, AE

SD-06 Test Reports

Field Quality-Control Reports; G

Field Quality Control Test Results; G

SD-08 Manufacturer's Instructions

Installation Details; G

SD-10 Operation and Maintenance Data

Fire-Alarm Systems And Components; G

SD-11 Closeout Submittals

Software Service Agreement; G

Record Of Completion Documents (As-Builts); G

Copy Of Site-Specific Software; G

Maintenance, Inspection And Testing Records; G

Software And Firmware Operational Documentation; G

1.07 QUALITY ASSURANCE

A. Installer Qualifications

1. Design shall be by a professional engineer with 5 years experience in fire alarm design or National Institute for Certification in Engineering Technologies (NICET) Level IV Technician. The installing contractor shall have the installation supervised by an individual that is NICET II certified in fire alarm systems. The owner may reject any proposed installer who cannot show evidence of such qualifications. The services of a technician provided by the control equipment manufacturer shall be provided to supervise installation, adjustments, and tests of the system. The equipment supplier shall have a field technician that is NICET II certified in fire alarm systems, and must be certified from the manufacturer to be competent on the equipment or software used on the project. The Contractor shall furnish evidence that the fire alarm equipment supplier has an experienced and effective service organization which carries a stock of repair parts for the system to be furnished. The Contractor shall guarantee labor, materials, and equipment provided under this contract against defects for a period of one year after the date of final acceptance of this work by the owner and the receipt of as-built drawings and schematics of all equipment.

Prior to installation, submit data for approval by the Authority Jurisdiction showing that the Contractor has successfully installed addressable, analog intelligent interior fire alarm systems of the same type as specified herein, or that the Contractor has a firm contractual agreement with a subcontractor having such required experience. Include the names and locations of at least three installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 18 months. Submit names and phone numbers of points of contact at each site.

A. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

B. 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.

C. Retain one of four paragraphs below to require independent system verification.

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants.

1.09 SOFTWARE SERVICE AGREEMENT

A. Services in this article may not be allowed for publicly funded projects.

B. Comply with UL 864

C. Technical Support: Beginning with Substantial Completion, provide software support for two years.

D. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

E. Provide 30 days notice to Contracting Officer to allow scheduling and access to system and to allow Contracting Officer to upgrade computer equipment if necessary.

PART 2 PRODUCTS

2.01 PRODUCT INFORMATION

A. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level IV minimum.
c. Licensed or certified by authorities having jurisdiction.

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

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

2. Provide point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals.

3. Provide plan view drawing showing device locations, terminal

cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

4. Include annotated catalog data, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components.

5. Provide a complete description of the system operation in matrix format on the drawings.

6. Provide complete riser diagrams indicating the wiring. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

7. Include voltage drop calculations for notification appliance circuits.

8. Include battery-size calculations. Verify that battery capacity exceeds supervisory and alarm power requirements.

    a. Provide complete battery calculations for both the alarm and supervisory power requirements. Ampere hour requirements for each system component shall be submitted with the calculations.

    b. Provide data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings.

    c. Provide data to indicate that the amplifiers have sufficient capacity to simultaneously drive all connected fire alarm speakers at full load plus 50 percent spare capacity. Annotate data for each circuit on the drawings.

    d. Provide a detailed description of the final acceptance testing procedures (including equipment necessary for testing smoke detectors using real smoke).

9. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

10. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

11. Include voice/alarm signaling-service equipment rack or

console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

D. Field quality-control reports.

E. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section OPERATION AND MAINTENANCE DATA, include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

A. Frequency of testing of installed components.

B. Frequency of inspection of installed components.

C. Requirements and recommendations related to results of maintenance.

D. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control unit.

7. Copy of NFPA 25.

F. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

2.02 MANUFACTURERS

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. Bosch Security Systems.
2. Faraday; Siemens Building Technologies, Inc.

3. Federal Signal Corporation.
4. Fire Control Instruments, Inc.; a Honeywell company.
5. Fire Lite Alarms; a Honeywell company
6. Gamewell; a Honeywell company.
7. NOTIFIER; a Honeywell company.
8. Siemens Building Technologies, Inc.; Fire Safety Division
9. SimplexGrinnell LP; a Tyco International company.
10. Or approved equal.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.

2. Smoke detectors.

3. Duct smoke detectors.

4. Verified automatic alarm operation of smoke detectors.

5. Fire-extinguishing system operation.

6. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.

2. Identify alarm at fire-alarm control unit and remote annunciators.

3. Transmit an alarm signal to the remote alarm receiving station.

4. Activate alarm communication system.

5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.

6. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.

7. Close smoke dampers in air ducts of designated air-conditioning duct systems.

8. Activate emergency lighting control.

9. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of primary power at fire-alarm control unit.

4. Ground or a single break in fire-alarm control unit internal circuits.

5. Abnormal ac voltage at fire-alarm control unit.

6. Break in standby battery circuitry.

7. Failure of battery charging.

8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit.

2.04 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.

b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 lines of 40 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

a. Initiating Device Circuits: Style D
b. Notification Appliance Circuits: Style Z.
c. Signaling Line Circuits: Style 4
d. Install no more than 50 addressable devices on each signaling line circuit.

2. Serial Interfaces: Two RS-232 ports for printers.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Record events by the system printer.

4. Sound general alarm if the alarm is verified.

5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

F. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

G. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm

communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium

J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.05 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

3. Station Reset: Key- or wrench-operated switch.

4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.06 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Detectors shall be four wire type.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

4. Base Mounting: Detector and associated electronic components

shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

6. Integral Visual-Indicating Light: LED type indicating detector has operated

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.
b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.07 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.

3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

4. Flashing shall be in a temporal pattern, synchronized with other units.

5. Strobe Leads: Factory connected to screw terminals.

6. Mounting Faceplate: Factory finished, red.

2.08 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.09 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.

2. Programming device.

3. LED display.

4. Manual test report function and manual transmission clear indication.

5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Retain applicable subparagraphs below; revise to match characteristics of fire-alarm control unit and requirements of the central station.

2. Address of the alarm-initiating device.

3. Address of the supervisory signal.

4. Address of the trouble-initiating device.

5. Loss of ac supply or loss of power.

6. Low battery.

7. Abnormal test signal.

8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.10 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.

2. Finish: Paint of color to match the protected device.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Smoke Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Smooth ceiling spacing shall not exceed 30 feet.

3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.

4. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

D. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

F. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back

boxes with the device-operating mechanism concealed behind a grille.

G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

H. Device Location-Indicating Lights: Locate in public space near the device they monitor.

I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.02 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section 08 71 00 DOOR HARDWARE. Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.

2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.

3. Smoke dampers in air ducts of designated air-conditioning duct systems.

4. Alarm-initiating connection to activate emergency lighting control.

5. Supervisory connections at valve supervisory switches.

3.03 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section 26 05 53 ELECTRICAL SYSTEMS IDENTIFICATION.

B. Install framed instructions in a location visible from fire-alarm control unit.

3.04 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.05 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

-- End of Section --

DIVISION 31 – EARTHWORK

SECTION 31 05 19

GEOTEXTILE
08/08

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4354	(2012) Sampling of Geosynthetics for Testing
ASTM D4355/D4355M	(2014) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4533/D4533M	(2015) Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2015a) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2016) Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4759	(2011) Determining the Specification Conformance of Geosynthetics
ASTM D4833/D4833M	(2007; E 2013; R 2013) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D4873/D4873M	(2016) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturing Quality Control Sampling and Testing; G

Geotextile; G

SD-04 Samples

Quality Assurance Samples and Tests; G

SD-07 Certificates

Certificate Of Compliance; G

1.03 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle geotextile in accordance with ASTM D4873/D4873M.

A. Delivery

Notify the Contracting Officer a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping.

Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

B. Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

C. Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.01 RAW MATERIALS

A minimum of 5 days prior to scheduled use, submit manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

A. Geotextile

Provide geotextile that is a nonwoven pervious sheet of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e., geotextiles made from yarns of a flat, tape-like character) will not be allowed. stabilizers and/or inhibitors to the base polymer shall be added to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material may also be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Geotextiles shall meet the requirements specified in Table 1. Where applicable, Table 1 property values represent minimum average roll values (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS
FOR DRAINAGE GEOTEXTILE

PROPERTY	UNITS	ACCEPTABLE VALUES	TEST METHOD
GRAB STRENGTH	LBS	160	ASTM D4632/D4632M
PUNCTURE	LBS	95	ASTM D4833/D4833M
TRAPEZOID TEAR	LBS	60	ASTM D4533/D4533M
MASS/UNIT AREA	G/SQ M	246	ASTM D4751
ULTRAVIOLET DEGRADATION	PERCENT	70 AT 500 HRS	ASTM D4355/D4355M

2.02 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. Perform manufacturing quality control sampling and testing in accordance with the manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

PART 3 EXECUTION

3.01 QUALITY ASSURANCE SAMPLES AND TESTS

A. Quality Assurance Samples

Contractor shall provide assistance to the Contracting Officer in the collection of quality assurance samples. Samples shall be collected upon delivery to the site at the request of the Contracting Officer and in accordance with ASTM D4354, Procedure B. Lot size for quality assurance sampling shall be considered to be the shipment quantity of the product or a truckload of the product, whichever is smaller. The unit size shall be considered one roll of geotextile. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

B. Quality Assurance Tests

Contractor shall provide quality assurance samples to an Independent Laboratory. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method ASTM D4355/D4355M shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

3.02 INSTALLATION

A. Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Sections 31 23 16 "BACKFILL AND COMPACTION"and 31 50 00 "SUBGRADE PREPARATION"..

B. Placement

Notify the Contracting Officer a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles.

3.03 SEAMS

A. Overlap Seams

Continuously overlap geotextile panels a minimum of 12 inches at all longitudinal and transverse joints.

3.04 PROTECTION

Protect the geotextile during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Use adequate ballast (e.g., sand bags) to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

3.05 REPAIRS

Repair torn or damaged geotextile. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Remove and replace geotextile rolls which cannot be repaired. Repairs shall be performed at no additional cost to the Government

3.06 COVERING

Do not cover geotextile prior to inspection and approval by the Contracting Officer. Place cover soil in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer. Use equipment with ground pressures less than 7 psi to place the first lift over the geotextile.

-- End of Section --

SECTION 31 05 20

GEOMEMBRANE
10/17

PART 1 GENERAL

1.01 BACKGROUND

During pipeline installation, portions of the existing geomembrane in the spillway area or crossing the clean corridor surrounding the storm water lines, will be cut to allow work under the liner. This Section address repairs to the existing geomembrane liners in the stormwater detention basin emergency overflow spillway and other locations if encountered.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1004	(2013) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D1603	(2014) Carbon Black Content in Olefin Plastics
ASTM D3895	(2014) Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	(2015) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D5199	(2012) Measuring Nominal Thickness of Geosynthetics
ASTM D5397	(2007; R 2012) Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
ASTM D5596	(2003; R 2016) Standard Test Method For Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5885/D5885M	(2015) Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D638	(2014) Standard Test Method for Tensile

	Properties of Plastics
ASTM D6392	(2012) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D7238	(2006; R 2012) Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
ASTM D7466	(2010) Standard Test Method for Measuring Asperity Height of Textured Geomembranes

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM9	(1995) Cold Weather Seaming of Geomembranes

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualificationsof Manufacturer, Fabricator, Installer,and Testing Laboratory; G

SD-02 Shop Drawings

Repair Drawings; G

As-Built Drawings; G

SD-03 Product Data

Manufacturer's Quality Control Tests, Inspections, And Verifications; G

SD-04 Samples

Samples; G

SD-06 Test Reports

Materials; G

Surface Preparation; G

Field Seaming; G

QC Testing; G

Non-Destructive Field Seam Continuity Testing; G

1.04 QUALIFICATIONS

A. Manufacturer

Manufacturer shall have produced the proposed geomembrane sheets for at least 5 completed projects having a total minimum area of 1.0 million square feet.

B. Fabricator

The fabricator is responsible for seaming geomembrane sheets into panels. Fabricator shall have fabricated the proposed geomembrane panels for at least 5 completed projects having a total minimum area of 1.0 million square feet.

C. Installer

The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 1 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.

D. QC Inspector

The QC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 1 million square feet.

E. QA Laboratory

The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery

Each geomembrane roll/panel shall be labeled with the manufacturer's name, product identification number, roll/panel number, and roll dimensions.

B. Storage

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. Rolls shall not be stored

more than two high. Palleted materials shall be stored on level surfaces and shall not be stacked on top of one another. Damaged geomembrane shall be removed from the site and replaced with geomembrane hat meets the specified requirements.

C. Handling

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.06 WEATHER LIMITATIONS

Geomembrane shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. Unless authorized by the Contracting Officer, no placement or seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F. Ambient temperature shall be measured at a height no greater than 6 inches above the ground or geomembrane surface. If seaming is allowed below 32 degrees F, the procedures outlined in GSI GRI GM9 shall be followed. In marginal conditions, seaming shall cease unless destructive field seam tests, conducted by the QC laboratory, confirm that seam properties meet the requirements listed in Table 3. Tests shall be conducted in accordance with paragraph Destructive Field Seam Testing.

1.07 EQUIPMENT

Equipment used in performance of the work shall be in accordance with the geomembrane manufacturer's recommendations and shall be maintained in satisfactory working condition.

PART 2 PRODUCTS

2.01 MATERIALS

A. Raw Materials

Resin used in manufacturing geomembrane sheets shall be made of virgin uncontaminated ingredients. No more than 10 percent regrind, reworked, or trim material in the form of chips or edge strips shall be used to manufacture the geomembrane sheets. All regrind, reworked, or trim materials shall be from the same manufacturer and exactly the same formulation as the geomembrane sheet being produced. No post consumer materials or

water-soluble ingredients shall be used to produce the geomembrane. For geomembranes with plasticizers, only primary plasticizers that are resistant to migration shall be used. The Contractor shall submit a copy of the test reports and QC certificates for materials used in the manufacturing of the geomembrane shipped to the site.

B. Sheet Materials

Geomembrane sheets shall be manufactured as wide as possible to minimize factory and field seams. Geomembrane sheets shall be uniform in color, thickness, and surface texture. For slopes greater than or equal to 1V on 3 H, sheets shall be textured on both faces. The textured surface features shall consist of raw materials identical to that of the parent sheet material and shall be uniform over the entire face of the geomembrane. Geomembrane sheets and factory seams shall conform to the requirements listed in Tables 1, 2, and 3 for Manufacturing Quality Control (MQC).

TABLE 1. SMOOTH HDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Thickness (min ave)	40 mils	per roll	ASTM D5199
Lowest individual of 10 values	-10 percent	per roll	ASTM D5199
Density (min)	0.940 g/cc	per 200,000 lb	ASTM D1505
Tensile Properties (1) (min ave) -yield stress -break stress -yield elong -break elong	 84 lb/in 152 lb/in 12 percent 700 percent	per 20,000 lb	ASTM D638 Type IV
Tear Resistance (min ave)	28 lb	per 45,000 lb	ASTM D1004
Puncture Resistance (min ave)	72 lb	per 45,000 lb	ASTM D4833/ D4833M
Stress Crack Resistance (2)	200 hr	per 200,000 lb	ASTM D5397 (Appendix)
Carbon Black Content	2 to 3 percent	per 20,000 lb	ASTM D1603 (3)

TABLE 1. SMOOTH HDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Carbon Black	Note (4)	per 45,000 lb	ASTM D5596
Oxidative Induction Time (OIT) (min ave) (5) -Std OIT or -High Pres OIT	 100 min 400 min	per 200,000 lb	 ASTM D3895 ASTM D5885/D5885M
Oven Aging at 85 deg C (min ave) (5), (6) -Std OIT or -High Pres OIT	 55 percent at 90 days 80 percent at 90 days	per year and change in formulation	 ASTM D3895 ASTM D5885/ D5885M
UV Resistance (min ave) (7) -High Pres OIT (8), (9)	 50 percent at 1600 hours	per year and change in formulation	ASTM D7238 ASTM D5885/ D5885M

TABLE 1. SMOOTH HDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD

MQC = Manufacturing Quality Control

Note (1): Minimum average machine direction and minimum average cross machine direction values shall be based on 5 test specimens in each direction. For HDPE geomembrane, yield elongation is calculated using a gauge length of 1.3 inches. For HDPE geomembrane, break elongation is calculated using a gauge length of 2.0 inches.

Note (2): For HDPE geomembrane, the yield stress used to calculate the applied load for test method ASTM D5397 (Appendix), shall be the manufacturer's mean value. ASTM D5397 does not need to be run on LLDPE geomembrane.

Note (3): Other methods such as ASTM D4218 or microwave methods are acceptable if an appropriate correlation to ASTM D1603 can be established.

Note (4): Carbon black dispersion for 10 different views:
- minimum of 8 of 10 in Categories 1 or 2.
- all 10 in Categories 1, 2, or 3.

Note (5): The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.

Note (6): Evaluate samples at 30 and 60 days and compare with the 90 day response.

Note (7): The condition of the test shall be a 20 hour UV cycle at 167 degrees F followed by a 4 hour condensation cycle at 140 degrees F.

Note (8): The standard OIT test (ASTM D3895) shall not be used in determining UV resistance.

Note (9): UV resistance is based on percent retained value regardless of the original HP-OIT value.

TABLE 2. TEXTURED HDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Nominal Thickness	40 mils		

TABLE 2. TEXTURED HDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Thickness (min ave)	-5 percent of nominal	per roll	ASTM D5994/ D5994M
Lowest individual for 8 out of 10 values	-10 percent of nominal	per roll	ASTM D5994/ D5994M
Lowest individual of 10 values	-15 percent of nominal	per roll	ASTM D5994/ D5994M
Asperity Height (min ave) (10)	10 mils	every second roll	ASTM D7466 (11)
Density (min)	0.940 g/cc	per 200,000 lb	ASTM D1505
Tensile Properties (1) (min ave) -yield stress -break stress -yield elong -break elong	 84 lb/in 60 lb/in 12 percent 700 percent	per 20,000 lb	ASTM D638 Type IV
Tear Resistance (min ave)	28 lb	per 45,000 lb	ASTM D1004
Puncture Resistance (min ave)	60 lb	per 45,000 lb	ASTM D4833/ D4833M
Stress Crack Resistance (2)	200 hr	per 200,000 lb	ASTM D5397 (Appendix)
Carbon Black Content	2 to 3 percent	per 20,000 lb	ASTM D1603 (3)
Carbon Black Dispersion	Note (4)	per 45,000 lb	ASTM D5596
Oxidative Induction Time (OIT) (min ave) (5) -Std OIT or -High Pres OIT	 100 min 400 min	per 200,000 lb	 ASTM D3895 ASTM D5885/ D5885M

TABLE 2. TEXTURED HDPE GEOMEMBRANE PROPERTIES			
PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD
Oven Aging at 85 deg C (min ave) (5), (6) -Std OIT or -High Pres OIT	 55 percent at 90 days 80 percent at 90 days	per year and change in formulation	 ASTM D3895 ASTM D5885/ D5885M
UV Resistance (min ave) (7) -High Pres OIT (8), (9)	 50 percent at 1600 hours	per year and change in formulation	ASTM D7238 ASTM D5885/ D5885M

TABLE 2. TEXTURED HDPE GEOMEMBRANE PROPERTIES

PROPERTY	TEST VALUE	MQC TESTING FREQUENCY (MIN.)	TEST METHOD

MQC = Manufacturing Quality Control

Note (1): Minimum average machine direction and minimum average cross machine direction values shall be based on 5 test specimens in each direction. For HDPE geomembrane, yield elongation is calculated using a gauge length of 1.3 inches. For HDPE geomembrane, break elongation is calculated using a gauge length of 2.0 inches.

Note (2): For HDPE geomembrane, the yield stress used to calculate the applied load for test method ASTM D5397 (Appendix), shall be the manufacturer's mean value. ASTM D5397 does not need to be run on LLDPE geomembrane.

Note (3): Other methods such as ASTM D4218 or microwave methods are acceptable if an appropriate correlation to ASTM D1603 can be established.

Note (4): Carbon black dispersion for 10 different views:
- minimum of 8 of 10 in Categories 1 or 2.
- all 10 in Categories 1, 2, or 3.

Note (5): The manufacturer has the option to select either one of the OIT methods to evaluate the antioxidant content.

Note (6): Evaluate samples at 30 and 60 days and compare with the 90 day response.

Note (7): The condition of the test shall be a 20 hour UV cycle at 167 degrees F followed by a 4 hour condensation cycle at 140 degrees F.

Note (8): The standard OIT test (ASTM D3895) shall not be used in determining UV resistance.

Note (9): UV resistance is based on percent retained value regardless of the original HP-OIT value.

Note (10): Textured Geomembrane Only: Of 10 readings, 8 out of 10 must be 7 mil, and lowest individual reading must be 5 mil.

Note (11): Textured Geomembrane Only: Alternate the measurement side for double sided textured sheet.

TABLE 3. HDPE SEAM PROPERTIES		
PROPERTY	TEST VALUE	TEST METHOD
Seam Shear Strength (min) (1)	81 lb/in	ASTM D6392
Seam Peel Strength (min) (1) (2)	52 lb/in	ASTM D6392

Note (1): Seam tests for peel and shear must fail in the Film Tear Bond mode. This is a failure in the ductile mode of one of the bonded sheets by tearing or breaking prior to complete separation of the bonded area.

Note (2): Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.

C. Factory Seams

Geomembrane sheets shall be factory seamed into maximum sized panels to minimize field seaming. Factory seaming shall be by methods approved by the geomembrane manufacturer. Seams shall meet the minimum shear and peel strength requirements shown in Table 3. Factory seams shall extend to the end of the sheet so that no unbonded edges greater than 1/8 inch wide are present.

2.02 TESTS, INSPECTIONS, AND VERIFICATIONS

A. Manufacturing, Sampling, and Testing

1. Raw Materials

Raw materials shall be tested in accordance with the approved MQC manual. Any raw material which fails to meet the geomembrane manufacturer's specified physical properties shall not be used in manufacturing the sheet. Seaming rods and pellets shall be manufactured of materials which are essentially identical to that used in the geomembrane sheet. Seaming rods and pellets shall be tested for density, melt index and carbon black content in accordance with the approved MQC manual. Seaming rods and pellets which fail to meet the corresponding property values required for the sheet material, shall not be used for seaming.

2. Sheet Material

Geomembrane sheets shall be tested in accordance with the approved MQC manual. As a minimum, MQC testing shall be conducted at the frequencies shown in Table 1. Sheets not meeting the minimum requirements specified in Table 1 shall not be sent to the site.

PART 3 EXECUTION

3.01 PREPARATION

The Contractor shall provide Repair Drawings describing procedures for removal of overlying materials, cutting and pealing back the geomembrane, restoration materials, geomembrane repair and restoration of spillway or clean corridor a minimum of 7 days prior to cutting of the geomembrane for pipeline installation.

3.02 SURFACE PREPARATION

Surface preparation shall be performed in accordance with Section 31 23 16 "BACKFILL AND COMPACTION". Rocks larger than 1/2 inch in diameter and any other material which could damage the geomembrane shall be removed from the surface to be covered with the geomembrane. Construction equipment tire or track deformations beneath the geomembrane shall not be greater than 1.0 inch in depth. Repairs to the subgrade shall be performed at no additional cost to the Government.

3.03 GEOMEMBRANE DEPLOYMENT

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. Geomembrane damaged during installation shall be replaced or repaired, at the QC inspector's discretion. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind.

3.04 FIELD SEAMING

A. Trial Seams

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment, and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D6392. One sample shall be obtained from each trial seam. This sample shall be at least 36 inches long by 12 inches wide with the seam centered lengthwise. Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. Where necessary, accelerated curing of trial seams made by chemical methods shall be conducted in accordance with GSI GRI GM7. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified in Table 3. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

B. Field Seams

Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. In sumps, corners and odd-shaped geometric locations, the number of field seams shall be minimized. Seaming shall extend to the outside edge of panels. Soft subgrades shall be compacted and approved prior to seaming. The seam area shall be free of moisture, dust, dirt, and foreign material at the time of seaming. Fish mouths in seams shall be repaired.

C. Polyethylene Seams

Polyethylene geomembranes shall be seamed by thermal fusion methods. Extrusion welding shall only be used for patching and seaming in locations where thermal fusion methods are not feasible. Seam overlaps that are to be attached using extrusion welds shall be ground prior to welding. Grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement. Extrusion welding shall begin within 10 minutes after grinding. Where extrusion welds are temporarily terminated long enough to cool, they shall be ground prior to applying new extrudate over the existing seam. The total depth of the grinding marks shall be no greater than 10 percent of the sheet thickness.

3.05 SAMPLES

One QC sample, 18 inches in length, for the entire width of a roll, shall be obtained for every 100,000 square feet of material delivered to the site. Samples shall not be obtained from the first three feet of the roll.

3.06 TESTS

A. QC Testing

The Contractor shall provide all QC samples to the QC laboratory to determine density, thickness, tensile strength at break, and elongation at break in accordance with the methods specified in Table 1. Samples not meeting the specified requirements shall result in the rejection of applicable rolls/panels. As a minimum, rolls/panels produced immediately prior to and immediately after the failed roll/panel shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls/panels on both sides of the original failing roll/panel pass the failed parameter.

B. Non-Destructive Field Seam Continuity Testing

Field seams shall be non-destructively tested for continuity over their full length in accordance with the installer's approved QC manual. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming. Any seams which fail shall be documented and repaired in accordance with the installer's approved QC manual.

3.07 DEFECTS AND REPAIRS

Tears, holes, blisters and other defects shall be repaired with patches. Patches shall have rounded corners, be made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects. Minor localized flaws shall be repaired by spot welding or seaming as determined by the QC inspector. Repairs shall be non-destructively tested. The QC inspector may also elect to perform destructive seam tests on suspect areas.

3.08 PROTECTION AND BACKFILLING

The deployed and seamed geomembrane shall be covered with the specified material within 5 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of cover materials. Cover soil shall not be dropped onto the geomembrane or overlying geosynthetics from a height greater than 3 feet. The soil shall be pushed out over the geomembrane or overlying geosynthetics in an upward tumbling motion. Soil shall be placed from the bottom of the slope upward.

3.09 RECORD DRAWINGS

The Contractor shall provide final As-Built Drawings for the geomembrane installation.

-- End of Section --

SECTION 31 21 14.13

VAPOR MITIGATION SUB-SLAB VENTING SYSTEM
10/17

PART 1 GENERAL

1.01 DESCRIPTION

Installation and operation of a vapor mitigation Sub-Slab Venting System (SSVS) to control the potential accumulation and infiltration into the GETS building, of volatile organic compounds contained in subsurface soils and groundwater.

1.02 REFERENCES

The publications listed below for, a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B31.1	(2016; Errata 2016) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A27/A27M	(2017) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A413/A413M	(2012) Standard Specification for Carbon Steel Chain
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A575	(1996; E 2013; R 2013) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D2855	(2015) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D422	(1963; R 2007; E 2014; E 2014) Particle-Size Analysis of Soils

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION (NJDEP)

NJDEP VITG	(2016, Version 4) Vapor Intrusion Technical Guidance

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping And Fittings; G

Source Of Crushed Stone; G

SD-06 Test Reports

Gradation Test Results; G

Post-Installation Diagnostic Test; G

Verification Sampling Results; G

Verification Sampling Results Report; G

PART 2 PRODUCTS

2.01 MATERIALS

A. Sub-Slab Venting Layer

1. Eight inch thick open-graded crushed stone in accordance with Section 31 23 16 BACKFILL AND COMPACTION.

2. Crushed stone shall be uniform in texture and quality and shall be free of organic matter, wood, garbage, metal, debris, or lumps of clay.

3. Identify source of crushed stone.

4. Gradation Testing: Three tests for gradation in accordance with ASTM D422.

5. Submit gradation test results to Contracting Officer.

B. Plastic (PVC) Pipe and Fittings

1. All sub-slab vent piping, including lateral, header, and riser pipes shall be laid, jointed and installed in accordance with the Contract Drawings.

2. Exposed pipe shall be provided with pipe supports in accordance with Section 40 05 15 PIPING SUPPORT SYSTEMS.

3. Plastic pipe shall be rigid polyvinyl chloride (PVC) pipe in conformity with the North American Standard for Nominal Pipe Size (NPS) system. The pipe shall be equal to the grade known in commerce as Type 1, Grade 1, Schedule 40 or Schedule 80, as shown on Contract Drawings, and shall conform to the current requirements specified in the following ASTM Designation:

a. Materials as per ASTM D1784.
b. Dimensional tolerances as per ASTM D1785.
c. Threaded pipe fittings shall be as per ASTM D2464.
d. Socket type fittings shall conform to ASTM D2467.
e. Under slab PVC pipe shall conform to ASTM D2774.
f. Section 40 27 00 PROCESS PIPING GENERAL, Data Sheet 2 - Polyvinyl Chloride (PVC) Pipe and Fittings.

4. The pipe and fittings shall be sound, cylindrical, free from cracks and other defects, and of uniform thickness and color. Each length of pipe and each fitting shall be suitably marked at the plant for identification. The pipe shall be joined by solvent cementing, cemented grooved collars, threading flanges, heat welding or adhesives as approved. All of the above materials shall be handled with care and the joint shall be clean and dry when made. The pipe and fittings shall be joined together in strict accordance with the instructions and recommendations of the pipe manufacturer.

5. Provide product data on piping and fittings.

B. Solvent Weld Type

Joints shall be of the PVC Solvent Weld type. Joints shall be manufactured in accordance with ASTM D2855. PVC solvent cement shall be in conformance with ASTM D2564.

C. Wind-Driven Rotary Turbine Ventilator

1. The roof-mounted wind-driven rotary turbine ventilator shall be galvanized stainless steel with an 8 inch throat size with a draw of 200 cfm. Contractor shall provide adaptor connection to connect the rotary turbine ventilator to the 4-inch diameter Schedule 80 PVC riser pipe.

PART 3 EXECUTION

3.01 GENERAL

A. Examine subgrade, areas, and conditions under which SSVS will be installed and tested, for compliance with requirements. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 SUB-SLAB VENTING LAYER INSTALLATION

A. Crushed stone shall be placed in loose lifts and then be compacted by 1 pass of a minimum 13 ton vibratory cylinder roller, as approved by the Contracting Officer.

B. Within confined areas, crushed stone shall be hand placed in loose layers and each layer shall be compacted with flat-face mechanical tampers.

3.03 VENT PIPING INSTALLATION

A. General

1. The Contractor shall lay out the 4-inch diameter Schedule 40 PVC perforated lateral ventilation piping per layout design as indicated on the Contract Drawings.

2. The Contractor shall connect the perforated lateral piping to a solid 4-inch diameter Schedule 40 PVC pipe header pipe at locations indicated on the Contract Drawings.

3. The Contractor shall connect the sub-slab header pipe to a solid 4-inch diameter Schedule 80 PVC riser pipe extending and mounted along the interior partition wall, at location shown on the Contract Drawings, and connected to roof-mounted wind-driven rotary turbine ventilator.

B. Solvent Weld Type

1. Pipe shall be carefully jointed in conformity with the best practice and the detailed instructions of the manufacturers. All pipe ends shall be thoroughly cleaned prior to and during the jointing operation. The pipe end shall be thoroughly coated with solvent cement in accordance with the recommendations of the manufacturer, and adequate joint setup time will be provided.

C. Pipe Hangers and Supports

1. The Contractor shall furnish and install all piping hanger and support systems required for the safe support of all exposed piping, as required.

2. Hangers, supports, anchors and accessories shall be deemed to include all pipe hanging and supporting devices of metallic and non-metallic construction as required for pipelines and appurtenances. Included in this classification are saddle stands, steel and cast iron stanchions, hangers, pipe pole supports, structural steel supports, pipe saddles, pipe rolls, inserts, anchors, fastening and attaching parts, hardware, all specials of any nature whatsoever, appurtenances and accessories.

3. The design of the hangers and support systems shall employ the various attachments to structure and attachments to piping in conformance with Section 40 05 15, PIPING SUPPORT SYSTEMS, and subject to the approval of the Contracting Officer.

4. All grout shall be of an approved non shrink, nonmetallic type.

5. Structural steel framework for supporting pipes shall be furnished and installed where required for adequate support, and shall be anchored to walls, floors and ceilings with stainless steel adhesive anchors. Framework design, materials, fabrication and installation shall be completed by the Contractor. In general, piping shall be supported by the framework through the use of approved pipe slides.

6. Material for hangers and supports shall conform to the requirements of the following standards:

	Standard
Structural	ASTM A36/A36M
Threaded Steel Rods	ASTM A575
Steel Castings	ASTM A27/A27M, Grade 65 35, Full
Wrought Steel Pipe	ASTM A53/A53M (Schedule 40)
Iron Castings	ASTM A48/A48M (Class 35)
Cast Iron Pipe Stanchions	ASME B31.1, Class 125
Malleable Iron Castings	ASTM A47/A47M
Bolting Materials: Bolts, Stud Bolts,	ASTM A307
Chains	ASTM A413/A413M

7. All hanger and support steel shall be prime and finished coated.

D. Strength and Identification

1. Vent riser pipes shall be clearly identified for individual services. Signs shall be permanent and suitable for interior and exterior use, as applicable. The signs shall be made of permanent adhesive tapes. Signs shall be installed at 10 foot vertical intervals.

E. Connections to Roof-Top Wind-Driven Rotary Turbine

1. Vent riser piping, adapters, flanges, reducers and related appurtenances required to match roof-top wind-driven rotary turbine component connections shall be furnished and installed as required for equipment furnished and installed under this and other sections of these Specifications.

2. A 120V AC, single-phase electrical outlet near the roof-top connection to the wind-driven rotary turbine shall be furnished and installed to allow for the activation of a replacement approved electrical fan, if necessary, based on the results of the Verification Sampling as discussed in Section 3.04 C.

3. Provisions shall be made for equipment removal for repair, servicing or replacement (including replacement with an approved equal active electrical fan, if necessary) by utilization of couplings and flanges.

F. Materials and Workmanship

1. All materials furnished under this Contract shall be of first class high grade quality and of the best workmanship and design, conforming to pertinent specifications of the American Standard Testing Materials, American Water Works Association, and American Standards Association, as herein specified or amended. No inferior or low grade materials will be either approved or accepted, and all work of assembly and construction shall be done in a neat, first class and workmanlike manner, based on best acceptable practice.

2. All castings shall be clean and sound, without defects of any kind; no plugging, welding or repairing of defects will be allowed. All like parts of equipment of the same size or capacity shall be interchangeable.

3. All parts entering into the assembly of the equipment are to be designed, constructed and fabricated for continuous and uninterrupted service, so as to eliminate, so far as practicable, the necessity of attention when operating over long periods. Suitable provision shall be made for easy adjustment or replacement of all parts requiring adjustment or renewal.

4. The Contractor shall be responsible for the dimensions to be confirmed or coordinated at the job site, as well as information that pertain solely to the fabrication processes

or to techniques of construction and for the coordination of the work of all trades.

G. Defective Work

1. Any material found by the Contracting Officer to be unsuitable, and not in conformity with these Specifications, as to quality of workmanship or operation, shall be removed from the site of the work.

2. If any equipment, or part thereof, is found defective prior to the expiration of the guarantee period, the Contractor shall, notwithstanding the fact that such work or materials may have been previously accepted or estimated for payment, correct all defects in a manner satisfactory to the Engineer including replacement if necessary to bring the equipment into conformance with the Specifications.

3.04 POST-INSTALLATION DIAGNOSTIC TESTING

A. General

1. The Contract shall conduct system start up and testing, including a post-installation diagnostic test and verification sampling no sooner than 30 days after the system activation but not in excess of 60 days.

B. System Startup

1. System Startup shall be conducted as recommended in the most recent update of the NJDEP VITG, and shall include, but may not be limited to the following:

a. Visual inspection of the system with the aid of the Vapor Intrusion Mitigation System & Installation Checklist, as provided in the most recent NJDEP VITG.
b. Identification of any problems (noise, vibration, condensate generation, complaints, etc.).
c. Determination as to whether alterations or augmentation of the system are required.
d. Establishment of an operational baseline from appropriate commissioning parameters, as approved by the Engineer.

C. SSVS Sampling

1. SSVS Sampling shall be conducted as recommended in the most recent update of the NJDEP VITG, and shall include, but may not be limited to the following:

a. Conduct sampling on the same day as the startup of the system - a minimum of 30 days after the system activation (not to exceed 60 days).

b. Sampling shall consist of collecting at one (1) sub-slab soil gas sample over an 8-hour collection period from the sampling port installed along the interior vent riser pipe, following sampling procedures in accordance with the most recent NJDEP VITG. In addition, Sampling shall include collection of at least two (2) indoor air and one

(1) concurrent background air sample over a 24-hour period following sampling procedures in accordance with the most recent NJDEP VITG.

c. Samples collected as part of the VS shall be analyzed for volatile organic compounds (VOCs) that are considered primary contaminants of concern for the site.

d. Verification Sampling results shall be submitted to the Contracting Officer within 5 days of the receipt of the analytical results.

e. Verification Sampling results shall be compared with the applicable NJDEP Vapor Intrusion Screening Levels (VISLs) and presented in a Verification Sampling Results Report, which shall be submitted to the Contracting Officer within 15 days of the receipt of the analytical results. The Verification Sampling Results Report shall include the Contractor's evaluation of the results in accordance with NJDEP VITG, and recommendations on the need to convert from the passive vapor mitigation SSVS to an active vapor mitigation SSVS.

3.05 CONVERSION TO ACTIVE VAPOR MITIGATION SSVS

A. General

The Contractor shall convert the passive vapor mitigation SSVS to an active vapor mitigation SSVS within 30 days after Contracting Officer's acceptance of the Verification Sampling results report, and recommendation to convert from a passive to active vapor mitigation SSVS.

B. Replacement of Roof-Top Wind-Driven Rotary Turbine with Electrical Fan

1. The Contractor shall replace the passive roof-top wind-driven rotary turbine with an approved equal roof-top electrical fan. The electrical fan shall be galvanized stainless steel (or approved equal) with an 8 inch throat size, and with an airflow capacity equal or greater than the rated airflow for the wind-driven rotary turbine.

2. Contractor shall provide adaptor connection to connect the roof-top electrical fan to the 4-inch diameter Schedule 80 PVC riser pipe.

C. System Startup

System Startup following the conversion shall be conducted in accordance with Section 3.04 B, and as recommended in the most recent update of the NJDEP VITG.

-- End of Section --

SECTION 31 21 14.14

VAPOR MITIGATION SUB-SLAB GAS VAPOR BARRIER SYSTEM
10/17

PART 1 GENERAL

1.01 DESCRIPTION

Provide all work necessary to install a fluid-applied sub-slab Gas Vapor Barrier (GVB)in conjunction with the Sub-Slab Venting System (SSVS), as specified in Section 31 21 14.13, VAPOR MITIGATION SUB-SLAB VENTING SYSTEM. The GVB shall be installed directly beneath the concrete slab within the entire occupied building footprint, and directly above the sub-slab venting layer and vent piping, as indicated on the Contract Drawings.

1.02 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM C704/C704M	(2015) Standard Test Method for Abrasion Resistance of Refractory Materials at Room Temperature
ASTM C836/C836M	(2015) High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use With Separate Wearing Course
ASTM D1434	(2015) Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting
ASTM D1693	(2015) Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D1970/D1970M	(2017) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2582	(2016) Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting
ASTM D4068	(2017) Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic

	Elastomers - Tension
ASTM D543	(2014) Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D751	(2006; R 2011) Coated Fabrics
ASTM E154/E154M	(2008a; R 2013; E 2013) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials
ASTM G152	(2013) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

GVB Barrier Application Plan; G

Qualifications Of Analytical Laboratory; G

SD-03 Product Data

For Each Type Of GVB Material; G

SD-04 Samples

GVB Membrane Field Sample; G

SD-06 Test Reports

Material Performance Testing; G

SD-07 Certificates

GVB Subcontractor Certification

SD-11 Closeout Submittals

Warranty; G

1.04 GVB BARRIER APPLICATION PLAN

A. Prepare a plan detailing the proposed application procedures for the barrier system. The plan shall include the following elements:

1. Application locations.
2. Drawing showing panel layout for GVB sheet materials. Indicate sheet overlap, all penetrations, and termination procedures.
3. Application procedures including measures for protecting surrounding equipment and materials, ambient temperatures for application, minimum clearance required, protection of membrane after application.
4. Proposed locations for destructive sample collection and procedures to repair membrane following sample collection
5. Required substrate conditions at the time of application.
6. Delivery and storage requirements for materials.

B. Submit samples of the liquid GVB barrier material and GVB sheet material for testing to verify conformance with properties specified in paragraph 2.02 and 2.03.

1. Identify and provide qualifications of analytical laboratory that will perform the material testing.
2. Summarize and submit results of material performance testing.

1.05 QUALITY ASSURANCE

A. The GVB subcontractor/applicator shall be trained and approved by GVB manufacturer. GVB subcontractor certification documentation shall be provided by the manufacturer and submitted to Contracting Officer.

B. Obtain GVB materials and system components from a single manufacturer source. Submit product data for each type of GVB material, including manufacturer's printed instructions for evaluating and preparing the substrate, technical data, and tested physical and performance properties to Contracting Officer.

C. Field Sample: Apply the barrier material to a 100 square foot area to generate a GVB membrane field sample to demonstrate application method, detailing, thickness, texture, and standard of workmanship. The field sample will be conducted by the same technician using the same materials and equipment as will be used during the final application.

1. Notify Contracting Officer one week in advance of the dates and times when field sample will be prepared.

2. If Contracting Officer determines that field sample does not meet requirements, reapply field sample until field sample is approved.

3. Retain and maintain approved field sample during construction in an undisturbed condition as a standard for judging the completed methane and vapor intrusion barrier. An undamaged field sample may become part of the completed work.

D. Pre-installation Conference: A pre-installation conference shall be held prior to application of the GVB system to assure proper site and installation conditions, to include Contracting Officer, Contractor, applicator, architect/engineer, other trades influenced by the GVB installation and special inspector (if any). The Contractor shall be responsible for meeting arrangements and shall prepare minutes of the meeting

E. The Contractor shall field fit and install the GVB at the locations and in accordance with the details shown on the Contract Drawings accompanying these specifications. For any details not covered by the drawings, details provided by the manufacturer may be used. Any planned deviation from those locations or details shall be submitted in the GVB application plan for review and acceptance prior to installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site as specified by manufacturer labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store materials as specified by the manufacturer in a clean, dry, protected location and within the temperature range required by manufacturer. Protect stored materials from direct sunlight. If freezing temperatures are expected, necessary steps should be taken to prevent freezing of components.

C. Remove and replace material that cannot be applied within its stated shelf life.

1.07 PROJECT CONDITIONS

A. Protect all adjacent areas where barrier is not to be installed. Where necessary, apply masking to prevent staining of surfaces to remain exposed wherever membrane abuts to other finish surfaces.

B. Perform work only when existing and forecasted weather conditions are within manufacturer's recommendations for the material and application method used.

C. Minimum clearance of 24 inches is required for application of product. For areas with less than 24-inch clearance, the membrane may be applied by hand.

D. Ambient temperature shall be within manufacturer's specifications. Consult manufacturer for the proper requirements when desiring to apply below recommended temperature.

E. All plumbing, electrical, mechanical and structural items to be placed under or passing through the GVB system shall be positively secured in their proper positions and appropriately protected prior to membrane application.

F. GVB shall be installed before placement of reinforcing steel. When not possible, all exposed reinforcing steel shall be masked by general contractor prior to GVB application.

G. Stakes used to secure the concrete forms shall not penetrate the GVB system after it has been installed. If stakes need to puncture the GVB system after it has been installed, the necessary repairs need to be made by a certified applicator.

1.08 WARRANTY

A. General Warranty: The special warranty specified in this section shall not deprive the Government of other rights the Government may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made by the contractor under requirements of the contract documents.

B. Special Warranty: Submit a written warranty signed by the GVB manufacturer agreeing to repair or replace GVB that does not meet requirements or that does not remain Volatile Organic Compounds (VOCs) vapor tight within the specified warranty period. Warranty does not include failure of GVB due to failure of substrate prepared and treated according to requirements or formation of new joints and cracks in the attached to structures that exceed 1/16 inch in width.

1. Warranty Period: 1 year after date of substantial completion. Longer warranty periods may be available upon request to the manufacturer.

C. Labor and material warranties are available upon request to the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Geo-Seal; Land Science Technologies™, San Clemente, CA.
B. CETCO Liquid Boot Company, Santa Ana, CA.
C. Or approved equal.

2.02 GAS VAPOR BARRIER MATERIALS

A. The Contractor shall install a liquid GVB system. The GVB shall be applied as a single course, high build, polymer modified asphaltic emulsion, water borne and spray applied at ambient temperatures. The dried thickness shall be a minimum of 60 dry mils (1 mil = 0.001 inches).

B. Liquid GVB shall meet or exceed the following physical properties using specified test methods and limits (or approved equal).

GAS VAPOR BARRIER	TEST METHOD	LIMITS
Tensile Strength - CORE only	ASTM D412	32 psi
Tensile Strength - System	ASTM D412	662 psi
Elongation	ASTM D412	4140 percent
Resistance to Decay	ASTM E154/E154M Section 13	4 percent Perm Loss
Accelerated Aging	ASTM G152	No Effect

GAS VAPOR BARRIER	TEST METHOD	LIMITS
Moisture Vapor Transmission	ASTM E96/E96M	0.026 g/ft2/hr
Hydrostatic Water Pressure	ASTM D751	26 psi
Perm rating	ASTM E96/E96M (US Perms)	0.21
Methane Transmission Rate	ASTM D1434	Pass/Fail
Adhesion to Concrete &	ASTM C836/C836M and	11 lbf./inch
Hardness	ASTM C836/C836M	80
Crack Bridging	ASTM C836/C836M	No Cracking
Heat Aging	ASTM D4068	Pass/Fail
Environmental Stress Cracking	ASTM D1693	Pass/Fail
Oil Resistance	ASTM D543	Pass/Fail
Soil Burial	ASTM D4068	Pass/Fail
Low Temperature Flexibility	ASTM C836/C836M	No Cracking at -4 degrees F
Resistance to Acids:		
Acetic		30 percent
Sulfuric and Hydrochloric		13 percent
Temperature Effect		
Stable		248 degrees F
Flexible		13 degrees F

C. Gas vapor detail materials (e.g. for sealing penetrations, overlaps, terminations, etc.) shall meet or exceed the following physical properties using specified test methods and limits (or approved equal).

GAS VAPOR DETAIL	TEST METHOD	LIMITS
Tensile Strength	ASTM D412	32 psi
Elongation	ASTM D412	3860 percent
Resistance to Decay	ASTM E154/E154M Section 13	9 percent Perm Loss
Accelerated Aging	ASTM G152	No Effect
Moisture Vapor Transmission	ASTM E96/E96M	0.026 g/ft2/hr

GAS VAPOR DETAIL	TEST METHOD	LIMITS
Hydrostatic Water Pressure	ASTM D751	28 psi
Perm rating (US Perms)	ASTM E96/E96M	0.17
Methane Transmission Rate	ASTM D1434	Pass/Fail
Adhesion to Concrete & Masonry	ASTM C836/C836M and ASTM C704/C704M	7 lbf./inch
Hardness	ASTM C836/C836M	85
Crack Bridging	ASTM C836/C836M	No Cracking
Low Temperature Flexibility	ASTM C836/C836M	No Cracking at -4 degrees F
Resistance to Acids:		
Acetic		30 percent
Sulfuric and Hydrochloric		13 percent
Temperature Effect		
Stable		248 degrees F
Flexible		13 degrees F

2.03 GVB MATERIALS

A. The GVB system shall include a base and bond layers, which are chemically resistant sheets comprised of a 5 mil high density polyethylene (HDPE) sheet thermally bonded to a 3 ounce non-woven geotextile.

B. GVB Course Materials

1. For foundation base layer, use base course and/or other base layer as required or approved by the manufacturer.

2. For top protective layer, use bond layer and/or other protection as required or approved by the manufacturer.

C. The base and bond layer materials shall meet or exceed the following physical properties using specified test methods and limits (or approved equal).

PROPERTIES	TEST METHOD	LIMITS
Film Thickness	ASTM D412	5 mil

PROPERTIES	TEST METHOD	LIMITS
Composite Thickness		18 mil
Water Vapor Permeability	ASTM E96/E96M	0.214
Adhesion to Concrete	ASTM D1970/D1970M	9.2 lbs/inch2
Dart Impact	ASTM D1970/D1970M	Greater than 1070 gms, method A
		594 gms, method B
Puncture Properties Tear	ASTM D2582	11,290 gms
	ASTM D2582	13,150 gms

2.04 AUXILLARY MATERIALS

A. Sheet Flashing: 60-mil reinforced modified asphalt sheet good with double-sided adhesive.

B. Reinforcing Strip: Manufacturer's recommended polypropylene and polyester fabric.

C. Seam Detailing Sealant Mastic: a high or medium viscosity polymer modified water based asphalt material.

D. Back Rod: Closed-cell polyethylene foam.

E. These materials shall be applied in accordance with manufacturer's recommendations and presented in GVB Application Plan.

PART 3 EXECUTION

3.01 SITE INSPECTION

Examine substrates, areas, and conditions under which GVB will be applied, with installer present, for compliance with requirements. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 SUBGRADE SURFACE PREPARATION

A. Verify substrate is prepared according to manufacturer's recommendations. On a horizontal surface, the substrate should be free from material that can potentially puncture the GVB. Additional protection or cushion layers might be required if the earth or gravel substrate contains too many jagged points and edges that could puncture one or more of the system components. Contact manufacturer to confirm substrate is within manufactures recommendations.

B. GVB shall the substrates identified on the Contract Drawings.

1. Structural Fill: Remove pieces of debris, gravel and/or any

other material that can potentially puncture the base layer. Remove any debris from substrate that can potentially puncture prior to application.

2. Crushed Stone: Contact the manufacturer to ensure the aggregate layer will not be detrimental to the membrane. The crushed stone layer must be compacted and rolled flat.

C. Mask off adjoining surface not receiving the GVB system to prevent the spillage or over spray affecting other construction.

D. Subgrades should be prepared and compacted to Contract specification requirements.

3.03 CONCRETE SURFACE PREPARATION

A. Clean and prepare concrete surface to manufacturer's recommendations. In general, only apply the GVB to dry, clean and uniform substrates. Concrete surfaces must be a light trowel, light broom or equivalent finish. Remove fins, ridges and other projections and fill honeycomb, aggregate pockets, grout joints and tie holes, and other voids with hydraulic cement or rapid-set grout. It is the applicator's responsibility to point out unacceptable substrate conditions to the general contractor and ensure the proper repairs are made.

B. When applying the GVB material to concrete it is important to not apply the product over standing water. Applying over standing water will result in the GVB not setting up properly on the substrate.

C. Surfaces may need to be wiped down or cleaned prior to application. This includes, but is not limited to, the removal of forming oils, concrete curing agents, dirt accumulation, and other debris. Contact form release agent manufacturer or concrete curing agent manufacturer for VOC content and proper methods for removing the respective agent.

D. Applying the GVB to "green" concrete is acceptable and can be advantageous in creating a superior bond to the concrete surface. To help reduce blistering, apply a primer coat of only the asphalt component of the GVB system. Some blistering of the membrane will occur and may be more severe on walls exposed to direct sunlight. Blistering is normal and will subside over time. Using a needle nose depth gauge confirm that the specified mil thickness has been applied.

3.04 PREPARATIONS AND TREATMENT OF TERMINATIONS

A. Prepare the substrate surface in accordance with paragraphs 3.02 and 3.03 of this Specification. Concrete surfaces that are not a light trowel, light broom or equivalent finish, shall to be repaired.

B. Terminations on horizontal and vertical surfaces shall extend 6 inches onto the termination surface. Job specific conditions may prevent a 6-inch termination. In these conditions, contact manufacturer for recommendations.

C. Apply 30 mils vapor barrier to the terminating surface and then embed the base layer by pressing it firmly into the core layer. Next, apply 60 mils of the core layer to the base layer. When complete, apply the bond layer. After the placement of the bond layer is complete, apply a final 30 mil seal of the core layer over the edge of the termination. For further clarification, refer to the termination detail provided by manufacturer.

D. The stated termination process is appropriate for terminating the GVB onto exterior footings, pile caps, interior footings and grade beams. When terminating the GVB to stem walls or vertical surfaces the same process should be used.

3.05 PREPARATIONS AND TREATMENT OF PENETRATIONS

A. All pipe penetrations should be securely in place prior to the installation of the vapor barrier GVB system. Any loose penetrations should be secured prior to application, as loose penetrations could potentially exert pressure on the membrane and damage the membrane after installation.

B. To properly seal around penetrations, cut a piece of the base layer that will extend 6 inches beyond the outside perimeter of the penetration. Cut a hole in the base layer just big enough to slide over the penetration, ensuring the base layer fits snug against the penetration, this can be done by cutting an "X" no larger than the inside diameter of the penetration. There should not be a gap larger than a 1/8-inch between the base layer and the penetration. Other methods can also be utilized, provided, there is not a gap larger than 1/8-inch between the base layer and the penetration.

C. Seal the base layer using the GVB material to the underlying base layer.

D. Apply one coat of GVB spray to the base layer and around the penetration at a thickness of 30 mils. Penetrations should be treated in a 6-inch radius around penetration and 3 inches onto penetrating object.

E. Embed a fabric reinforcing strip after the first application of the GVB spray material and then apply a second 30 mil coat over the embedded joint reinforcing strip ensuring its complete saturation of the embedded strip and tight seal around the penetration.

F. After the placement of the bond layer, a cable tie should then be placed around the finished penetration. The cable tie should be snug, but not overly tight so as to slice into the finished seal.

G. A final application of GVB material may be used to provide a finishing seal after the bond layer has been installed.

H. Metal or other slick penetration surfaces may require pretreatment in order to achieve proper adhesion. For plastic pipes, sand paper may be used to achieve a profile; an emery cloth is more appropriate for metal surfaces. An emery cloth should also be used to remove any rust on metal surfaces.

3.06 BASE LAYER INSTALLATION

A. Install the base layer over substrate material in one direction with 6-inch overlaps and the geotextile (fabric side) facing down.

B. Secure the base seams by applying 60 mils of GVB spray between the 6 inches of overlapped sheets with the geotextile side down. In windy conditions it might be necessary to encapsulate the seam by spraying the GVB layer over the completed base seam.

C. Visually verify there are no gaps/fish-mouths in seams.

D. For best results, install an equal amount of base and GVB spray material in one day. Leaving unsprayed base overnight might allow excess moisture to collect. If excess moisture collects, it needs to be removed.

3.07 VAPOR BARRIER APPLICATION

A. Set up spray equipment according to manufacturer's instructions.

B. Mix and prepare materials according to manufacturer's instructions.

C. The two catalyst nozzles (8001) should be adjusted to cross at about 18 inches from the end of the wand. This apex of catalyst and emulsion spray should then be less than 24 inches but greater than 12 inches from the desired surface when spraying. When properly sprayed the fan pattern of the catalyst should range between 65 degrees and 80 degrees.

D. Adjust the amount of catalyst used based on the ambient air temperature and surface temperature of the substrate receiving the membrane. In hot weather use less catalyst as hot conditions will quickly "break" the emulsion and facilitate the curing of the membrane. In cold conditions and on vertical surfaces use more catalyst to "break" the emulsion quicker to expedite curing and set up time in cold conditions.

E. To spray the layer, pull the trigger on the gun. A 42 degree fan pattern should form when properly sprayed. Apply one spray coat of vapor barrier spray to obtain a seamless membrane free from pinholes or shadows, with an average dry film thickness of 60 mils.

F. Apply the vapor barrier layer in a spray pattern that is perpendicular to the application surface. The concern when spraying at an angle is that an area might be missed. Using a perpendicular spray pattern will limit voids and thin spots, and will also create a uniform and consistent membrane.

G. Verify film thickness of GVB every 500 square ft, for information regarding quality control measures, refer to the quality control procedures in paragraph 3.09 of this Specification.

H. The GVB will generally cure in 24 to 48 hours. As a rule, when temperature decreases or humidity increases, the curing of the membrane will be prolonged. The membrane does not need to be fully cured prior the placement of the bond layer, provided mil thickness has been verified and a smoke test will be conducted.

I. Do not penetrate membrane after it has been installed. If membrane is penetrated after the membrane is installed, it is the responsibility of the general contractor to notify the certified installer to make repairs.

J. If applying to a vertical concrete wall, apply vapor barrier spray directly to concrete surface and use manufacturer's recommended protection material based on site specific conditions. If applying against shoring, contact manufacturer for site specific installation instructions.

NOTE: Care should be taken to not trap moisture between the layers of the GVB. Trapping moisture may occur from applying a second coat prior to the GVB fully curing. Repairs and detailing may be done over the core layer when not fully cured.

3.08 BOND PROTECTION COURSE INSTALLATION

A. Install bond protection course perpendicular to the direction of the base course with overlapped seams over nominally cured membrane no later than recommended by manufacturer and before starting subsequent construction operations.

B. Sweep off any water that has collected on the surface of the vapor barrier layer, prior to the placement of the bond layer.

C. Overlap and seam the bond layer in the same manner as the base layer.

D. To expedite the construction process, the bond layer can be placed over the vapor barrier layer immediately after the spray application is complete, provided the vapor barrier mil thickness has been verified.

3.09 QUALITY ASSURANCE

A. The GVB system must be installed by a trained and certified installer approved by the manufacturer.

B. For projects that will require a material or labor material warranty, the manufacturer will require a manufacturer's representative or certified third party inspector to inspect and verify that the membrane has been installed per the manufacturer's recommendations. The certified installer is responsible for contacting the inspector for inspection. Prior to application of the membrane, a notice period for inspection will be agreed upon between the applicator and inspector.

C. To verify the mil thickness of the GVB, the following measurement devices shall be used:

1. Mil reading caliper: Calipers shall be used to measure the thickness of coupon samples. To measure coupon samples correctly, the thickness of the sheet layers (18 mils each) must be taken into account. Mark sample area for repair.

2. Wet mil thickness gauge: A wet mil thickness gauge shall be used to measure the mil thickness of the vapor barrier layer.

The thickness of the sheet layers do not factor into the mil thickness reading.

When first using a wet mil thickness gauge on a project, collect coupon samples to verify the wet mil gauge thickness readings.

3. Needle nose digital depth gauge: A needle nose depth gauge shall be used when measuring the vapor barrier thickness on vertical walls or in field measurements. Mark measurement area for repair.

4. Shrinkage of 5 to 10 percent should be accounted for during membrane curing. To account for shrinkage, a freshly sprayed membrane should have a minimum wet thickness of 63 (5 percent shrinkage) to 66 (10 shrinkage) mils (not including the thickness of the sheet material).

5. Follow manufacturer's instruction on how to properly conduct the GVB thickness sampling.

D. The number and locations of destructive coupon samples shall be based on manufacturer's recommendations and approved by the Contracting Officer. Areas where coupon samples have been removed shall be marked and repaired.

E. Smoke testing shall be performed on completed on the liner system following installation. Refer to smoke testing protocol provided by the manufacturer. For projects that will require a material or labor material warranty, the manufacturer will require a smoke test.

F. Conduct visual inspections prior to placement of concrete, but after the installation of concrete reinforcing to identify any punctures that may have occurred during the installation of rebar, post tension cables, etc. Punctures in the GVB system should be easy to identify due to the color contrasting layers of the system.

G. Submit all field quality control result, including failing results, to Contracting Officer. Provide documentation that all areas with a failing test was repaired and retested until a passing test was achieved.

-- End of Section --

SECTION 31 23 10

EXCAVATION
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926.652	Safety and Health Regulations for Construction; Subpart P, Excavations; Requirements for Protective Systems

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Trenching And Shoring Plan; G

Excavation Plan; G

1.03 QUALITY ASSURANCE

Provide adequate survey control to avoid unauthorized overexcavation.

Following removal of the asphalt cap, all on-site soil shall handled as RCRA/TSCA contaminated soil unless characterized and determined to be non hazardous.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

C. Material excavated to be used as earthfill shall meet the requirements specified in Section 31 23 16, BACKFILL AND

COMPACTION.

1.05 EXCAVATION PLAN

Contractor shall prepare an excavation plan detailing procedures for excavation, stockpiling and disposal of contaminated soil at the site during construction. The plan shall included the following elements at a minimum:

A. Health and safety procedures.
B. Soil erosion and sedimentation controls procedures.
C. Removal of asphalt cap and restoration of cap in disturbed areas.
D. Methods and sequencing of excavation.
E. Proposed locations and management of stockpiled excavated material.
F. Proposed offsite excess contaminated soil disposal sites.
G. Numbers, types, and sizes of equipment proposed to perform excavations.
H. Handling and disposal of excess soil generated during the construction process.
I. Anticipated difficulties and proposed resolutions.

1.06 TRENCHING AND SHORING PLAN

Contractor shall prepare a trenching and shoring plan detailing protective procedures for excavation of soils to depths greater than 4 feet below the ground surface in accordance with OSHA regulations (29 CFR 1926.652) and EM 385-1-1. The plan shall include, but not be limited to, the following topics:

A. Glossary of terms.
B. Requirements for protective systems in accordance with 29 CFR 1926.652 and EM 385-1-1.
C. Locations where protective systems will be installed.
D. Details of the types of the protective systems to be used.
E. Training for staff on protection systems.
F. Emergency telephone numbers and emergency rescue.

1.07 UTILITY NOTIFICATION AND COORDINATION

Coordinate the Work with various utilities within Project limits. Notify applicable utilities and New Jersey One Call prior to commencing Work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown on Contract Drawings and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, asphalt cap, and similar items, wherever applicable. Trim to neat lines where concrete is

to be deposited against earth.

B. Do not overexcavate without written authorization of Contracting Officer.

C. Provide adequate support to existing utilities within the excavation to prevent damage.

D. Use of explosives is prohibited.

3.02 UNCLASSIFIED EXCAVATION

Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Pipes, Conduits, Direct-Buried Cables:

a. Less than 4 inch Outside Diameter or Width: 18 inches.
b. Greater than 4 inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable.

2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.

3. Increase trench widths by thicknesses of sheeting.

B. Dimensions shown on the Contract Drawings shall apply in cases of conflict with above.

3.04 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3 inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6 foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed in area designated in excavation plan and in accordance with health and safety procedures.

B. Stockpile crushed stone removed under existing asphalt cap for later reuse. Take steps to minimize the mingling of the underlying fill material with the crushed stone.

C. Stockpile excavated materials at locations shown in Contract Drawings or at approved locations in Excavation Plan.

D. Place stockpiled soil on liner as shown on Contract Drawings. Maintain soil erosion control measures around soil stockpiles.

E. Cover all stockpiles when not in use.

F. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

G. Confine stockpiles to within approved work areas.

H. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

I. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF EXCESS SOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite in accordance with Section 02 81 00 HANDLING, TRANSPORT AND DISPOSAL OF WASTE MATERIALS.

B. The Contractor shall not spill, overflow, or release excavated material during transport to the disposal site.

C. Dispose of debris resulting from removal of contaminated soil with excess soil in accordance with Section 02 81 00 HANDLING, TRANSPORT AND DISPOSAL OF WASTE.

3.07 CONTACT WATER

The Contractor shall collect and manage all water that comes in contact with exposed soils or Contact Water in accordance with Section 01 57 13, TEMPORARY STORMWATER, EROSION AND SEDIMENT CONTROL. At no time shall the Contract Officer be allowed to enter storm drains that drain into the existing storm water detention basins.

-- End of Section --

SECTION 31 23 16

BACKFILL AND COMPACTION
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM D698	(2012; E 2014; E 2015) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D4253	(2016) Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	(2016) Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4832	(2010) Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D6913	(2004; E 2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM D6938	(2017) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

NEW JERSEY ADMINISTRATIVE CODE (NJAC)

NJAC 7:26D	Soil Remediation Standards
NJAC 7:26E	Technical Requirements for Site Remediation

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.

2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Government.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM D1557 specified to determine maximum dry density for relative compaction.

2. Determine field moisture content on basis of fraction passing 3/4 inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.

2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area: Area within planes sloped downward and outward at

60 degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.

2. 1 foot outside outermost edge at surface of roadways or shoulder.

3. 0.5 foot outside exterior at spring line of pipes or culverts.

I. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

J. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

K. Structural fill: On-site soils recovered during excavation of pipe trenches or building. This material may contain PCBs with concentrations up to 499 mg/kg and other contaminants. All work with on-site soils shall comply with requirements of Section 01 35 29, HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES and Section 02 81 00 HANDLING TRANSPORTATION AND DISPOSAL OF WASTE. Where feasible, excavated on-site soils are to be used as backfill. Debris, including rock, concrete, metal clay, silt, organic soils and organic matter and other objectionable materials found in the excavated soil greater than 2 inches in size shall be removed prior to use as fill.

L. Off-site Borrow Materials - Materials obtained from sources offsite, suitable for specified use as noted on Contract Drawings:

1. Crushed Rock: Clean stone placed under wellhead, gas venting layer, concrete slabs, other structures, asphalt pavement and other locations as indicated on the Contract Drawings.

2. Pipe Bedding: Granular fill materials placed around pipes and conduits in utility trenches.

3. Rip Rap: Large rock used to stabilize soil from erosion caused by flowing water such as in the retention basin spillway.

4. Recycled Concrete Aggregate (RCA): Crushed clean and washed recycled aggregate in 3/4 inch size containing maximum 10 percent fines passing the number 200 sieve.

M. Controlled Low Strength Material (CLSM) - Concrete slurry (flowable fill) used to replace unsuitable soils in non structural applications.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Backfill Sampling and Placement Plan; G

Qualifications of Analytical Laboratory; G

Qualifications for Geotechnical Engineer; G

Manufacturer's Data Sheets for Compaction Equipment; G

SD-06 Test Reports

Certified Chemical Analytical Results For Borrow Source Materials; G

Certified Modified Proctor Compaction Test Results for Fill Materials; G

Certified Gradation Test ResultsFor Borrow Source Materials; G

Compressive Strength Of CLSM; G

Laboratory Performance Of Mix Designs; G

In-Place Fill Testing; G

1.04 BACKFILL SAMPLING AND PLACEMENT PLAN

The Contractor shall prepare a Backfill Sampling and Placement Plan including, but not limited to the following:

A. Identify sources of all fill materials to be used at the site.

B. Provide a schedule for sampling, analysis, and delivery of all fill materials.

C. Identify and provide qualifications of analytical laboratory that will perform all analyses. Note: The selected laboratory must be certified to handle the required analyzes for the on-site soil to be used as fill in accordance with all health and safety protocols. As noted elsewhere on-site soils contain up to 499 mg/kg of PCBs and potentially other contaminants.

D. Identify procedures for the on-site stockpiling and staging of all fill materials within the Limits of Construction, including on-site soils excavated during construction. Stockpiling and staging of on-site soils shall comply with Section 02 81 00 HANDLING, TRANSPORT, AND DISPOSAL OF WASTE MATERIALS and Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES.

E. Provide a schedule and sequencing plan for the delivery of materials based on planned productivity during construction.

F. Identify and submit qualifications for Geotechnical Engineer to perform on-site testing of fill materials as specified in paragraph 3.03.

G. Identify and provide manufacturer's data sheets for compaction

equipment.

1.05 QUALITY ASSURANCE

A. Notify Government when:

1. Excavation is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.

2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.

3. Fill material appears to be deviating from Specifications.

B. Where possible, furnish each type of material from a single source throughout the Work. Notify Contracting Officer if there is a need to change borrow source for any reason.

1.06 SEQUENCING AND SCHEDULING

A. Sequence backfilling operations with Section 31 23 10, EXCAVATION to minimize the amount of open soil exposed at any one time. Stabilize and cover areas as soon as backfilling is complete.

B. Complete applicable Work specified in Section 31 23 10, EXCAVATION and Section 31 50 00, SUBGRADE PREPARATION, prior to placing fill or backfill.

C. Do not place backfill until after subgrade has been prepared as specified in Section 31 50 00, SUBGRADE PREPARATION and Section 31 60 00, FOUNDATION PREPARATION and approved by Government.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.

2. During production of imported material, test as follows:

a. Crushed Stone: One test per source.
b. Pipe Bedding: Three tests per source.
c. Rip Rap: One test per source.
d. Recycled Concrete Aggregate: One test per 500 cubic yards.

3. Test Method: ASTM C33/C33M, ASTM C117, ASTM C136/C136M, ASTM D6913.

4. Submit certified gradation test results for all fill materials.

B. Any clean imported material to be used on the project from offsite sources shall be sampled in accordance with the Contractor's approved UFP-QAPP, to ensure that they are free of chemical and radiological contamination. Do not bring material onsite until tests have been approved by the Government.

1. A minimum of one chemical test shall be performed per every

5,000 cubic yards of each type of imported virgin material to be used as site fill materials and no less than one test per borrow area. Additional tests shall be performed for each type of material used, at a frequency of one sample per every 5,000 cubic yards of material. The Government shall accompany the Contractor for testing performed at the site.

2. Analytical parameters to verify that backfill samples are free of chemical and radiological contamination shall be in accordance with Table 1 and 2 in Section 01 35 45, CHEMICAL DATA QUALITY CONTROL. Analytical sampling results for backfill shall be submitted to the Government for approval.

3. Sample data shall be sufficient to demonstrate that backfill materials do not contain contaminant levels that are hazardous to human health or the environment. Material delivered to the site shall meet the definition provided in NJAC 7:26E-1.8. The Contractor shall compare sample data against available site background data and/or NJAC 7:26D. The data will be compared to the most stringent NJDEP soil cleanup standard, which will be the lowest value for each listed compound from Table 1B-Non-Residential Direct Health Based Criteria and Soil Remediation Standards (mg/kg), where those numbers are not below background or method detection limits.

C. Certified Test Results shall be submitted for each source of fill material.

1. Certified gradation test results in accordance with ASTM D6913 and/or ASTM C136/C136M, for imported materials.

2. Certified modified Proctor compaction test results in accordance with ASTM D1557, for structural fill (up to 12 test samples).

3. Certified chemical analytical results in accordance with methods in Section 01 35 45, CHEMICAL DATA QUALITY CONTROL for imported materials.

D. Contract with an independent testing laboratory to provide testing services required. Contractor shall be responsible for the cost of all testing required.

E. Compressive Strength of CLSM: Perform test in accordance to ASTM D4832. Perform a minimum of one test per day or per every 100 cubic yards of CLSM placed, whichever is more.

F. Certify Laboratory Performance of Mix Designs: Controlled low strength material.

2.02 STRUCTURAL FILL

A. Excavated material from required on-site excavations approved by the Government that meets the specified requirements should be used as fill to the extent practicable. The material shall be free from rocks larger than 2 inches, clay and silt, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials removed to the extent practicable.

B. Provide imported material of equivalent quality if required to accomplish Work. Substitution of imported backfill to be used in place of on-site soils must be approved by Contracting Officer.

C. Structural Fill shall be placed in accordance with Section 31 60 00 FOUNDATION PREPARATION.

2.03 PIPE BEDDING

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand meeting the following gradation, as determined in accordance with ASTM D6913.

Pipe Bedding Gradation	
SIEVE SIZE	PASSING
1 inch	100 percent
0.5 inch	0 to 5 percent
#4	0 to 1 percent

2.04 CRUSHED STONE AND RECYCLED CONCRETE AGGREGATE

A. Crushed stone: In accordance with AASHTO #57 coarse aggregate stone, uniform in texture and quality and free of organic matter, wood, garbage, metal, debris, or lumps of clay.

Crushed Stone Gradation	
SIEVE SIZE	PASSING
1.5 inches	100 percent
1 inch	95 to 100 percent
0.5 inch	25 to 80 percent
#4	0 to 10 percent
#8	0 to 5 percent

2.05 RIPRAP

A. Durable field or quarry stone that is sound, hard, dense, resistant to action of air or water, and free of seams, cracks, or other structural defects.

B. Stone pieces shall have a specific weight of 140 lbs/cu ft meeting the following size requirements:

Riprap Gradation	
SIZE	PASSING BY WEIGHT (%)
12 inches	100
9 inches	60-85
6 inches	25-50
3 inches	5-20
1.5 inches	0-5

2.06 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.

2. Aggregate: ASTM C33/C33M, Size 7.

3. Fly Ash (Pozzolan) (if used): Class C fly ash in accordance with ASTM C618, except as modified herein:

a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.

4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.07 WATER FOR MOISTURE CONDITIONING

Contractor shall use potable water.

2.08 MARKING TAPE

In accordance with Section 26 05 43, UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS.

PART 3 EXECUTION

3.01 GENERAL

A. Prepare subgrade as specified in Section 31 50 00, SUBGRADE PREPARATION.

B. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials. Do not place fill when raining.

C. Place and spread fill and backfill materials in horizontal lifts of uniform thickness in maximum 8 inch thick lifts, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only

where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

D. During filling and backfilling, keep level of fill and backfill around each structure and in trench even.

E. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.

2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Building: Backfill in accordance with Section 31 60 00 FOUNDATION PREPARATION. and Section 31 21 14.13 VAPOR MITIGATION SUB-SLAB VENTING SYSTEM

B. Backfill with Structural Fill to lines and grades shown with proper allowance for pavement restoration where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.

C. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00.00, CAST IN PLACE CONCRETE. Obtain Government's acceptance of concrete work and attained strength prior to placing backfill.

D. Within 5 feet of Structures: Place on-site fill in lifts of 8-inch maximum thickness and compact each lift to a minimum of 92 percent relative compaction as determined in accordance with ASTM D1557 at moisture content 2 percent wet of optimum for material.

E. Backfill remainder of the excavation with on-site fill. Place on-site fill in lifts of 8-inch maximum thickness and compact each lift to a minimum of 95 percent relative compaction.

3.03 BACKFILL IN TRENCHES

A. Trench Preparation

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, or direct-buried cable. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.

2. Remove water in a manner that minimizes soil erosion from

trench sides and bottom.

3. Provide continuous water control until trench backfill is complete.

4. Remove foreign material and backfill contaminated with foreign material that falls into trench.

5. All Contact Water from trenches and dewatering liquids will be containerized and treated prior to disposal. Contractor responsible for obtaining any and all permit for disposal or discharge of fluids.

B. Trench Bottom

1. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

2. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Government. Government will determine depth of overexcavation, if any required.

C. Trench Stabilization Material Installation

1. To be used where soft subgrade is encountered.

2. Rebuild trench bottom with trench stabilization material.

3. Place material over full width of trench in 6 inch lifts to required grade, providing allowance for bedding thickness.

4. Compact each lift to 95 percent of the maximum dry density determined by ASTM D698 so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

D. Pipe Bedding

1. Furnish imported bedding material.

2. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

3. Hand grade and compact each lift to 92 percent of the maximum dry density determined by ASTM D1557 to provide a firm, unyielding surface.

4. Four inch minimum thickness under pipe or conduit. Total depth of pipe bedding layer shall be 12 inches.

5. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

6. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

7. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

E. Marking Tape Installation

Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material as shown on Drawings. Coordinate with piping installation drawings.

F. Backfill Above Pipe Zone

1. Process excavated material to meet specified gradation requirements.

2. Adjust moisture content as necessary to obtain specified compaction.

3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.

4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.

5. Backfill to grade with proper allowances for asphalt cap reconstruction, wherever applicable.

6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

7. Correct excess or deficiency of backfill material apparent after settlement and within correction period by regarding, and disposing of excess material or adding additional material where deficient.

8. Beneath Paved Areas: Backfill trench above the pipe zone with structural fill in lifts not exceeding 6 inches. Compact each lift to a minimum of 95 percent relative compaction in accordance with ASTM D1557 at moisture content 2 percent wet of optimum for material prior to placing succeeding lifts.

G. Backfill at Pipe Crossings

1. Backfill with CLSM when:

   a. When both pipelines are new and clearance between them is less than 12 inches.
   b. When a new pipeline is crossing over an existing pipeline and the clearance between them is less than 12 inches.
   c. At all pipe crossings where a new pipeline is crossing under an existing pipeline.

2. Place CLSM in lifts as necessary to prevent uplift (floatation) of pipe, conduit, cables, duct banks and existing structures, and to prevent high lateral each pressures on existing structures. Bring CLSM up uniformly to the corresponding elevations.

3. Place subsequent pours of CLSM after underlying pour has set for at least 24 hours.

4. Do not place CLSM on frozen ground. Weather conditions shall be the same as placing concrete.

H. Backfill Under Wellheads

Backfill with crushed stone as shown on Contract Drawings. Place fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

3.04 OTHER AREAS OF THE SITE

Backfilling other areas of site may be necessary prior to the replacement of the asphalt cap. In those areas, the following shall apply:

A. Allow for 15 inch thickness for asphalt pavement Section 32 12 16 ASPHALT PAVING.

B. Maximum 6 inch thick lifts, except 8-inch thick lifts for Structural Fill.

C. Place and compact fill across full width of open area.

D. Compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557 at moisture content 2 percent wet of optimum for material.

3.05 SETTLEMENT OF BACKFILL

Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

3.06 IN-PLACE FILL TESTING

A. A qualified independent testing agency shall provide proper Site testing. The Contractor shall be responsible for removing any material that does not meet the Specification requirements at no additional cost to the Government.

B. Gradation:

1. One confirmation sample from each 100 cubic yards of finished product or more often as determined by Government, if variation in gradation is occurring, or if material appears to depart from Specifications.

2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective

measures are taken.

3. Remove material placed in Work that does not meet specification requirements.

C. In-Place Density Tests: In accordance with ASTM D6938.

1. Testing requirements for foundation soils under building as specified in Section 31 60 00 FOUNDATION PREPARATION.

3. Testing requirements for aggregate base course as specified in Section 32 12 16 ASPHALT PAVING.

3. Trenches and Other Areas: Minimum of two tests per lift around structures.

4. Additional tests shall be performed if requested by the Government. The frequency and location of testing shall be determined solely by the Government. The Government may require a test on any lift of fill at any time, location, or elevation.

D. Chemical and Radiological Analysis: One confirmation sample per 5,000 cubic yards of each type of imported material per source in accordance with Section 01 35 45 CHEMICAL DATA QUALITY CONTROL.

3.07 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Government as follows:

1. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

2. Beneath Slabs-On-Grade: Granular fill.

3. Trenches:

a. Unauthorized Overexcavation: Either trench stabilization material or pipe bedding material.

b. Authorized Overexcavation: Trench stabilization material as specified in paragraph 3.03 and 3.08.

3.08 RESTORATION

Final restoration shall be undertaken as soon as an area is no longer needed for construction, stockpiling, or access. Excavated material unsuitable for backfill shall be removed from the construction site and disposed of as specified in Section 02 81 00 HANDLING, TRANSPORT, AND DISPOSAL OF WASTE MATERIALS. Workspace and access road shall be restored to pre-disturbance conditions. Care shall be taken to avoid damage to adjacent vegetation, earthen dikes, or other facilities.

-- End of Section --

SECTION 31 50 00

SUBGRADE PREPARATION
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 16, BACKFILL AND COMPACTION.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 16, BACKFILL AND COMPACTION.

D. Relative Density: As defined in Section 31 23 16, BACKFILL AND COMPACTION.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

1.03 SEQUENCING AND SCHEDULING

Complete applicable Work specified in Section 31 23 10, EXCAVATION, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

Notify Government when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A: In Trenches and Open Areas: Compact subgrade to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Under Structures: In accordance with Section 31 60 00 FOUNDATION PREPARATION.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniformly throughout. Do not exceed 2 percent beyond laboratory determined optimum moisture content.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process to bring it to within 2 percent of its optimum moisture content.

3.04 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact if is sand or gravel, or

2. Over excavate as specified in Section 31 23 10, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 31 23 16, BACKFILL AND COMPACTION.

B. Unsuitable Material: Over excavate as specified in Section 31 23 10, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 31 23 16, BACKFILL AND COMPACTION.

-- End of Section --

SECTION 31 60 00

FOUNDATION PREPARATION
11/08

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D6913	(2004; E 2017) Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
ASTM D6938	(2017) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.02 DEFINITIONS

A. Foundations

The foundation is comprised of the surfaces upon which structures are placed. Vertical surfaces, where permitted or required by these specifications, are included.

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Tabular List Of Light Power Tools; G

SD-06 Test Reports

Soil Testing Results; G

In Place Soils Test Records; G

Records Of Inspection; G

PART 2 PRODUCTS

2.01 MATERIALS

A. Soil Testing Prior to Construction

Before the start of any backfilling activities, provide a minimum of three (3) representative fill soil samples for Laboratory Compaction Characteristics Using Modified Effort in accordance with ASTM D1557 and Particle-Size Distribution Gradation in accordance with ASTM D6913. Soil testing results shall be submitted to Contracting Officer.

B. Excavated Soil Material

On average the uppermost 6 feet of the soils consists of likely uncontrolled/undocumented fill, the top of which is locally covered with asphalt pavement. The asphalt has a thickness ranging from 0.6 feet to 0.9 feet. The soils below the asphalt are described as brown to gray-brown/black to reddish brown medium to fine to coarse to fine sand, trace silt, some gravels. Near Bound Brook, soft silt and clay in thickness about 3-1/2 feet are present. Also, gray gravel, little medium fine sand was observed in thickness of about 1.5 feet. Pieces of concrete and bricks were observed in borings.

The uppermost 6 feet of soil fill below the asphalt within the footprint of the proposed building structure shall be excavated and re-used to provide a satisfactory subgrade/bearing soils to support the column and floor loads of the proposed building structure.

PART 3 EXECUTION

3.01 EXAMINATION

The limits of the proposed foundations for the various parts of the work are approximately as indicated in the Geotechnical Report attached to Section 31 23 16 BACKFILL AND COMPACTION. The Contracting Officer reserves the right to change the depth to, or the width of, the foundations if, conditions exposed in the foundation excavations, or as determined by exploratory drilling, warrant such modifications.

3.02 PREPARATION

Submit for approval, tabular list of light power tools, to be used in lieu of hand tools, prior to their use on the job site. Hand tools, where required or permitted by these specifications include, but are not limited to shovels, bars, picks, wedges, and brooms. Light power tools may be used in lieu of hand tools only when such use is approved.

3.03 FINAL FOUNDATION PREPARATION

Following removal of the asphalt cap, general excavation shall be performed in accordance with Section 31 23 10 EXCAVATION, the Excavation Plan developed therein, and as described below.

Unless otherwise directed, Final Foundation Preparation shall be performed in the following manner. This work shall consist of removing

loose and/or soft soils, pockets of fines, any foreign and compressible materials, and other objectionable material from the in place surface including areas of depression, large and crevices. Picking, barring, and hand excavation may be necessary to obtain a foundation surface free from loose, soft, foreign, or compressible materials. Slopes shall not be steeper than 1.0 vertical on 1.0 horizontal. Overhangs shall not be permitted at any location. Overhangs shall be excavated and backfilled with compacted granular materials. Placement of such filter materials shall be in accordance with the provisions summarized below. Vertical surfaces shall not be permitted. The final surface shall be thoroughly cleaned and shall be maintained in a clean condition until the placement of soils as follows:

The foundation soils shall be placed to at or below the frost penetration depth of 36 inches under the footings by re-placing the excavated fill soils. Foundation construction shall proceed in the following manner:

A. Remove existing pavement and other foreign surface features for disposal (i.e., asphalt, concrete, etc.).

B. Excavate to a depth of approximately 6 feet below the existing ground surface for the entire footprint area of the building plus an additional 5 feet on each side. During excavation, remove all foreign material, including pre-existing foundations, concrete pieces, plastic, etc. and dispose of off-site. Stockpile excavated soils for re-use.

C. Following excavation, observe the exposed subgrade and remove and replace any soft spots, buried foundations, and foreign elements with 3/4-inch, single-sized crushed stone, or recycled concrete aggregate, or filter materials.

D. Compact the exposed subgrade using a smooth-roller roller with a minimum static weight of 10 tons, or contact pressure of 80 psi, whichever greater, until achieving a minimum dry density of 95 percent in accordance with ASTM D1557 at a moisture content of 2 percent wet of optimum.

E. Place excavated fill in maximum 8 inch thick lifts, and compact each lift to 95 percent of the fill's dry density as observed in ASTM D1557 at a moisture content of 2 percent wet of optimum. In-place testing in accordance with ASTM D6938.

F. Repeat previous step (#5) until bringing the site to the foundation bottom elevation.

G. Construct concrete slab foundation as shown on Contract Drawings.

H. In areas under the concrete slab, interior to the footings, compact foundations soils as described in this paragraph until reaching the required elevation as shown on the Contract Drawings.

H. In areas outside the structure foundation (where excavation was 5-foot larger than the structure footprint area) backfill soils in 8 inch thick lifts and compact each lift to 92 percent of the fill's maximum dry density at the building perimeter in accordance with ASTM D1557 at a moisture content of 2 percent wet of optimum.

3.04 TESTS

A. General

Establish and maintain quality control for foundation/subgrade preparation operations to assure compliance with Contract Specifications and maintain records of the quality control for all operations including, but not limited to the following:

1. Equipment: Quantity and type. Unless directed otherwise by the Contracting Officer, conduct at least three (3) field density tests at the exposed subgrade and at each 8-inch thick lift in accordance with ASTM D6938 to confirm the required density criteria has been met.

2. Foundation Excavation: Maintain strict adherence to foundation excavation limits and depths.

3. Inspection, Mapping: Orderly prosecution of inspections and cleanup of foundation excavation areas.

B. Reports

Submit three copies of the test records as well as the records of inspection and corrective action taken, if any, daily.

3.05 FOUNDATION INSPECTION

Inspections to determine adequacy of the foundations will be performed by the Contracting Officer in all foundation areas between completion of excavation and placement of asphalt pavement or concrete slab. The Contractor shall cooperate to the extent necessary to assist in inspection and mapping activities which may require additional survey control points and access. Coordinate the schedule for foundation excavation and preliminary cleanup with the Contracting Officer to ensure that the cleanup and inspection proceed in an orderly manner.

-- End of Section --

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 32 12 16

ASPHALT PAVING
09/17

PART 1 GENERAL

1.01 SCOPE OF WORK

Contractor shall provide all labor, materials, tools, and equipment to install all temporary and permanent paving as shown, specified, and ordered.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C131	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

NEW JERSEY DEPARTMENT OF TRANSPORTATION

NJDOT STANDARD SPECIFICATIONS	(2007) New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction

ASTM INTERNATIONAL (ASTM)

ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D2172/D2172M	(2017) Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D2950/D2950M	(2014) Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D4867/D4867M	(2009; R 2014) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D546	(2017) Standard Test Method for Sieve Analysis of Mineral Filler for Asphalt Paving Mixtures

ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM D979/D979M	(2015) Sampling Bituminous Paving Mixtures
ASTM D3666	(2016) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Calibration Laboratory Qualifications; G

Testing Laboratory Qualifications; G

SD-05 Design Data

Mix Design; G

Bituminous Mix Tests; G

SD-06 Test Reports

Specific Gravity Of Mineral Filler; G

Specific Gravity Of Asphalt; G

Pavement Courses Testing; G

Aggregates Tests; G

Field Density Tests; G

SD-07 Certificates

Test Laboratory Certification

1.04 QUALITY ASSURANCE

A. Required Data

The Mix Design shall show the following:

1. Source and proportions, percent by weight, of each ingredient of the mixture.
2. Correct gradation, the percentages passing each size sieve listed in the specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture.

3. Amount of material passing the No. 200 sieve determined by dry sieving.
4. Number of blows of hammer compaction per side of molded specimen.
5. Temperature viscosity relationship of the asphalt cement.
6. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight.
7. Asphalt absorption by the aggregate.
8. Effective asphalt content as percent by weight of total mix.
9. Temperature of the mixture immediately upon completion of mixing.
10. Asphalt performance grade.
11. Curves for the leveling, binder, and wearing courses.

B. Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

C. Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

1. Stability: Peak.
2. Unit Weight: Peak.
3. Percent Air Voids: Median.

1.05 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.06 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than one inch and 55 degrees F for course thicknesses one inch or less.

1.07 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within 12 months of commencing work.

A. Testing Laboratory

Provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

B. Surge and Storage Bins

Use surge and storage bins for temporary storage of hot bituminous mixtures will not be permitted.

C. Drum-Dryer Mixer

Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.

D. Paving Equipment

1. Spreading Equipment

Self-propelled electronically controlled type, unless other equipment is authorized by the Contracting Officer. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Equipment shall be capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

2. Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

3. Hand Tampers

Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

4. Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

PART 2 PRODUCTS

2.01 PRODUCTS

Paving Materials (Job-Mix Designs)

1. Subgrade shall be crushed stone in accordance with Section 31 23 16 BACKFILL AND COMPACTION.
2. Surface course (Mix I-4) shall conform to the NJDOT STANDARD SPECIFICATIONS, as amended.
3. Prime coat as per Section 404.13 of NJDOT STANDARD SPECIFICATIONS.

2.02 SOURCE QUALITY CONTROL

A. Laboratory

Employ a commercial laboratory approved by the Contracting Officer to perform testing. The laboratory used to perform all sampling and testing shall meet the requirements of ASTM D3666 and NJDOT. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

1. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

2. A listing of equipment to be used in developing the job mix.

3. A copy of the laboratory's quality control system.

4. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

B. Tests

Perform testing in accordance with the NJDOT STANDARD SPECIFICATIONS Sections 301, 305, 404, and 903.

PART 3 EXECUTION

3.01 GENERAL

A. Subgrades

Subgrades shall be prepared in accordance with Section 31 23 16 BACKFILL AND COMPACTION.

B. Base Course

Base Course shall be constructed in accordance with NJDOT STANDARD SPECIFICATIONS Section 301.

C. Surface Course

Surface Course shall be constructed in accordance with NJDOT STANDARD SPECIFICATIONS Section 404.

3.02 TRANSPORTATION OF BITUMINOUS MIXTURES

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck.

If air temperature is less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided.

Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

The Contracting Officer shall have access at all times to all areas of the plant for checking adequacy of equipment, inspecting operation of the plant, verifying weights, proportions, and material properties, checking the temperatures maintained in the preparation of the mixtures, and taking samples.

3.03 SPRAYING OF CONTACT SURFACES

Spray surface of crushed stone with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture.

3.04 PLACEMENT

A. Machine Spreading

The range of temperatures of the mixtures at the time of spreading shall be between 250 degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected.

Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope.

Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control.

When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than 30 feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

Minimum Spreading Temperature								
Base Temp in Degrees F*	Wearing, Binder, or Leveling Course Thickness, Inches							
	1/2	3/4	1	1 1/2	2	3	3 1/2	4
20-32**	---	---	---	---	---	---	275**	260**
+32-40*	---	---	---	---	295	280	270	260
+40-50	---	---	---	300	285	275	265	255
+50-60	---	---	300	290	280	270	260	255
+60-70	---	300	290	280	275	265	255	250
+70-80	300	290	280	275	270	265	255	250
+80-90	290	280	275	270	265	260	250	250
+90	280	275	270	265	265	255	250	250

Table Notes:
* Base on which mix is placed.
** Increase by 15 degrees when placement is on base or subbase containing frozen moisture. Normally, hot mix paving is not allowed on base temperatures below 45 degrees F.

B. Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited.

When segregation occurs in the mixture during placing, suspend

spreading operation until the cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine.

Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

C. Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250 and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected.

Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation.

Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

3.05 COMPACTION OF MIXTURE

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths.

Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactable condition.

Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 90 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D1559.

During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators.

Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers.

Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.06 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density.

Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

A. Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll.

B. Longitudinal Joints

Space 6 inches apart. Adjust screed to permit compaction to produce a smooth dense joint. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.07 FIELD QUALITY CONTROL

A. Sampling

1. Aggregates At Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M at the source. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

2. Cold Feed Aggregate Sampling

Take two samples daily from the belt conveying materials from the cold feed. Collect materials in three increments at random to make a representative composite sample of not less than 50 pounds. Take samples in accordance with ASTM D75/D75M.

3. Coarse and Fine Aggregates

Take a 50 pound sample from the cold feed at least once daily for sieve analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

4. Mineral Filler

ASTM D546. Take samples large enough to provide ample material for testing. Include the Specific Gravity of Mineral Filler.

5. Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D979/D979M. Include the Specific Gravity of Asphalt.

B. Testing

1. Aggregates Tests

Perform the following Tests:

a. Gradation: ASTM C136/C136M.
b. Mineral Filler Content: ASTM D546.
c. Abrasion: ASTM C131 for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

2. Bituminous Mix Tests

Test one sample for each 500 tons, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D2172/D2172M; perform a sieve analysis on each extraction sample in accordance with ASTM C136/C136M and ASTM C117. Test one sample for each 500 tons or fraction thereof for stability and flow in accordance with ASTM D1559. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D4867/D4867M

3. Pavement Courses Testing

Perform the following tests:

a. Density: Compare density of in-place material against laboratory specimen or certificates on same bituminous concrete mixture. Use nuclear devices to determine densities in accordance with ASTM D2950/D2950M. A minimum of one in-place density test shall be performed for every 500 square yards of pavement and a minimum of one in-place density test for each property at which pavement is constructed.

   Minimum acceptable density of in-place course material will be 90 percent of the recorded laboratory specimen or certificate density. Maximum acceptable density will be 98 percent.

b. Thickness: Determine thickness of each course from samples taken for the field density tests. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

c. Smoothness: Straightedge test the compacted surface of each course as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness of each course shall not vary more than 1/4 inch in 10 feet; variations in the wearing course shall not vary more than 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than that specified.

d. Finished Grades: Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 1/4 inch. Finished surface of the final wearing course will be tested by running lines of levels at intervals of 10 feet longitudinally and transversely to determine elevations of completed pavement. Within 45 days after completion of final placement, Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited.

e. Finish Surface Texture of Surface Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be repaired as directed by the Contracting Officer.

3.08 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F.
Measure surface temperature by approved surface thermometers or other satisfactory methods.

3.09 PATCHING

As directed by Contracting Officer, in writing, remove and replace all defective areas. Cut out such areas and fill with fresh bituminous concrete. Compact to the required density.

3.10 CLEANING AND PROTECTION

A. Cleaning

After completion of paving operations, clean surfaces of excess or spilled bituminous materials and all foreign matter.

B. Cover Openings

Cover openings of drainage structures in the area of paving until permanent coverings are placed.

3.11 FINISHING

Cover openings of drainage structures in the area of paving until permanent coverings are placed.

The Contractor shall be responsible for repairing all incidental damage and settlement that occurs in roadways as result of construction activities. Material and labor to complete all repair work, in accordance with all local codes and ordinances, shall be at the Contractor's expense. The Government will not provide additional compensation for this work.

-- End of Section --

SECTION 32 31 13

CHAIN LINK FENCES AND GATES
10/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only

ASTM INTERNATIONAL (ASTM)

ASTM A392	(2011a) Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A1011/A1011M	(2017) 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
ASTM F567	(2014a) Standard Practice for Installation of Chain Link Fence
ASTM F626	(2014) Standard Specification for Fence Fittings
ASTM F900	(2011) Industrial and Commercial Swing Gates
ASTM F1043	(2017a) Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework
ASTM F1083	(2016) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F1916	(1998) Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout Of Fencing, Gates, And Accessories; G

SD-03 Product Data

Product Data; G

1.03 QUALITY ASSURANCE

A. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

B. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout.

1.04 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot galvanized after weaving.

B. Height: 84 inches, unless otherwise shown.

C. Core Wire Gauge: No. 9.

D. Pattern: 2 inch diamond-mesh.

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

2.02 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, light industrial fence, except as modified in this section.

2. Round Steel Pipe, Schedule 40: ASTM F1083.

3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.

B. Posts:

1. Line and terminal - Hot dipped galvanize conforming to ASTM F1083.

2. Round Steel Pipe: Outside Diameter: 2.375 inches.

2.03 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.

2. Outside Diameter: 1.66 inches.

B. Protective Coatings: As specified for posts.

C. Strength and Stiffness Requirements: ASTM F1043, top rail, light industrial fence.

2.04 FENCE FITTINGS

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

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

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece.

2. Length not less than 2 inches shorter than full height of chain link fabric.

3. Provide one bar for each gate and end post, and two for each corner and pull post.

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

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

2.05 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.

2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.

3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.

4. Gate leaves more than 8-feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.

5. Gate Fabric Height: Same as for adjacent fence height.

6. Welded Steel Joints: Paint with zinc-based paint.

7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.

8. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

2.06 CONCRETE

A. Provide as specified in Section 03 30 00.00, CAST-IN-PLACE CONCRETE.

2.07 PRODUCT INFORMATION

Submit the following product information:

A. Layout of fencing, gates, and accessories required. Drawings shall show post sizes and sections; post setting and bracing; gate details; details of attachment of fabric to support members; and any other details required to erect the fence along the lines indicated on the Contract Drawings.

B. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

1. Fence, gate posts, rails, and fittings.

2. Chain link fabric.

3. Gates and hardware.

4. Privacy windscreen.

PART 3 EXECUTION

3.01 GENERAL

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

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

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780/A780M.

3.02 PREPARATION

A. Clear area on either side of fence. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2 inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes.

Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

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

B. Posthole Depth:

1. Minimum 3 feet below finished grade.

2. 2 inches deeper than post embedment depth below finish grade.

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

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

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

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

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

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3 fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

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

3.06 CHAIN LINK FABRIC

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

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

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

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

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

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.07 GATES

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

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

3.08 FIELD QUALITY CONTROL

A. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.

2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.

3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.09 CLEANUP

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

-- End of Section --

DIVISION 33 – UTILITIES

SECTION 33 05 01.10

HIGH-DENSITY POLYETHYLENE PIPE AND FITTINGS
04/08

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the requirements for welding, testing, and installation of HDPE piping.

B. HDPE piping (pressure) shall be used as transmission piping conveying the extracted groundwater from extraction wells to the Groundwater Treatment Facility.

C. HDPE piping (non pressure) shall be used for the effluent discharge pipe conveying treated groundwater to the discharge point to Bound Brook and and secondary carrier lines.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C219	(2017) Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C901	(2008) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service
AWWA C906	(2015) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 65 In., (1,575 mm) for Water Distribution and Transmission
AWWA M55	(2006) PE Pipe - Design and Installation

ASME INTERNATIONAL (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM A193/A193M	(2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2017) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or

	High-Temperature Service, or Both
ASTM D2657	(2007; R 2015) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D3308	(2012) PTFE Resin Skived Tape
ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM D638	(2014) Standard Test Method for Tensile Properties of Plastics
ASTM F2620	(2013) Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
ASTM F714	(2013) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 192.285	Plastic Pipe: Qualifying Persons to Make Joints

PLASTICS PIPE INSTITUTE (PPI)

PPI TN-38	(2011) Bolt Torque for Polyethylene Flanged Joints
PPI TR-33	(2012) Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Hydrostatic Testing Plan; G

Qualifications for Manufacturers and Welders; G

SD-02 Shop Drawings

Connection Details; G

SD-03 Product Data

Manufacturer's Catalog Information onPipe, Fittings, And Other Materials; G

SD-06 Test Reports

Fusion Weld Documentation Report; G

Leakage Test; G

Pressure Test; G

SD-07 Certificates

Manufacturer's Certificate Of Compliance; G

SD-11 Closeout Submittals

Documentation ofInvert Of Installed Pipe; G

1.04 HYDROSTATIC TESTING PLAN

A. Contractor shall prepare a plan for hydrostatic testing of HDPE pressure pipe and fittings.

B. Submit the plan at least 15 days prior to testing and include the following as a minimum:

1. Testing procedures and equipment.
2. Piping systems and section(s) to be tested.
3. Safety procedures including method of isolating pipe during testing.
4. Sources of water and methods of disposal.
5. Fusion parameters including recommended limits of criteria recorded by data logger.

C. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.

1.05 QUALITY ASSURANCE

A. Work shall comply with appropriate codes and standards of following organizations for handling, heat fusion, and underground installation of low pressure polyethylene pipe.

1. American Gas Association (AGA).

2. Plastic Pipe Institute (PPI).

B. Submit Manufacturer's Certificate of Compliance in accordance with Section 01 43 33.

C. Contractor shall document grade control for trench excavation and invert of installed pipe in the form of survey notes or other method approved by the Contracting Officer. Grade control shall be documented at every 50 ft. station, at changes in grade, and utility crossings. Northing and Easting coordinates and elevations of top of transmission piping (or containment pipe, if required) shall be documented at all utility crossings.

D. The Effluent Discharge Pipe will be placed with a continuous

constant slope from the GETS Facility to the discharge point as shown on the Contract Drawings, with no peaks or depressions. Final discharge location to be determined in the field with Contracting Officer. Pipe slope at invert shall be monitored continuously during installation to verify conditions in the field.

D. Continuous piping runs (i.e., no joints) from the extraction wells to the GETS Facility shall be employed for the tranmission piping to the extent feasible. Contractor may join pipe lengths to achieve the specified piping run length with Contracting Officer approval. If joints are required, fusion welding is the only acceptable method of pipe joining. Requirements for pipe fusion are further described within this Specification.

E. Qualifications

1. Pipe Manufacturer: Listed with Plastic Pipe Institute (PPI) as meeting recipe and mixing requirements of resin manufacturer for resin used to manufacture pipe for this Project.

2. Pipe Welders: Persons fusing HDPE pipe shall be certified under 49 CFR 192.285, have a minimum of 1 year of experience with fusing HDPE pipe and shall have received a minimum of 20 hours of training for fusing HDPE pipe from pipe supplier or fusing equipment supplier. Certification of qualifications shall be submitted for each welder.

3. Each joint fusion shall be measured and logged by an electronic monitoring device (data logger) affixed to the fusion machine, and shall be capable of being retrieved electronically. A fusion weld documentation report shall be submitted for each joint. Data to be logged and included in fusion reports shall include the following :

a. Pipe size and dimensions.
b. Machine size.
c. Operator identification.
d. Job identification number.
e. Weld Number.
f. Fusion, heating, and drag pressure settings.
g. Heater plate temperature.
h. Time stamp.
i. Heating and curing time of weld.
j. Curing temperature readings and time stamps of readings.
k. Ambient temperature and humidity.
l. Error messages and warnings for out of range temperature or pressure settings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping

1. In accordance with manufacturer's recommendations.

2. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.

3. Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage

1. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

2. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

3. Keep pipe shaded from direct sunlight prior to installation in trench.

4. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

5. Store rubber gaskets in cool, well ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

C. Handling

1. Protect pipe from excessive heat or harmful chemicals.

2. Cleaning solutions, detergents, or solvents, when required, shall be used in accordance with the manufacturer's recommendations.

3. Pipes shall not be bent under the minimum radius recommended by the manufacturer for type and grade.

4. Avoid imposing strains that overstress or buckle the piping or impose excessive stress on the joints.

5. Equipment used for handling pipe sections shall be of size and nature to adequately hoist continuous or constructed lengths without damaging pipe or rendering equipment to be unstable.

6. Do not drag pipe across ground for distances or in manner which has potential to damage pipe.

7. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pipe and fittings specified in this section shall be products of:

1. CP Chem Performance Pipe.
2. JM-Manufacturing Co.
3. KWH Pipe-Sclairpipe.
4. Poly Pipe.
5. Central Plastics.
6. WL Plastics.
7. ISCO Industries.
8. Or approved equal.

2.02 MATERIALS

A. Pipe and Fittings

1. Conform to the requirements of AWWA C906 or AWWA C901 as appropriate for pipe size.

a. Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 3408 material. Pressure rating shall be based on hydrostatic design stress of 800 psi at 73.4 degrees F.
b. PE 4710 material with cell classification of 445474C, or better.

2. Maximum Allowable Hoop Stress:

a. 800 psi up to 80 degrees F for PE 3408/3608 in accordance with AWWA C906.
b. 1,000 psi up to 80 degrees F for PE 4710 in accordance with AWWA C906.

3. Pipe sizes shall conform to ASTM F714.

4. Pipe sizes shall conform with IPS HDPE pipe sizing.

5. Pipe and fittings shall have a pressure rating of nominal SDR-11.

6. Piping shall be legibly marked at intervals of no more than 5 feet with the following information:

a. Manufacturer's name or trademark.
b. Nominal pipe size.
c. HDPE cell classification.
d. Appropriate legend, such as SDR-11, AWWA C901 or AWWA C906, date of manufacture, and point of origin.

7. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.

8. Fittings:

a. Fittings from polyethylene compound having cell

classification equal to or exceeding compound used in pipe to ensure compatability of polyethylene resins.

b. Provide manufacturer's standard molded fittings rather than factory fabricated fittings in available diameter.

c. Fittings shall be of same manufacture as pipe being provided; be of same SDR or heavier; and meet or exceed pressure rating of pipe.

9. Submit the following information:

a. Catalog information confirming pipe, fittings, and other materials verifying conformance with requirements of this section.

b. Drawings of specific connection details.

2.03 JOINTS

A. Thermal butt-fusion or electrofusion shall be employed for all necessary joints for the transmission lines, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Heat fusion joints shall be in conformance with ASTM D2657.

B. The effluent discharge pipe may be fusion welded or flanged.

C. Mechanical joints, if required, shall be in conformance with ASME B16.1.

2.04 MISCELLANEOUS MATERIALS

Miscellaneous materials shall comply with the following requirements:

A. Joint Lubricants

Joint lubricants shall be as recommended by the pipe manufacturer.

B. Bolts, Nuts and Washers

1. Type 316 stainless steel, ASTM A193/A193M, Grade B8 hex head bolts; and ASTM A194/A194M, Grade 8 hex head nuts.

C. Joint Compound

A stiff mixture of graphite and oil or inert filler and oil.

D. Joint Tape

ASTM D3308.

E. Wall Anchor

1. Material: Same as HDPE pipe.
2. Internal Diameter: Equal to adjacent pipe.
3. Shear Strength: Equal to or greater than tensile strength of adjacent pipe.
4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.

F. Wall Sleeves

1. Diameter, ends, and length shall be as shown on Contract Drawings.
2. Shall include integral seep ring to minimize seepage between metal sleeve and concrete.

G. Wall Couplings

1. Diameter, ends, and length shall be as shown on Contract Drawings.
2. Wall couplings shall provide flexible mechanical joint.
3. Body and end rings shall be coated with fusion bonded epoxy.
4. Body shall include integral seep ring.
5. Shall comply with AWWA C219.

H. Electrofusion Flex Restraint:

1. Material: HDPE.
2. Method of Attachment: Electrofusion.
3. Designed for restraining movement of HDPE pipe.
4. Manufacturers:

a. Central Plastics Company.
b. ISCO Industries.
c. Or approved equal.

2.05 SYSTEM REQUIREMENTS

A. Transmission Piping: 1.25 inch internal diameter SDR-11, rated for burial to 35 feet at soil density of 110 lbs/cu ft and pressure rated to 125 psi at 73 degrees F.

B. Carrier/Secondary Containment: 3 inch internal diameter SDR-11, rated for burial to 35 feet at soil density of 110 lbs/cu ft and pressure rated to 125 psi at 73 degrees F. Refer to Part 3 for secondary containment details.

2.06 PIPE LOCATING TAPE

As specified in Section 31 23 16 BACKFILL AND COMPACTION.

2.07 PIPE BEDDING AND PIPE ZONE MATERIAL

Granular material or controlled low strength material as specified in Section 31 23 16 BACKFILL AND COMPACTION.

2.08 TRENCH STABILIZATION MATERIAL

As specified in Section 31 23 16 BACKFILL AND COMPACTION.

PART 3 EXECUTION

3.01 GENERAL

Notify Contracting Officer at least 2 weeks prior to field fabrication of pipe or fittings.

3.02 EXAMINATION

A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer's instructions.

3.03 PREPARATION OF TRENCH

Prepare trench as specified in Section 31 23 10, EXCAVATION. Unless otherwise permitted by Contracting Officer, maximum length of open trench shall not exceed 200 feet.

3.04 INSTALLATION

A. General

1. Pipe, pipe fittings, and appurtenances shall be installed in accordance with manufacturer's instructions, unless otherwise shown or specified. Excavation, trenching, and backfilling shall be as specified in Section 31 23 10 EXCAVATION and Section 31 23 16, BACKFILL AND COMPACTION.

2. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.

B. Cutting

1. Pipe shall be cut in a neat manner with mechanical cutters. Wheel cutters shall be used where practicable. Sharp and rough edges shall be ground smooth and loose material removed from the pipe before laying.

C. Heat Fusion of Pipe

1. Heat fusion joints shall comply with the manufacturer's instructions concerning equipment, temperature, melt time, heat coat, and joining time. Flanged and mechanical joints shall be made in compliance with the manufacturer's instructions. Depending on Site conditions, perform butt-fusion joining in or outside of excavation.

2. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.

3. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.

4. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.

5. Branch saddle fusions shall be joined in accordance with

manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.

6. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.

7. At end of each working day, cover open ends of fused pipe. Cap to prevent entry by animals or debris.

8. Use compatible fusion techniques when polyethylene of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.

9. Remove and extract internal fusion bead from pipe.

    a. Verify complete internal fusion bead removal was performed. Accomplish by examination of extracted internal fusion bead or by means of closed circuit television (CCTV) examination.

    b. Extracted Internal Fusion Bead:

        1) Appearance shall have same double roll back semblance as does the external fusion bead.

        2) Possess smooth root cut, or pipe smoothness and shall be verified by means of closed circuit television (CCTV) examination.

    c. Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness.

10. Inspect all welds visually to verify weld has been performed properly. Improper welds shall be removed and pipe refused.

D. Flange Jointing

1. Connect HDPE pipe to auxiliary equipment such as manifold, valves, and other fittings with flanged connections as follows:

    a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.
    b. Convoluted backing flange, as specified.
    c. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.
    d. Follow requirements of PPI TN-38 including mandatory 4 hour bolt re-torquing.

2. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

E. Pipe Layout

1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe. Measure for grade at pipe invert, not at top of pipe.

2. Pipe shall be installed in accordance with manufacturer's recommendations and ASTM D2774. Where manufacturer's recommendations and ASTM D2774 vary, conform to strictest specification.

3. Keep trench dry until pipe laying and joining is completed.

4. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.

5. Position slings for handling pipeline away from butt-fused joints.

6. Before lowering and while suspended, the pipe shall be inspected for defects. Defective material shall be rejected. Remove sections of damaged pipe and replace it with undamaged pipe.

7. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.

8. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.

9. Snake pipe from one side of trench to other to allow for thermal and settling movements, and as recommended by pipe manufacturer.

10. Prevent foreign material from entering pipe during placement.

11. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.

12. In general, lay pipe upgrade with bell ends pointing in direction of laying.

13. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:

    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.

14. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

15. Allow pipe sufficient time to adjust to trench temperature prior to testing and backfilling activities.

16. Connect piping to the extraction well piping using appropriate fittings and in accordance with the procedures in this Specification.

17. Terminate piping runs in stub-ups in designated location within the GETS building.

18. Tolerances:

    a. Deflection from Horizontal Line: Maximum 2 inches.
    b. Deflection from Vertical Line: Maximum 1/4 inch.
    c. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.

F. Secondary Containment Piping For Utility Crossings

1. Where transmission piping crosses the existing 36-inch water line, piping shall be contained in a secondary carrier pipe.

2. Carrier pipe shall be of sufficient length to extend 10 feet on either side of the centerline of the water line.

3. Transmission piping shall be fed through the length of the secondary containment pipe. No sealing or capping of the secondary pipe is required.

G. Effluent Discharge Pipe

1. An animal screen will be placed over the discharge end of the pipe at the concrete collar as shown on the Contract Drawings.

3.05 PLACEMENT OF PIPE LOCATING TAPE

Place pipe locating tape in accordance with Section 31 23 16 BACKFILL AND COMPACTION.

3.06 PIPE BEDDING AND ZONE MATERIAL

Place pipe bedding and pipe zone material in accordance with Section 31 23 16 BACKFILL AND COMPACTION.

3.07 FIELD QUALITY CONTROL

A. Fusion Weld Documentation Report

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine, and shall be capable of being retrieved electronically. Data to be logged shall include the following:

    a. Pipe size and dimensions.
    b. Machine model and size.
    c. Operator identification.
    d. Job identification number.
    e. Weld number.
    f. Fusion, heating, and drag pressure settings.
    g. Heater plate temperature.
    h. Time stamp showing when weld was performed.
    i. Heating and curing time of weld.

j. Curing temperature readings and time stamps of readings.
k. Error messages and warnings for out of range temperature or pressure settings.

2. In addition to logged items above, the following shall be logged or annotated on report:

a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
b. Ambient temperature and humidity.
c. If internal bead was removed.

3.08 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Dispose of water and flushed foreign matter.

B. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fps, velocity, clean pipe in-place from inside by brushing and sweeping, then flush or blow line at lower velocity clean pipe by use of pipe pig as approved by Contracting Officer. Multiple passes of pipe pig may be required to adequately clean line.

C. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

3.09 TESTING AND INSPECTION

A. Joint and Mandrel Testing (non pressurized piping)

1. Joint:

a. Test Procedure: ASTM D638.
b. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
c. Test Frequency: One test for Effluent Discharge Line

2. Mandrel:

a. After leak testing, mandrel test pipeline.
b. Mandrel Configuration: Rigid, with circular cross section of diameter not less than 92 percent of average inside diameter of pipeline and with length of circular portion equal to nominal diameter of pipeline.
c. Pulling Method: Manually, by hand.

B. Hydrostatic Tests (pressurized pipe)

The pipeline shall be subjected to both a pressure test and a leakage test. The method proposed for disposal of waste water from hydrostatic tests shall be approved by the Contracting Officer. Testing is the responsibility of the Contractor. Perform testing using an approved independent testing laboratory or the Contractor, subject to approval. The test may be witnessed by the Contracting Officer. The Contracting Officer shall be notified at least 7 days in advance of equipment tests. The final test report shall be delivered to the Contracting Officer within 30

days of the test.

1. Pressure Test

After the pipe has been installed, joints completed, thrust blocks have been in place for at least five days, and the trench has been partially backfilled, leaving the joints exposed for examination, the pipe shall be filled with water to expel all air. The pipeline shall be subjected to a test pressure of 125 psi or 150 percent of the working pressure, whichever is greater, for a period of at least one hour. Each valve shall be opened and closed several times during the test. The exposed pipe, joints, fitting, and valves shall be examined for leaks. Visible leaks shall be stopped or the defective pipe, fitting, joints, or valve shall be replaced.

2. Leakage Test

The leakage test may be conducted subsequent to or concurrently with the pressure test. The amount of water permitted as leakage for the line shall be placed in a sealed container attached to the supply side of the test pump. No other source of supply will be permitted to be applied to the pump or line under test. The water shall be pumped into the line by the test pump as required to maintain the specified test pressure as described for pressure test for a 2 hour period. Exhaustion of the supply or the inability to maintain the required pressure will be considered test failure. PE pipe can experience diametric expansion and pressure elongation during initial testing. The manufacturer shall be consulted prior to testing for special testing considerations. Allowable leakage shall be determined by the following I-P formula:

L = NDP/K Where:

L = Allowable leakage in gallons per hour.

N = Number of joints in length of pipeline tested.

D = Nominal diameter of the pipe in inches.

P = Square root of the test pressure in psig.

K = 7400 for pipe materials.

At the conclusion of the test, the amount of water remaining in the container shall be measured and the results recorded in the test report.

3. Retesting

If any deficiencies are revealed during any test, such deficiencies shall be corrected and the tests shall be reconducted until the results of the tests are within specified allowances, without additional cost to the Government.

-- End of Section --

SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS
09/17

PART 1 GENERAL

1.01 DEFINITIONS

A. CCTV: Closed Circuit Television.

B. SDR: Standard Dimension Ratio.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C105/A21.5	(2010) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C900	(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)

ASTM INTERNATIONAL (ASTM)

ASTM A746	(2009; R 2014) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C361	(2016) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C596	(2009; R 2017) Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Written In-Plant Quality Control Program; G

Field Leakage Testing Plan; G

Name And Qualifications Of Inspection Firm; G

SD-02 Shop Drawings

Tee Fabrication Details; G

SD-03 Product Data

Certified Statement From Manufacturer Of Gaskets; G

Product Information, Including But Not Limited To, Brand Name And Model Number Of Video Equipment; G

SD-05 Design Data

Quick Setting Grout Design Mix; G

Fabrication Plans And Calculations; G

SD-06 Test Reports

Pipe And Pipe Joint Test Results; G

Test Or Historical Performance Data; G

Manufacturer's Certificate Of Compliance; G

PVC Pipe Deflection Test Results; G

CCTV Inspection Results; G

Test Report Documentation; G

SD-07 Certificates

Letter Of Certification

SD-08 Manufacturer's Instructions

Manufacturer's Written Instructions; G

1.04 QUALIFICATIONS

CCTV Inspection Firm: Actively performed such services for minimum of 2 years. Submit name and qualifications of inspection firm.

PART 2 PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE

A. 15-Inch Diameter and Smaller

1. In accordance with ASTM D3034.

2. Joints: Integral bell and spigot, in accordance with ASTM D3212.

3. Minimum SDR: 26.

4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.

5. Fittings: SDR 35 minimum wall thickness.

6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

2.02 DUCTILE IRON PIPE

A. Pipe

1. Conform to ASTM A746.

2. Pressure class 250 psi minimum for pipe diameters 24 inches and smaller.

3. Joints: Push-on with rubber gaskets conforming to AWWA C111/A21.11. Lubricant for joining pipe as approved by pipe manufacturer.

4. Fittings: Ductile iron conforming to AWWA C110/A21.10, lined and coated same as pipe.

B. Lining

1. Calcium Aluminate Cement Mortar:

a. 3/16-inch nominal mortar lining made with calcium aluminate cement and calcium aluminate aggregate, such as SewerGuard by Griffin Pipe Products.

b. Line interior of bell and exterior of spigot, in areas exposed to contents of pipe, with mortar lining manufacturer's recommended epoxy.

C. Polyethylene Wrap and Tape for Ductile Iron Pipe

1. Polyethylene Wrap: 8 mils, minimum thickness, conforming to AWWA C105/A21.5.

2. Adhesive Tape: Thermoplastic pressure sensitive; minimum thickness of 8 mils; minimum width of 1 inch.

2.03 SERVICE CONNECTIONS AND PIPE FITTINGS

A. Acceptable Pipe Materials: Polyvinyl chloride.

B. Use one type of service connection pipe material throughout, no interchanging of pipe and fittings allowed. Long-radius bends shall be used for changes in direction, unless approved otherwise by Government.

C. Size shall be as shown on Drawings.

2.04 PIPE FOR WATERLINE CROSSINGS

A. PVC pressure pipe conforming to AWWA C900 or ASTM D2241; SDR 26, maximum.

B. Ductile iron pipe conforming to AWWA C151/A21.51.

2.05 PIPE TO MANHOLE CONNECTOR

A. Manufacturers and Products:

1. Uniseal, Evansville, Indiana; Pipeconx, Universal Pipe Connector.
2. NPC Inc., Milford, NH; Kor-N-Seal.
3. Or approved equal.

2.06 FLEXIBLE COMPRESSION COLLAR

A. Mechanical joint coupling with No. 305 stainless steel bands.

B. Manufacturers:

1. Calder, Inc., Bellflower, CA.
2. Fernco Inc., Davison, MI.
3. Or approved equal.

2.07 CONCRETE

Compressive Strength: Minimum 2,500 psi at 28 days.

2.08 JOINT CEMENT MORTAR

A. Mixture: 1 part cement and 2 parts of clean sand well graded of such size that will pass No. 8 sieve.

B. Combine cement and sand in proper proportions and thoroughly mix with water.

C. Quantity of water used in preparation of mortar shall be minimum required to produce mixture sufficiently workable for purpose intended.

D. No admixtures shall be used, unless otherwise specified or acceptable to Government.

2.09 QUICK SETTING GROUT

A. High strength, nonstaining grout.

B. Reach initial set within 90 minutes at 70 degrees F and minimum compressive strength of 2,500 psi within 24 hours.

C. Shrinkage shall be less than 0.01 percent when tested in accordance with ASTM C596.

2.10 PRODUCT INFORMATION

Submit the following product information:

1. Information on gasket polymer properties, including certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe, AWWA C111/A21.11 for ductile iron pipe, and ASTM C361 for reinforced concrete pipe.

2. Tee fabrication details.

3. Fabrication plans and calculations for reinforced concrete pipe, fittings, and joint details. Include concrete mix design, reinforcement dimensions, concrete cover, spacing, and placement tolerances to be used.

4. Quick setting grout design mix.

5. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, MANUFACTURER'S FIELD SERVICES, that products furnished meet requirements of the Specifications.

6. Manufacturer's Written In-Plant Quality Control Program. Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.

7. Letter of certification from independent testing agency certifying that pipe furnished meets requirements of this section.

8. Test or historical performance data to verify that joint design meets requirements of these Specifications.

9. Provide pipe and pipe joint test results with delivery of pipe. Do not deliver pipe not meeting test requirements to Project Site.

10. Manufacturer's written instructions for pipe handling and

installation.

PART 3 EXECUTION

3.01 EXAMINATIONS

Notify Contracting Officer immediately of manufacturing imperfections or damage caused by improper handling. Verify size, pipe condition, and pipe class prior to installation of pipe.

3.02 PREPARATION

A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by Contracting Officer.

B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used

C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

3.03 INSTALLATION

A. General

1. Install pipe sections in accordance with manufacturer's recommendations.

2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.

3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.

B. Line and Grade

1. Establish line and grade for pipe by use of lasers.

2. Measure for grade at pipe invert, not at top of pipe.

3. Do not deviate from line or grade, as shown on Contract Drawings, more than 1/2 inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing

1. Use gasket lubricant as recommended by gasket manufacturer.

2. Lay pipe upgrade with bell ends pointing in direction of laying.

3. When field cutting or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and

approved by the Contracting Officer.

4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.

5. Assemble joint in accordance with recommendations of manufacturer.

6. Apply sufficient pressure in making joint to assure that joint is "home" as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.

7. Place pipe to specified line and grade to form smooth flow line.

8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.

9. Check for alignment and grade after joint has been made.

10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.

11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.

12. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.

13. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.

14. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with the manufacture's recommendations, or concrete closure collar.

D. Gasketed Joint Protection

1. Point (fill with joint cement mortar) 360 degrees of circumference. Quick setting grout may be substituted for joint cement mortar when approved by Contracting Officer.

   a. Thoroughly clean joint of lubricant materials and dirt.

   b. Prewet joint before applying mortar.

   c. Pointing shall be done in such a manner that there are no bulges, ridges, or other irregularities.

   d. Pointing shall be flush with interior of pipe.

   e. Do not point joints closer than three pipe joints from

next pipe section to be placed.

f. Pointing Mortar:

1) 1 part cement to 1.5 parts sand, unless otherwise approved by Contracting Officer.
2) Plastic and of such consistency that it will readily adhere to pipe.

E. Connection to Existing Structure or Manhole

1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.

2. Plug or close off pipe stubbed with watertight plug.

3. Connect PVC pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.

F. Crossing Water Lines

Where sewer crosses less than 18 inches below water line, use ductile iron or PVC pressure pipe for crossing or encase in concrete envelope for a minimum distance of 10 feet on each side of water line.

G. Ductile Iron Pipe

1. Cutting and Dressing of Ductile Iron Pipe Ends:

a. Cut at right angles to centerline of pipe to leave smooth end, without damage to pipe.

b. Use only approved mechanical cutter.

c. Taper cut end of pipe to be used with rubber gasket joints by grinding or filing 1/8-inch back at an angle of approximately 30 degrees with centerline of pipe.

d. Remove sharp or rough edges.

e. Abrade cut ends with grinding wheel and apply lining repair material. Use only compatible repair materials provided by pipe lining manufacturer. Allow repair lining to harden and cure before installation.

2. Polyethylene Wrap:

a. Before installing wrap, clean pipe exterior of foreign material.

b. Cut wrap approximately 2 feet longer than pipe section.

c. Overlap wrap approximately 1 foot; seal joints with adhesive tape.

d. Tape entire circumference of pipe at 3-foot intervals along pipe.

e. Repair rips, punctures, or other damage to polyethylene with adhesive tape.

f. When fittings cannot be practically wrapped in a tube, use a flat sheet or split tube of polyethylene. Securely tape seams.

3.04 CONCRETE CLOSURE COLLAR

Use only when approved by Contracting Officer, and then only to make connections between dissimilar pipe or where standard rubber gasketed joints or flexible compression collars are impractical or unavailable.

A. Procedure:

1. Remove water from excavation; placement of concrete in standing water will not be allowed.

2. Wash pipe to remove loose material.

3. Wrap and securely fasten light gauge sheet metal or building felt around pipe joint to ensure that concrete does not enter line.

4. Wet nonmetallic pipe thoroughly prior to concrete placement.

5. Placement shall be monolithic for each collar.

6. Place to minimum 6 inch thickness around outside diameter of pipe.

7. Extend concrete minimum of 12 inches on each side of joint.

8. Cure concrete, after initial set, by covering with well moistened earth.

3.05 EXISTING SERVICE CONNECTION TEES

A. Locate prior to constructing tee in new sewer pipeline.

B. Install as shown on Contract Drawings.

C. Install caps or plugs on tees.

D. Furnish tee outlets with gasketed type joint or approved adapter to join service connection pipe.

E. Concrete encase tees in trenches deeper than 12 feet. Do not encase joints at ends of tee fitting.

3.06 EXISTING SERVICE CONNECTION INSTALLATION

A. Minimum Slope: 1/4 inch per foot.

B. Minimum Trench Depth: 4 feet. Government will determine required depth at end of line.

C. Progress of Construction: Unless otherwise approved by Contracting

Officer, install connection to existing service not more than 5 days after backfilling of sewer trench.

E. Laying and Jointing of Existing Service Connection Pipe and Fittings:

1. Maximum deflection permissible with any one fitting shall not exceed 45 degrees and shall be accomplished with long-radius curves or bends. Short-radius elbows or curves will not be permitted, except by permission of Government.

2. Make service connection to existing sewer system at manhole when directed by Government. Where service connection pipe is connected to existing manhole or concrete structure, make connection so standard pipe joint is located not more than 1.5 feet from structure.

3. Provide end of service connection line and fittings with standard watertight plug, cap, and stopper, suitably braced to prevent blow-off during hydrostatic or air testing.

F. First length of pipe out from tee on lateral or main shall not be greater than 3 feet in length.

G. Line and Grade for Existing Service Connection Pipe and Fittings:

1. Install sewer tee so as to locate connection pipe within horizontal distance of 1 foot either side of staked location.

2. Lay pipe uniformly between tee or top of riser section and end of service connection. Where minimum slopes are used, lay pipe by means of good quality builder's level not less than 24 inches long.

H. Existing Service Connection Marker:

1. Place at end of the connection to existing service as shown on Contract Drawings.

2. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and replace marker.

3.07 CLEANING

A. Clean each section of completed sewer pipeline prior to testing.

B. Place screen or dam in downstream manhole of section being cleaned to catch debris.

C. Remove material from each manhole section before cleaning the next section downstream.

D. Method: High velocity hydro-cleaning equipment.

E. Cleaning water may be discharged into existing sewer system after screening and removal of debris.

3.08 HYDROSTATIC AND PNEUMATIC TESTS

A. General

1. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.

2. Pipe 18 inches in diameter and smaller shall be tested for leakage using Hydrostatic Exfiltration or Pneumatic Test Methods at Contractor's option.

3. Pipe over 18 inches in diameter shall be tested for leakage using Hydrostatic Exfiltration Test Method.

4. Individual joints may be tested on pipe 36 inches in diameter and larger at Contractor's option.

5. Pipe shall successfully pass leakage test prior to acceptance.

6. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

7. Isolate new pipelines that are connected to existing pipelines. Install pipe plugs as required to allow section of new pipe to be pressure tested.

8. Plug wyes, tees, stubs, and service connections with gasketed caps or plugs securely fastened or blocked to withstand internal test pressure. Such plugs or caps shall be removable, and their removal shall provide socket suitable for making flexible jointed lateral connection or extension.

9. Furnish testing equipment and perform tests as approved by Contracting Officer. Testing equipment shall provide observable and accurate measurement of leakage under specified conditions.

10. Supply of temporary water shall be as stated in Section 01 50 00, TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS.

11. Dispose of water used in testing.

12. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

13. Submit Field Leakage Testing Plan at least 15 days in advance of the testing and include the following information, at minimum:

    a. Testing dates.
    b. Piping systems and sections to be tested.
    c. Test type(s).
    d. Method of isolation.
    e. Method of conveying water from source to system being tested.

f. Calculation of maximum allowable leakage for piping section(s) to be tested.
g. Method of disposal of test water, if applicable.

B. Hydrostatic Exfiltration Test

1. Fill pipe test section 24 hours prior to time of testing, if desired, to permit normal absorption into VCP and RCP pipe walls.

2. Procedure:

a. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on full area of pipe.
b. Expel air from piping system during filling.
c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
d. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional makeup water only as necessary to restore test pressure.
e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

3. Measurement Accuracy: Plus or minus 1/8 gallon of water leakage under specified conditions.

4. PVC and ductile iron pipe and joints shall sustain maximum water loss limit of 0.8 gallon per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Allowable leakage shall be modified as stated below if hydrostatic head is other than 6 feet.

5. Hydrostatic Head:

a. At least 6 feet above maximum estimated groundwater level in section being tested, but no less than 6 feet above inside top of highest section of pipe in test section, including service connections.
b. In every case, determine height of water table at time of test by exploratory holes or such other methods approved by Contracting Officer. Contracting Officer will make final decision regarding test height for water in pipe section being tested.
c. If hydrostatic head is other than 6 feet, allowable leakage as computed by criteria above shall be adjusted by the square root of actual head divided by square root of 6.

6. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 16 feet of water column. In no case shall length be greater than 700 feet or distance between manholes when greater than 700 feet.

7. Dispose of test water in a manner acceptable with Government and regulatory agencies.

C. Pneumatic Testing for 18-Inch and Smaller Diameter Pipe

1. Equipment

a. Calibrate gauges with standardized test gauge provided by Contractor at start of each testing day. Contractor will witness calibration

b. Install compressor, air piping manifolds, gauges, and valves at ground surface.

c. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.

d. Restrain plugs used to close sewer lines to prevent blowoff.

2. Procedure

a. No person shall enter manhole or structure, or occupy area above opening of manhole or structure where pipe is under pressure.

b. Determine height of groundwater table at time of test.

c. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average backpressure of groundwater submerging pipe.

d. Allow 2 minutes minimum for air temperature to stabilize.

e. Allowable leakage for sewers constructed of air-permeable materials, such a concrete or clay:

1) When pressure is decreased to 3.5 psig, air pressure test shall begin.
2) Test shall consist of measuring time in seconds for pressure in pipe to drop from 3.5 psig to 2.5 psig.
3) Pipe leakage shall be considered acceptable if time in seconds for pressure drop is equal to or greater than required time as calculated below:

$K = 0.0111d2L$
$C = 0.000392dL$

If Ct is less than or equal to 1.0, then time = Kt
If Ct is between 1.0 and 1.75, then time = Kt/Ct
If Ct is greater than or equal to 1.75, then time = Kt/1.75

Where:
d = pipe diameter in inches
L = pipe length in feet
K = value for each length of pipe of a specific diameter
C = value for each length of pipe of a specific diameter
Kt = Sum of all K values

Ct = Sum of all C values

f. This method is based on allowable air loss rate of 0.003 cubic foot per minute (cfm) per square foot of internal pipe surface, with total air loss rate not less than 2.0 cfm nor greater than 3.5 cfm.

g. Allowable leakage for sewers constructed of nonair-permeable materials such as ductile iron, and polyvinyl chloride (PVC).

1) When nonair-permeable pipe is subjected to low pressure air test, time in seconds for pressure drop shall be equal to or greater than three times required time calculated using procedure above.

2) Defective Piping Sections: Replace or test and seal individual joints and retest as specified.

D. Hydrostatic Joint Testing

1. If pipe fails to pass hydrostatic test and location of leak cannot be readily identified, individual joint tests shall be performed. After leaking joints have been located and repaired, retest pipeline.

2. Testing shall be performed prior to installing PVC liner patch at joints.

3. Provide device specifically designed for testing of pipe joints and consisting of a metal cylinder, seal ring on each side of joint, and method of applying pressure to joint.

a. Manufacturer:

1) Mechanical Research and Design, Inc., Manitowoc, WI.
2) Cherne Industries, Inc., Minneapolis, MN.
3) Or approved equal.

4. Measurement Accuracy: Plus or minus 0.05 gallon of water leakage under specified conditions.

5. Determine height of groundwater table at time of test.

6. Minimum Pressure, Each Joint: 2.5 psi above backpressure of groundwater.

7. Minimum Test Duration, Each Joint:

a. 20 minutes for 60-inch diameter pipe and smaller.
b. 10 minutes for pipe larger than 60-inch diameter.

8. Maximum Leakage: Leakage per joint shall not exceed maximum water loss limit of 0.0008 gallon per hour per inch-diameter times length of distance between pipe joints.

E. Test Report Documentation

1. Test date.

2. Pipe section or pipe joint tested.
3. Test Method.
4. Test Pressure.
5. Length of test.
6. Pressure or water loss.
7. Remarks, including:

    a. Leaks (type, location).
    b. Repair/replacement performed to remedy excessive leakage.

8. Signed by Contractor and Government to represent that test has been satisfactorily completed.

F. Subsequent Failure

Visible infiltration of groundwater following successful test shall be considered evidence that original test was in error or that subsequent failure of pipeline has occurred.

G. PVC Pipe Deflection Test

1. General

    a. Test installed pipeline for deflection by pulling a mandrel through sewer without aid of mechanical pulling device.

    b. Perform test at least 10 days after trench backfill and compaction have been completed. Submit PVC pipe deflection test results to Contracting Officer for approval.

2. Mandrel

    a. Full circle, solid or rigid odd number of legs (minimum 9 legs) steel cylinder with pulling rings at each end.

    b. Diameter: Sized to allow only as much initial deflection for ultimate deflection of 5 percent.

    c. Obtain Government approval, through Contractor calculations, for use of mandrel smaller than 96-2/3 percent of inside diameter of pipe.

3. Correcting Deficiencies or Obstructions

    a. Excavate to springline of pipeline and replace and recompact pipe zone material.

    b. Internal pipe rerounding or vibration will not be allowed.

    c. If pipe does not pass mandrel test after replacement of pipe zone material and trench backfill, re-excavate and replace pipeline.

3.09 INSPECTION

A. Television Pipeline Inspection

1. General

a. Internally inspect sewer pipelines by closed circuit television (CCTV) after completion of pipeline cleaning and testing. Provide product information, including but not limited to, brand name and model number of video equipment to be used for inspection.

b. Conduct inspection in presence of Government.

Submit CCTV inspection results, including videotapes and inspection logs, according to the following requirements. Videotapes shall become property of the Government.

2. Procedure

a. Provide complete and continuous taped record and written log of inspection.

b. Format: DVD.

c. Television Camera Equipment:

1) Rotating lens or pan and tilt.
2) Resolution: Minimum 350 lines per inch.
3) Focal Distance: Adjustable through a range of 6 inches to infinity.
4) Remote-Reading Footage Counter: Accurate to less than 1 percent error.
5) Lighting: Sufficient to provide clear, in-focus picture of entire inside periphery of pipe, and minimizes reflection.

d. Pull camera at uniform rate, stopping to properly document defects. Maximum pull of camera shall not exceed 30 feet per minute.

3. Quality Standard

a. Provide clear, sharp image when played back on conventional television receiver.

b. Neatly label videotape showing contents, project title, tape number, pipe structure identification numbers, date tape was made, and inspection company.

c. Tapes to include:

1) Opening Screen:

a) Date of inspection.
b) Pipe structure identification number.
c) Upstream and downstream node identification numbers.

d) Street address.
e) Pipe size.
f) Normal (upstream to downstream) or reverse (downstream to upstream) pull.

2) Continuous View: Current distance along reach (tape counter footage).

d. Log sheets to show time and date of inspection, location, upstream and downstream manholes, direction of pull, pipeline length, pipe size, pipe material, location of lateral connections, video tape number and detail of defects encountered.

e. Show sufficient detail to determine cracks in pipe, offset joints, leaking joints, sags, and other flaws in pipeline installation. Record location of deficiencies by distance from center of reference manhole.

f. Upon completion, playback DVD in presence of Government. Any DVD not meeting quality standard will be rejected and taping process repeated.

g. Correct deficiencies found as a result of video replay, and repeat CCTV inspection.

B. Deficiencies Requiring Correction

1. Variations in alignment greater than specified herein.

2. Joint separations greater than allowed by pipe manufacturer.

3. Visible infiltration.

4. Presence of debris or foreign objects.

5. Obvious damage or defects in pipeline.

-- End of Section --

SECTION 33 05 13

MANHOLES, FRAMES, AND COVERS
09/17

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section. The publications are referred to within the text by the basic designation only:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(2010)Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
AASHTO M 306	(2010; R 2015) Standard Specification for Drainage, Sewer, Utility, and Related Castings

ASTM INTERNATIONAL (ASTM)

ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM C1311	(2014) Standard Specification for Solvent Release Agents
ASTM C14	(2015) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C192/C192M	(2016a) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C31/C31M	(2015a; E 2016) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C387/C387M	(2015) Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
ASTM C39/C39M	(2017) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C443	(2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C478	(2015a) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C990	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM F593	(2013a; E 2016) Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F594	(2009; E 2015) Standard Specification for Stainless Steel Nuts

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Well Vault; G

Precast Manholes Riser Sections; G

Precast Base and Top Slab Sections; G

Design Of Manhole Frame To Structure Seals; G

SD-06 Test Reports

Source Quality ControlTest Results; G

SD-07 Certificates

Current PCI Certification

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.

2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 SHOP DRAWINGS

Contractor shall submit Shop Drawings in accordance with the following:

A. Well Vault: Details of construction.
B. Precast Manholes Riser Sections: Details of construction.
C. Precast Base and Top Slab Sections: Details of construction.
D. Design of manhole frame to structure seals.

2.02 GENERAL

A. Wellheads shall be constructed of flush-mounted, highway traffic Manholes sections and cover in accordance with AASHTO M 306 HS-20.

B. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.

2. Gaskets: Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:

a. Corrosion or rotting under wet or dry conditions.
b. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
c. Biological environment in soils.
d. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
e. Chemical attack by constituents in soil and groundwater on the property.
f. Temperature ranges, variations, and gradients in construction area.
g. Variations in moisture conditions and humidity.
h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
i. Vibrations because of traffic loading.
j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.

3. Materials shall be compatible with each other and manhole materials.

4. Designed to provide a 20 year service life.

C. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:

a. Cement: Meet requirements of ASTM C150/C150M.

b. Compressive Strength:

1) Minimum 4,000 psi.
2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.

2. Cement: Meet requirements of ASTM C150/C150M Type IIA.

3. Reinforcement: Grade 60, unless otherwise specified.

4. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.

5. Joint:

a. Form joint contact services with machined castings.

b. Surfaces shall be parallel with nominal 1/16 inch clearing and tongue equipped with recess for installation of O ring rubber gasket.

c. Watertight consisting of the following:

1) Rubber ring gaskets.
2) Bituminous joint sealing compound.
3) Portland cement mortar consisting of 1 part cement complying with ASTM C150/C150M and 1-1/2 parts clean, sharp sand mixed with only enough water for workability. Do not use additives.

6. Gasket: Meet requirements of ASTM C443.

2.03 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.

2. Diameter: Minimum 48 inches.

3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.

4. Top and bottom surfaces shall be parallel.

5. Joints: Tongue-and-groove and confined O ring with rubber gaskets meeting ASTM C443.

B. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.

2. Fabricate in accordance with ASTM C478.

C. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:

a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
b. Henry Company, Houston, TX; Ram-Nek.
c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C 56.
d. Or approved equal.

2. Confined Plastic or Rubber O Ring:

a. As recommended by precasting manufacturer.
b. Meet requirements of ASTM C443.

2.04 MANHOLE FRAMES AND COVERS

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.

2. Cast Iron: ASTM A48/A48M Class 30B.

3. Ductile Iron: ASTM A536, Grade 60 40 12.

4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: Solid cover (no holes). True and seat within ring at all points.

C. Watertight Cover Gasket: Molded from high-quality rubber such as nitrile or EPDM.

2.05 MANHOLE FRAME CONNECTION TO STRUCTURE

A. Butyl Sealant:

1. Conform to ASTM C1311, or AASHTO M 198 and ASTM C990.

2. Trowelable or cartridge applied.

3. Manufacturers and Products:

a. Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
b. Bostik, Middleton, MA; Chem-Calk 300.
c. Press-Seal Gasket Company, Fort Wayne, IN; EZ-Stik #3.
d. Or approved equal.

B. External Wrap:

1. Meet requirements of ASTM C923.

2. Construct of high quality rubber that will provide flexible watertight seal around joint.

3. Thickness: Minimum 60 mils.

4. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.

5. Length: Extend from manhole frame and extension ring to cone section.

6. Bands: If required, constructed of minimum 16 gauge sheet if channeled, or 5/16 inch diameter if round.

7. Manufacturers and Products:

a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
c. Cretex Specialty Products, Waukesha, WI; X 85 Seal.
d. Or approved equal.

D. Frame to Structure Anchor Bolts:

1. 3/4 inch diameter HAS stainless steel bolts; minimum 6 5/8 inch embedment.
2. Manufacturer and Product: Hilti; HVA Capsules Adhesive Anchoring System or approved equal.

2.06 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8 inch screen.

B. Admixtures: May be included; do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.

2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.

2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.07 BACKFILL AROUND AND UNDER MANHOLES

A. Structural fill as specified in Section 31 23 16, BACKFILL AND COMPACTION.

B. Crushed Stone as specified in Section 31 23 16, BACKFILL AND COMPACTION.

C. Place in accordance with Contact Drawings.

2.08 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor N Seal flexible rubber boot with stainless steel accessories.

2. A LOK Products, Inc., Tullytown, PA; Z LOK XP or A LOK flexible connectors.
3. Or approved equal.

2.09 SOURCE QUALITY CONTROL

A. Prior to delivery of precast manhole sections to Site, yard permeability tests may be required at point of manufacture. Government will select precast sections not to exceed 5 percent of the total project quantity to test from material which is to be supplied to Project. Test specimens shall be mat tested and meet permeability test requirements of ASTM C14.

B. Concrete Testing:

1. Test two concrete test cylinders for each manhole. Compressive strength shall be tested in accordance with ASTM C31/C31M, ASTM C39/C39M, and ASTM C192/C192M.

2. Submit test results.

C. Inspection:

1. Material Quality:

a. Manufacturing process and finished sections shall be subject to inspection and approval by Government.

1) Inspections may take place at manufacturer's plant, at Site after delivery, or at both.

2) Sections not meeting requirements of this Section or that are determined to have defects which may affect durability of structure are subject to rejection.

3) Sections rejected after delivery shall be removed and replaced at no cost to the Government.

4) Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Government.

5) If structure cannot be repaired it shall be removed and replaced entirely at Contractor's expense.

2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.

3. Imperfections may be repaired, subject to approval of Government, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this Specification or that are determined to have defects which may affect durability of structure are subject to rejection.

2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Government.

3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 10, EXCAVATION.

B. Backfill: As specified in Section 31 23 16, BACKFILL AND COMPACTION.

3.03 WELLHEAD VAULTS

A. Construct to units in accordance with details shown on the Contract Drawings, plumb and true to alignment and grade.

B. Make pipe penetrations watertight.

C. Extend electrical conduits entering well vaults 2 inches beyond the inside wall of well vaults.

3.04 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Place Ring Footing on compacted Crushed Stone.

2. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Inspect precast manhole sections to be joined.

2. Clean ends of sections to be joined.

3. Do not use sections with chips or cracks in tongue.

C. Preformed Plastic Gaskets or Rubber O Ring (In lieu of mortar joints):

1. Use only pipe primer furnished by gasket manufacturer.

2. Install gasket material in accordance with manufacturer's

instructions.

3. Completed Manhole: Rigid and watertight.

D. Mortar Joints:

1. Thoroughly wet joint with water prior to placing mortar.

2. Place mortar on groove of lower section prior to section installation.

3. Fill joint completely with mortar of proper consistency.

4. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joint.

5. Prevent mortar from drying out and cure by applying approved curing compound or comparable approved method.

6. Do not use mortar mixed for longer than 30 minutes.

7. Chip out and replace cracked or defective mortar.

8. Completed Manhole: Rigid and watertight.

E. External Joint Wraps: Install in accordance with manufacturer's instructions.

F. Extensions:

1. Install to height not exceeding 12 inches.
2. Lay grade rings in mortar with sides plumb and tops level.
3. Seal joints with mortar as specified for sections and make watertight.

3.05 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install interior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 WATERTIGHT MANHOLE COVERS

A. Manholes covers shall be bolted down with sealing gasket.

-- End of Section --

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING
05/16

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300	(2010; Addenda 2011) Hypochlorites
AWWA B301	(2010) Liquid Chlorine
AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2010) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2011) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116/A21.16	(2015) Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
AWWA C150/A21.50	(2014) Thickness Design of Ductile-Iron Pipe
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2011) Ductile-Iron Compact Fittings for Water Service
AWWA C207	(2013) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm through 3600 mm 4 in. through 144 in.
AWWA C502	(2014) Dry-Barrel Fire Hydrants
AWWA C509	(2015) Resilient-Seated Gate Valves for Water Supply Service
AWWA C550	(2013) Protective Interior Coatings for Valves and Hydrants

AWWA C600	(2010) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2013) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C651	(2014) Standard for Disinfecting Water Mains
AWWA C800	(2014) Underground Service Line Valves and Fittings
AWWA C901	(2008) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13mm) Through 3 In. (76 mm), for Water Service
AWWA C906	(2015) Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 65 In., (1,575 mm) for Water Distribution and Transmission
AWWA M55	(2006) PE Pipe - Design and Installation
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM B88	(2016) Standard Specification for Seamless Copper Water Tube
ASTM C94/C94M	(2017) Standard Specification for Ready-Mixed Concrete
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D3261	(2016) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM F1055	(2016) Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing
ASTM F1674	(2011) Standard Test Method for Joint Restraint Products for Use with PVC Pipe

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 24	(2013) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

NSF INTERNATIONAL (NSF)

NSF 372	(2011) Drinking Water System Components - Lead Content
NSF/ANSI 14	(2016a) Plastics Piping System Components and Related Materials
NSF/ANSI 61	(2016) Drinking Water System Components - Health Effects

UNDERWRITERS LABORATORIES (UL)

UL 246	(2011; Reprint Feb 2013) Hydrants for Fire-Protection Service

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipe, Fittings, Joints and Couplings; G, AE

Valves; G, AE

Valve Boxes; G, AE

Hydrant; G, AE

Meters; G

Pipe Anchorage; G, AE

Tapping Sleeves; G, AE

Corporation Stops; G, AE

SD-06 Test Reports

Bacteriological Samples; G, AE

SD-07 Certificates

Pipe, Fittings, Joints and Couplings

Valves

Meters

Disinfection Procedures

Manufacturer's Certification; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

SD-11 Closeout Submittals

As-Built Drawings; G

1.03 QUALITY CONTROL

A. Regulatory Requirements

Comply with NSF/ANSI 61 and NSF 372 for materials for potable water piping, components and specialties for domestic water; comply with lead content requirements for "lead-free" plumbing as defined by the U.S. Safe Drinking Water Act effective January 2014.

Comply with NSF/ANSI 14 for plastic potable water piping and components. Provide plastic pipe and fittings, bearing the seal of the National Sanitation Foundation (NSF) for potable water service from the same manufacturer.

Comply with NFPA 24 for materials, installation, and testing of fire main piping and components.

B. Local Water District Requirements

In addition to the information supplied in this specification, the requirements and specifications of the local water district (New Jersey American Water) must be followed. Contractor shall contact the local water district prior to making any connections into public water supplies.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling and in accordance with manufacturer's instructions. Store materials on site in enclosures or under

protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves, hydrant, and other accessories free of dirt and debris.

B. Handling

Handle pipe, fittings, valves, hydrant, and other accessories in accordance with manufacturer's instructions and in a manner to ensure delivery to the trench in sound undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place other material, hooks, or pipe inside a pipe or fitting after the coating has been applied. Inspect the pipe for defects before installation. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. Clean the interior of pipe and accessories of foreign matter before being lowered into the trench and keep them clean during laying operations by plugging. Replace material found to be defective before or after laying with sound material without additional expense to the Government. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

Handle PVC and PVCO pipe, fitting, and accessories in accordance with AWWA C605. Handle PE pipe, fittings, and accessories in accordance with AWWA M55.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Fire Hydrant Line

Provide fire hydrant line indicated as 6 inch diameter line of SDR-11 high density polyethylene (HDPE) pipe and 6 inch diameter fire hydrant lead of ductile iron pipe. Provide water main accessories and valves as specified and where indicated.

B. Water Service Lines

Provide water service line indicated as 1 inch diameter pipe size from water distribution main to building service at the point indicated. Provide water service lines of SDR-11 high density polyethylene (PE) pipe. Provide water service line appurtenances as specified and where indicated.

C. Water Service Casing Pipe

The water line is buried in contaminated soil. Provide watertight casing pipe for the water service line from water distribution main to building service at the point indicated. Provide casing pipe of SDR-11 high density polyethylene (HDPE). Provide appurtenances as specified and where indicated.

2.02 PIPE, FITTINGS, JOINTS AND COUPLINGS

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on joints. Include information concerning gaskets with submittal for joints and couplings.

A. Ductile-Iron Piping

1. Pipe and Fittings

a. General: Ductile iron pipe shall conform to the latest specifications as adopted by the American National Standards Institute, Inc., (ANSI) and the American Water Works Association (AWWA). Specifically, ductile iron pipe shall conform to AWWA C151/A21.51. The pipe or fitting exterior shall be coated with a bituminous coating in accordance with AWWA C151/A21.51. The pipe or fitting interior shall be cement mortar lined and seal coated in compliance with the latest revision of AWWA C104/A21.4.

b. Quality: Pipe and fittings shall meet the following minimum quality requirements by conforming to the following standards: AWWA C105/A21.5, AWWA C110/A21.10, AWWA C115/A21.15, AWWA C116/A21.16, AWWA C150/A21.50, AWWA C151/A21.51, AWWA C153/A21.53. Ductile iron water pipe and fittings will be accepted on the basis of the Manufacturer's certification that the material conforms to this specification. The certification for iron fittings shall list a fitting description, quantity, bare fitting weight and source, (AWWA Standard C110, C153 or Manufacturer, if fitting is not listed in either standard). The certification shall accompany the material delivered to the project site. The Government reserves the right to sample and test this material subsequent to delivery at the project site. If foreign manufactured fittings are provided, then the Contractor is obligated to notify the Contracting Officer with a submittal and provide the necessary documentation to satisfy the Contracting Officer and the Government that the materials provided meet the specified AWWA standards and, among other documentation that may be required, provide certificates of compliance on the component supplied.

c. Pipe Class: The pressure class of pipe to be furnished shall be in accordance with the table and the notes listed below.

Minimum Rated Working Pressure for Ductile Iron Pipe	
Pipe Size (Inch)	Pressure Class
6	350

(1) The noted pressure class is adequate to support 3/4 and 1-inch corporation stops. Use a full saddle for larger taps (e.g.., air relief valves or larger

corporations) due to limited wall thickness.

(2) There are special conditions where a larger wall thickness is required. The Contracting Officer shall direct the Contractor on the proper pressure class pipe to use in specific instances; e.g. at treatment plant or booster station sites where frequent excavation can be anticipated in the vicinity of pipe, where the pipeline is laid on a river channel bottom to prevent external damage to the pipe and minimize the potential for costly pipe replacement, etc.

2. Fittings

Standard fittings shall be ductile iron conforming to AWWA C110/A21.10. Compact ductile iron fittings shall meet the requirements of AWWA C153/A21.53. The fittings shall be coated on the outside with a petroleum asphaltic coating in accordance with AWWA C110/A21.10 or fusion coated epoxy in accordance with AWWA C116 and lined inside with cement-mortar and seal coated in accordance with AWWA C104/A21.4 or fusion coated epoxy in accordance with AWWA C116. Fittings shall be suitable for the following working pressures unless otherwise noted in AWWA C110/A21.10 or AWWA C153/A21.53:

Pressure (psi)		
Size (inches)	Compact Fittings	Standard Fittings
3 to 24	350	250, 350 (with special gaskets)

The use of standard ductile iron fittings having a 250 psi pressure rating with ductile iron pipe (having a rating of 350 psi) is not permitted except by the expressed written approval by the Contracting Officer.

3. Joints and Jointing Material

a. Mechanical and Push-On Joints: Mechanical and push-on joints including accessories shall conform to AWWA C111/A21.11. Anti-Rotation l T-Bolts shall be used on mechanical joints shall be of domestic origin, high strength, low alloy steel bolts only, meeting the current provisions of AWWA C111/A21.11 for rubber gasket joints for cast iron or ductile iron pipe and fittings. Bolt manufacturer's certification of compliance must accompany each shipment. T-bolts shall be Xylan or FluoroKote #1, (corrosion resistant) to handle corrosive conditions on any buried bolts.

b. Flanged Joints: Flanged joints shall meet the requirements of AWWA C115/A21.15 or ASME B16.1. Do not use flanged joints in underground installations except within structures. Furnish all flanged joints with a minimum 1/8-inch, thick red rubber or styrene

butadiene rubber gasket. The bolts shall have American Standard heavy unfinished hexagonal head and nut dimensions all as specified in ANSI B18.2. Xylan or FluoroKote #1 Hex Bolts (corrosion resistant) to handle corrosive conditions shall be used on any buried flanged bolts. Flange gaskets shall be rubber in composition; paper gaskets are not permitted. Bolts and nuts hall be threaded in accordance with ASME B1.1, Unified Inch Screw Threads (UN and UNR Thread Form) class 2A external and class 2B internal. For bolts of 1-3/4-inches in diameter and larger, bolt studs with a nut on each end are recommended. Material for bolts and nuts shall conform to ASTM A307, 60,000 PSI Tensile Strength, Grade B, unless otherwise specified. Bolt manufacturer's certification of compliance must accompany each shipment.

c. Restrained Joints: Restrained joints for valves and fittings shall be of the boltless push-on type which provides joint restraint independent of the joint seal. Field Lok gaskets are not permitted on valves or fittings. Restrained push-on joints allowed for pipe only shall have accessories conforming to AWWA C111/A21.11. Restrained system shall be suitable for the following minimum working pressures:

Restrained Joint Minimum Working Pressures	
Size	Pressure (psi)
Less than 20 inches	350

Where adjacent fittings are to be placed (as in a mechanical joint hydrant tee and a mechanical joint hydrant valve), the use of a suitably sized Foster adaptor is permitted to facilitate restraint between the fittings.

d. Insulating Joints: Designed to prevent metal-to-metal contact at the joint between adjacent sections of piping. Provide flanged type joint with insulating gasket, insulating bolt sleeves, and insulating washers. Provide full face dielectric type gaskets, as recommended in the Appendix to AWWA C115/A21.15. Bolts and nuts, as recommended in the Appendix to AWWA C115/A21.15.

B. High Density Polyethylene (HDPE) Piping

Research has documented that certain pipe materials (such as polyethylene, polybutylene, polyvinyl chloride, and asbestos cement) and elastomers, such as used in jointing gaskets and packing glands, may be subject to permeation by lower molecular weight organic solvents or petroleum products. Products supplied under this Specification Section assume that petroleum products or organic solvents will not be encountered. If during the

course of pipeline installation the Contractor identifies, or suspects the presence of petroleum products or any unknown chemical substance, notify the Contracting Officer immediately. Stop installing piping in the area of suspected contamination until direction is provided by the Contracting Officer.

Pipe and fittings shall be made from the same resin meeting the requirements of the Plastic Pipe Institute (PPI) material designation PE 3408 with an ASTM D3350 minimum cell classification of PE 345464C. The material shall have a minimum Hydrostatic Design Basis (HDB) of 1,600 psi at 73 degrees F. All materials which come in contact with water, including lubricants, shall be evaluated, tested, and certified for conformance with NSF/ANSI 61.

1. Pipe

   a. General: All pipe and fittings shall be manufactured in ductile iron pipe sizes (DIPS) only in accordance with AWWA C906. The pipe shall contain no recycled compound except for rework material generated in the manufacturer's own plant that has the same cell classification as the material to which it is being added. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity. The nominal pipe diameter is specified on the Contract Drawings. The DR (dimension ratio) and the pressure rating of the pipe shall be as noted on the plans. The minimum pressure rating will be 200 psi.

   b. Deflection: HDPE may be deflected subject to approval by the Contracting Officer. The following table shows maximum deflection based upon the allowable strain of the pipe wall. Potential flow restrictions, surge and other nontrench stability and pipe strain issues may reduce the values shown here per the Contracting Officer's recommendations. The bend radius multiplier determines the minimum radius of the pipe curvature and is calculated by multiplying the outside diameter of the pipe by the multiplier from the appropriate DR used. Bending radius allowed by the manufacturer can vary. Verify the multiplier with the manufacturer. In no case shall the radius be less than 125 percent of the manufacturer's permitted multiplier.

Pipe Dimension Ratio (DR)	Allowable Deflection (percent)	Bend Radius Multiplier
11	2.7	25
17	4.2	32.5

2. Fittings

   Plain end butt fused fittings shall be used when joining polyethylene materials. Butt fusion fittings shall comply with ASTM D3261.

Electrofusion couplings may be used when joining polyethylene pipes of diameters 3 inches or less. Electrofusion fittings shall comply with ASTM F1055.

Mechanical (compression) fittings shall be used only when joining polyethylene materials to different piping materials and approved by the Contracting Officer. Mechanical (compression) fittings used with polyethylene pipe shall be specifically designed for, or tested and found to be acceptable for, use with polyethylene pipe.

The fittings shall contain no recycled compound except for rework material generated in the manufacturer's own plant that has the same cell classification as the material to which it is being added. The fittings shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

C. Water Service Piping

All Products described below shall meet the requirements of NSF/ANSI 61. Research has documented that certain pipe materials (such as polyethylene) and certain elastomers (such as those used in gasket material and packing glands) may be subject to permeation by lower-molecular weight organic solvents or petroleum products. Products supplied under this Specification Section assume that petroleum products or organic solvents will not be encountered. If during the course of pipeline installation the Contractor identifies, or suspects the presence of petroleum products or any unknown chemical substance, notify the Contracting Officer immediately. Stop installing.

1. Copper Service Line Material

Copper pipe shall be Type L or Type K, as specified, meeting the requirements of ASTM B88. The pipe size (1 inch) and type are to be confirmed by the Contracting Officer. Type K is normally required in corrosive environments where polyethylene is not allowed.

2. Polyethylene Service Line Materials

Polyethylene service line material shall be Class 160 (minimum), ultra high molecular weight, conforming to AWWA C901. Water service pipe size (1 inch) to be confirmed by the Contracting Officer. Copper tube size (CTS) or iron pipe size (IPS) to be determined by the Contracting Officer.

3. HDPE Casing Pipe Materials

HDPE piping material shall conform with IPS HDPE pipe sizing and shall have a pressure rating of nominal SDR-11 rated for burial to 35 feet at soil density of 110 lbs/cu ft and pressure rated to 125 psi at 73 degrees F.

D. Pipe Anchorage

Provide all plugs, caps, tees, and bends (both horizontal and

vertical) with concrete thrust blocking and/or restrained joint pipe as represented on the Drawings. Provide temporary thrust restraint at temporary caps and plugs. Submit details of temporary restraint to the Contracting Officer for approval. At connections with existing water mains where there is a limit on the time the water main may be removed from service, use metal harnesses of anchor clamps, tie rods and straps; mechanical joints utilizing set-screw retainer glands; or restrained push-on joints as permitted by the Contracting Officer. No restraining system can be installed without the approval of the Contracting Officer. Submit details of the proposed installation to the Contracting Officer for approval. For pipe up to 12 inches in size, use a minimum of two 3/4-inch tie rods. If approved for use, install retainer glands in accordance with the manufacturer's instructions. Material for metal harnessing and tie-rods shall be ASTM A36/A36M or ASTM A307, as a minimum requirement.

2.03 VALVES

A. Gate Valves 3 Inch Size and Larger

All gate valves, 3 inches through 12 inches NPS, shall be iron body, resilient seated, nut-operated, non-rising stem gate valves suitable for buried service. The valve interior and exterior shall be epoxy coated at the factory by the valve manufacturer in accordance with AWWA C550 (6-8 mil average, 4 mil minimum). The valves shall be designed for a minimum differential pressure of 250 psi and a minimum internal test pressure of 500 psi unless otherwise noted on the plans. Valves shall be designed to operate in the vertical position. Valves shall comply fully with AWWA C509. Valve ends shall be push on joint or MJ (when restrained), or as shown on the plans or approved in writing in accordance with AWWA C111/A21.11. Stems shall be made of a low zinc alloy in accordance with AWWA C509 4.2.2.4.3. Stem seals shall be double O-ring stem seals. Square operating nuts conforming to AWWA C509 shall be used. Valves shall open (left or right) in accordance with the Government's standard. All valve materials shall meet the requirements of NSF 61. Test valves (Operation Test and Hydrostatic Tests) at the manufacturer's plant in accordance with AWWA Standard C509. Provide the Contracting Officer with certified copies of all tests prior to shipment. The Contracting Officer reserves the right to observe all tests.

B. Valve Boxes

Provide a valve box for each gate valve on buried piping. Valve boxes shall be of the standard, adjustable, cast iron extension type, multiple piece, 5-1/4-inch shaft, screw type, and of such length as necessary to extend from the valve to finished grade. Cast iron valve boxes shall be hot coated inside and out with an asphaltic compound. Valve box bases shall conform to the following table.

Valve Size	Base
4 inches and Smaller	round, 8 inches in height, 10-7/8 inches diameter at bottom
6 inches and 8 inches	round, 11 inches in height, 14-3/8 inches diameter at bottom

2.04 FIRE HYDRANTS AND HOSE HOUSES

A. Fire Hydrant

Provide one hydrant where indicated. Contractor shall contact the local water district and obtain written fire hydrant mechanical details for the water district prior to ordering any fire hydrants in accordance with the drawings.

1. Dry-Barrel Type Fire Hydrant

Provide Dry-barrel type hydrant, AWWA C502 or UL 246, "Base Valve" design, with 6 inch inlet, 5 1/4 inch valve opening, one 4 1/2 inch pumper connection, and two 2 1/2 inch hose connections. Hydrant shall open left or right as required and be clearly marked on the top of the hydrant with a 1-1/2 inch pentagon top nut and have not less than two (2) O-ring stem seals. Provide hydrant that conforms to the requirements of AWWA C502, traffic-model break-away type fire hydrant. All hydrant materials shall meet the requirements of NSF/ANSI 61. Hydrant interior and exterior shall be epoxy coated at the factory by the hydrant manufacturer in accordance with AWWA C550 (6-8 mil average, 4 mil minimum). Hydrant is to be fully operational under normal conditions.

2.05 METERS

Contractor shall contact the local water district for requirements on water meters, meter housing, and other meter appurtenances.

2.06 ACCESSORIES

A. Tapping Sleeves

Provide stainless steel tapping sleeves where indicated on plans. The stainless steel band flange shall be manufactured in compliance with AWWA C207, Class D ANSI B.16.1 drilling, recessed for tapping valve MSS-SP60. Mechanical Joint tapping sleeve outlet shall meet or exceed all material specifications as listed below and be suitable for use with standard mechanical joint by mechanical joint resilient wedge gate valves per AWWA C509-94 and be NSF 61 approved. The gasket shall provide a 360-sealing surface of such size and shape to provide and adequate compressive force against the pipe after assembly, to affect a positive seal under the combinations of joint and gasket tolerances. The materials used shall be vulcanized natural or vulcanized synthetic rubber with antioxidant and antiozonant ingredients to resist set after installation. No reclaimed rubber

shall be used. A heavy-gauge-type 304-stainless armor plate shall be vulcanized into the gasket to span the lug area. The lugs shall be heliarc welded (GMAW) to the shell. The lug shall have a pass-through-bolt design to avoid alignment problems and allow tightening from either side of the main. Bolts shall NOT BE integrally welded to the sleeve. Bolts and nuts shall be type 304 (18-8) stainless steel and Teflon coated or as specified in the bolt section below at the discretion of the Contracting Officer. Bent or damaged units will be rejected. Quality control procedures shall be employed to insure that the shell, Lug, (4 inches and Larger Nominal Pipe Diameter) armor plate, gasket and related hardware are manufactured to be free of any visible defects. Each unit, after proper installation, shall have a working-pressure rating up to 250 psi. The sleeve construction shall provide a positive means of preventing gasket cold flow and/or extrusion.

B. Insulating Joints

Provide a rubber-gasketed insulating joint or dielectric coupling between pipe of dissimilar metals which will effectively prevent metal-to-metal contact between adjacent sections of piping.

C. Dielectric Fittings

Install dielectric fittings between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains to prevent metal-to-metal contact of dissimilar metallic piping elements and compatible with the indicated working pressure.

D. Tracer Wire for Nonmetallic Piping

Provide bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

E. Polyethylene Encasement

Polyethylene encasement shall conform to AWWA C105/A21.5. The polyethylene film supplied shall be translucent and blue in color (or as approved by Contracting Officer) and distinctly marked (at minimum 2 foot intervals) with the following information:

1. Manufacturer's name (or trademark),
2. Year manufactured,
3. Minimum film thickness and material type (LLDPE or HDCLPE),
4. Range of nominal pipe diameter size
5. AWWA C105/A21.5 (compliance)
6. Warning label "WARNING-CORROSION PROTECTION-REPAIR ANY DAMAGE"
7. Labeled "WATER"

Tape shall be polyethylene compatible adhesive and a minimum of 1.5 inches wide. Shall be Scotchwrap #50, Fulton #355, or Polyken #900. Store all polyethylene encasement out of the sunlight. Exposure of wrapped pipe should be kept to a minimum.

F. Water Service Line Appurtenances

1. Corporation Stops

Corporation stops shall be of the brass ball valve type manufactured in accordance with AWWA C800. The inlet connection shall have standard AWWA tapered threads unless otherwise required by the Contracting Officer. The outlet connection shall be a compressed fitting end. The sizes shall range from 1/2 inch to 2 inches and shall match the size of specified copper pipe material.

2. Curb or Service Stops

Curb stops shall be bronze body construction, ball valves, with Double O-ring stem seals. Curb stops shall conform to AWWA C800. End connections shall be suitable for flared copper connection. If required by the Contracting Officer, valves shall be furnished with square gate valve operating nuts. Sizes shall be from 3/4 inch to 2 inches and shall match the service line size.

3. Curb Boxes

Curb boxes shall be standard cast iron, sliding or screw type, 1 inch or 2-1/2 inches as required, complete with lid and head bolt. Boxes shall be adjustable from 18-inches to 66-inches. . Provide a round head. Cast the word "WATER" on the lid. Factory coat the box with a heavy coat of bituminous paint.

2.07 DISINFECTION

Furnish liquid chlorine and injection equipment and/or calcium hypochlorite (HTH) as needed to disinfect all pipelines and appurtenances. Liquid chlorine contains 100 percent available chlorine and is packaged in steel containers, usually of 100 lb, 150 lb, or 1 ton net chlorine weight. Liquid chlorine is to be furnished in accordance with AWWA B301. Calcium hypochlorite is available in granular form or in approximately 5-g tablets, and contains approximately 65 percent available chlorine by weight and is employed in calculations used in this specification. The material should be stored in a cool, dry, and dark environment to minimize its deterioration. Do not use calcium hypochlorite intend for swimming pool disinfection, as this material (containing trichloroisocyanuric acid) has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time had been achieved. Calcium hypochlorite must conform to AWWA B300.

PART 3 EXECUTION

3.01 PRECAUTIONS

A. Connections to Existing System

Perform all connections to the existing water system in the presence of the Contracting Officer.

B. Operation of Existing Valves

Do not operate valves within or directly connected to the existing water system unless expressly directed to do so by the Contracting Officer.

3.02 INSTALLATION OF PIPELINES

A. General Requirements for Installation of Pipelines

Submit manufacturer's instructions for pipeline installations. These manufacturer's instructions apply to all pipeline installation except as noted herein.

1. Existing Utilities

Maintain the minimum required distance between the water line and other utility lines in strict accordance with all Federal, State, and local requirements and all right-of-way limitations. Notify the applicable State Agency with jurisdiction over underground facilities and/or all utility companies that construction work under this Contract will pass through containing their underground facilities. Notify these parties in advance to support the construction work (minimum 72 hours). All excavation in the vicinity of existing underground utilities shall be performed in accordance with applicable regulations.

Support, relocate, remove, or reconstruct existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or drains. The obstruction shall be permanently supported, relocated, removed or reconstructed where they obstruct the grade or alignment of the pipe. Contractor must do so in cooperation with the owners of such utility structures. Before proceeding, the Contractor must reach an agreement with the Contracting Officer on the method to work around the obstruction. No deviation shall be made from the required line or depth without the consent of the Contracting Officer.

Repair or replace any damage to existing structures, work, materials, or equipment incurred by Contractor's operations. Repair all damage to streets, roads, curbs sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, trees, shrubs or other public or private property caused by transporting equipment, materials or personnel to or from the work site. Make satisfactory and acceptable arrangements with the persons or agencies having jurisdiction over the damaged property concerning repair or replacement. Brace and support existing pipes or conduits crossing the trench, or otherwise exposed to prevent trench settlement from disrupting the line or grade of the pipe or conduit. Before proceeding, the Contractor must reach an agreement with the Contracting Officer on the method of bracing and support. Repair or replace all utility services broken or damaged at once to avoid inconvenience to customers. Storm sewers shall not be interrupted overnight. Use temporary arrangements, as approved by the Contracting Officer, until any damaged items can be permanently

repaired. Maintain all items damaged or destroyed by construction and subsequently repaired.

Relocate existing utilities or structures, where necessary, and restore it to a condition equal to that of the original facility. Obtain approval of the owner of the utility or structure prior to relocating and/or restoring the facility.

a. Separation of Water Mains and Sanitary Sewers

1) Normal Conditions

Lay water mains at least 10 feet horizontally from any existing or proposed sanitary sewer. Measure the distance from edge to edge. In cases where it is not practical to maintain a 10-foot separation, the applicable State Agency may allow deviation on a case-by-case basis, if supported by data from the Engineer. Such deviation may allow installation of the water main closer to a sanitary sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sanitary sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sanitary or the water main is encased by a casing pipe.

2) Unusual Conditions

Notify the Contracting Officer when it is impossible to obtain the proper horizontal and vertical separation as stipulated above. If directed by the Contracting Officer, both the water main and sanitary sewer line shall be constructed of, mechanical joint ductile iron or welded joint protected steel pipe. Other types of restrained joints of equal or greater integrity may be used at the discretion of the Contracting Officer after consultation with the applicable State Agency. Thermoplastic sanitary sewer pipe may be used provided mechanical or solvent weld pipe joints are used and accepted by the Contracting Officer. Pressure test these joints before backfilling to assure that they are water tight. Where water mains must cross under a sanitary sewer, additional protection shall be provided by:

a) vertical separation of at least 18 inches between the bottom of the sanitary sewer and the top of the water line,
b) Adequate structural support for the sanitary sewer to prevent excessive deflection of the joints and the settling on and breaking of the water line,
c) Centering the section of water pipe at the point of the crossing so that the joints shall be equidistant and as far as possible from the sanitary sewer line.

Consult the applicable State Agency, through the Contracting Officer, to discuss the use of double casing or concrete encasement of sanitary sewer and/or water lines as possible alternatives when the above conditions cannot be met.

2. Earthwork

Perform earthwork operations in accordance with Section 31 23 10, EXCAVATION and Section 31 23 16, BACKFILL AND COMPACTION..

3. Pipe Laying and Jointing

Lay all pipe to the depth specified. Measure the depth from the final surface grade to the top of the pipe barrel. The minimum pipe cover shall be 4 feet below grade or as shown on the Drawings. Do not lay pipe in a wet trench, on subgrade containing frost, or when trench conditions are unsuitable for such work. If all efforts fail to obtain a stable dry trench bottom and the Contracting Officer determines that the trench bottom is unsuitable for such work, the Contracting Officer will order the kind of stabilization to be constructed, in writing. In all cases, water levels must be at least 6 inches below the bottom of the pipe. Thoroughly clean the pipes and fittings before they are installed. Keep these materials clean until the acceptance of the completed work. Lay pipe with the bell ends facing in the direction of laying, unless otherwise shown on the Drawings, or directed by the Contracting Officer. Exercise care to ensure that each length abuts the next in such a manner that no shoulder or unevenness of any kind occurs in the pipe line. Do not wedge or block the pipe during laying unless by written order of the Contracting Officer. Before joints are made, bed each section of pipe the full length of the barrel, at the required grade, and at the invert matching the previously laid pipe. Dig bell holes sufficiently large to permit proper joint making. Do not bring succeeding pipe into position until the preceding length is embedded and secure in place. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying. Take up, such in-place pipe sections found to be defective and replace them with new pipe. Take up, relaying, and replacement will be at the Contractor's expense. Place enough backfill over the center sections of the pipe to prevent floating.

Take all other necessary precautions to prevent the floating of the pipeline by the accumulation of water in the trench, or the collapse of the pipeline from any cause. Place enough backfill over the center sections of the pipe to prevent floating. Should floating or collapse occur, restoration will be at the Contractor's expense. Prevent foreign material from entering the pipe while it is being placed. Do not place debris, tools, clothing, or other materials in the pipe during laying operations. Close all openings in the pipeline with watertight plugs when pipe laying is stopped at the close of the day's work, or for other reasons such as

rest breaks or meal periods. Only cut pipe with equipment specifically designed for cutting pipe such as an abrasive wheel, a rotary wheel cutter, a guillotine pipe saw, or a milling wheel saw. Do not use chisels or hand saws. Grind cut ends and rough edges smooth. Bevel the cut end slightly for push-on connections as per manufacturer recommendations. In distributing material at the site of the Work, unload each piece opposite or near the place where it is to be laid in the trench. If the pipe is to be strung out, do so in a straight line or in a line conforming to the curvature of the street. Block each length of pipe adequately to prevent movement. Block stockpiled pipe adequately to prevent movement. Do not place pipe, material, or any other object on private property, obstructing walkways or driveways, or in any manner that interferes with the normal flow of traffic. Exercise special care to avoid damage to the bells, spigots or flanged ends of pipe during handling, temporary storage, and construction. Replace damaged pipe that cannot be repaired to the Contracting Officer's satisfaction, at the Contractor's expense.

4. Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

5. Installation of Polyethylene Encasement

Encase piping in polyethylene as required to prevent contact with surrounding backfill and bedding material in all areas shown on the plans or designated by the Contracting Officer. Polyethylene shall be 12 mils. Install the polyethylene wrap material in accordance with the DIPRA Field Polyethylene Installation Guide and AWWA C105/A21.5. Polyethylene shall fit snugly and not tightly stretched. All holes or tears shall be repaired with tape. Large holes or tears shall be repaired by taping another piece of polyethylene over the hole. Tape or plastic tie straps at joint overlaps and at every 3 foot interval. Dig bell holes and slide polywrap over the adjacent pipe and provide a minimum of 1 foot of overlap. Tightly secure bottom of polywrap using two to three passes of polyethylene tape on the pipe to polywrap connection and the overlap polywrap to polywrap connection. Where polyethylene wrapped pipe being installed connects to a pipe that is not wrapped (including existing pipe), extend the wrap a minimum of 3 feet onto the previously uncovered pipe. This includes service lines which may be wrapped in polyethylene or dielectric tape. Direct service taps for polyethylene encased pipe shall follow the procedure described in AWWA C600. Access to the main for tapping through polyethylene is accomplished by making two to three passes of polyethylene tape around the pipe and over the polywrap. The tap is to be made directly through the tape and polywrap.

6. Connections to Existing Water Lines

Make connections to existing water lines after coordination with the facility and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped and as indicated , except as otherwise specified, tap concrete pipe in accordance with AWWA M9 for tapping concrete pressure pipe.

7. Penetrations

Provide ductile-iron or Schedule 40 steel wall sleeves for pipe passing through walls of valve pits and structures. Fill annular space between walls and sleeves with rich cement mortar. Fill annular space between pipe and sleeves with mastic.

8. Flanged Pipe

Only install flanged pipe aboveground or with the flanges in valve pits.

B. Special Requirements for Installation of Water Lines

1. Installation of Ductile-Iron Piping

Unless otherwise specified, install pipe and fittings in accordance with the paragraph GENERAL REQUIREMENTS FOR INSTALLATION OF PIPELINES and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.

a. Push-On Jointing: Clean the surfaces that the gasket will contact thoroughly, just prior to assembly using a bacteria free solution (bleach, potable water or NSF approved material). Insert the gasket into the groove in the bell. Apply a liberal coating of special lubricant to the gasket and the spigot end of the pipe before assembling the joint. Center the spigot end in the bell and push home the spigot end.

b. Mechanical Jointing: Clean and lubricate all components with soapy water prior to assembly. Slip the follower gland and gasket over the pipe plain end making sure that the small side of the gasket and lip of the gland face the bell socket. Insert the plain end into socket. Push gasket into position with fingers. Seat gasket evenly. Slide gland into position, insert bolts, and tighten nuts by hand. Tighten bolts alternately (across from one another) to the recommended manufacturing rating or if not provided, to the following normal torques:

Bolt Size	Torque in Foot-Pounds
5/8 inches	40-60

Bolt Size	Torque in Foot-Pounds
3/4 inches	60-90
1 inches	70-100
1-1/4 inches	90-120

After field installation, all bolts shall receive petrolatum tape or petroleum wax protection or other approved coating material. Protection shall be applied before applying polywrap.

c. Restrained Jointing:.

1) Ball and Socket: Assemble and install the ball and socket joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Check the retainer ring fastener.

2) Push-on: Assemble and install the push-on joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Check the retainer ring fastener. Protect pipe from damage from the jacking device (backhoe bucket, pipe jack, etc.) when "pushing home" any pipe by using wood or other suitable (non metallic) material.

3) Mechanical Joint: Assemble and install the mechanical joint according to the manufacturer's recommendations. Thoroughly clean and lubricate the joint. Use approved restrained joint device on fittings and valves where required and approved for use by Contracting Officer.

d. Allowable Deflection: The maximum allowable deflection at the joints for push-on joint pipe shall be the lesser of manufacturer's recommendations or as described in the DIPRA Guideline, Ductile Iron Pipe Joints and Their Uses, as follows:

Pipe Size	Deflection Angle	Maximum Deflection	
		18-ft length	20-ft length
3 to 12 inches	5 degrees	19 inches	21 inches

Use short lengths of pipe (minimum length 3 feet, no more than three short sections), when approved by the Contracting Officer, to make curves that cannot be made with full length sections of pipe without exceeding the allowable deflection. Making these curves will be at no additional cost to the Government.

e. Pipe Protection: Protect pipe from damage from the jacking device (backhoe bucket, pipe jack, etc.) when

"pushing home" any pipe. Wood or other suitable material (non metallic) shall be used to push home the pipe.

f. Gaskets: Gaskets shall be as provided or recommended by the manufacturer and satisfy AWWA C111/A21.11 in all respects. As noted in the products section of this specification, some gasket materials are prone to permeation of certain hydrocarbons which may exist in the soil (see part 2). Under these conditions and at the Contracting Officer's discretion require contractor to provide FKM (Viton, Flourel) gasket material in areas of concern.

2. Installation of High Density Polyethylene (HDPE) Piping

Install PE pipes in accordance with AWWA M55 and ASTM D2774.

a. Pipe Bending: Maximum pipe bending radius shall be in conformance with the manufacturer’s recommendation for the specific diameter and dimension ratio (DR) of the pipe. Whenever possible, changes in direction shall be accomplished by bending the pipe in lieu of installing a fitting, except as approved by the Contracting Officer.

b. Pipe and Fitting Joining:

1.) Butt Fusion: Butt fusion procedures shall be in accordance with the manufacturer’s recommendations. Surfaces must be clean and dry before joining. The fusion equipment operator shall be fully trained in the use of the respective equipment. The wall thicknesses of the adjoining pipes shall have the same DR at the point of fusion. Butt fusion equipment shall be equipped with a Datalogger. Records of each weld (including, as a minimum, heater temperature, fusion pressure, and a graph of the fusion cycle) shall be appropriately identified and provided to the Contracting Officer.

2.) Electrofusion: May only be used on pipes with diameter of 3 inches or less. Electrofusion reports of each weld shall be appropriately identified and provided to the Contracting Officer. The reports shall include, as a minimum, the fusion date, time, ambient temperature, fitting type and size, user ID, and the manufacturer of the part.

3.) Mechanical Joining: Mechanical (compression) joining of pipe and fittings is only permissible when joining polyethylene pipe to unlike materials. HDPE stiffeners shall be utilized with all mechanical (compression) fittings. Anchorage must be provided at changes in direction for any mechanical fittings. Use of positive restrained joints fittings (non-friction type) is permissible when approved by the Contracting Officer.

3. Pipe Anchorage Installation

a. Provide thrust blocks where indicated. Use concrete, ASTM C94/C94M, having a minimum 28-day compressive strength of 3,000 psi. Construct blocking against the vertical face of undisturbed earth or sheeting left in place. Prevent the concrete from enclosing more than half the circumference of the pipe unless it is a straddle block. See the thrust blocking details. Notify the Contracting Officer whenever field conditions are noted which are more restrictive than the thrust block design data included on detail drawings.

b. Provide restrained joints in accordance with NFPA 24, Chapter 10 and in accordance with ASTM F1674.

c. Protection of Metal Harnessing: Protect ties rods, clamps and other metal components against corrosion by hand application of petrolatum tape and by encasement of the entire assembly with 8-mil thick (12 mil thick in corrosive soils) loose polyethylene film in accordance with AWWA C105/A21.5. Apply tape on all exposed tie rods prior to installing polyethylene.

C. Installation of Valves

1. Installation of Gate Valves

Prior to installation, inspect valves for direction of opening, freedom of operation, tightness of pressure containing bolting, cleanliness of valve ports and especially of seating surfaces, handling damage, and cracks. Correct defective valves or hold for inspection by the Contracting Officer. Provide valves with adequate support, such as crushed stone and concrete pads, so that the pipe will not be required to support the weight of the valve. Set truly vertical. After field installation of the valve all exposed ferrous restraint materials and external bolts except the operating nut shall receive a layer of petrolatum tape coating or, where approved, rubberized-bitumen based spray-on undercoating applied before backfill. If polyethylene is applied to the pipe, the entire valve shall be encased in polyethylene encasement prior to backfill. The polyethylene encasement shall be installed up to the operating nut leaving the operating nut exposed and free to be operated. Provide a valve box for each valve. Set the top of the valve box neatly to existing grade, unless directed otherwise. Do not install in a way that allows the transfer shock or stress to the valve. Center and plumb the box over the wrench nut of the valve. Do not use valves to bring misaligned pipe into alignment during installation. Support pipe in such manner as to prevent stress on the valve.

2. Installation of Valve Boxes

Valve boxes shall be supported so that no load can be transmitted from the valve box to the valve. See drawing details. Install a self-centering alignment ring at the operating nut American Flow Control, or equal or otherwise

make sure that the bottom of the box is centered over the operating and runs perpendicular to the horizontal.

D. Installation of Fire Hydrant

1. General

Locattion of hydrant to be determined by the Contracting Officer and in compliance with local regulations. The location shall provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians. When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap will be less than eighteen to twenty- four inches, depending on local requirements, from the gutter face of the curb. Hydrant shall stand plumb with the pumper nozzle facing the curb. Set hydrant with nozzles at least 18 inches above the finished grade as shown on the plans. Set the break flange at least two but no more than six inches above finished grade. Connect hydrant to the main with a 6 inch branch connection controlled by an independent 6 inch gate valve, unless otherwise shown on the plans. Hydrant assembly must be restrained from the hydrant back to the main. Paint hydrant above the bury line in accordance with the local operations standards. Touch up paint (as specified by the Government or Local Water Authority under Special Conditions) shall be applied upon completion of installation as needed. Take extreme care to avoid getting any paint on the "O" ring under the top operating nut or on the hydrant nozzles. Should paint be found on the "O" ring, the Contractor shall remove the paint and replace the "O" ring at his expense. Any paint on the hydrant nozzles shall be removed at the Contractor's expense.

2. Drainage Pit

Unless otherwise directed by the Contracting Officer, excavate a drainage pit 2 feet in diameter and 2 feet deep below but not beyond each hydrant. Fill the pit with compacted 3/4 inch clean granular under and around the base of the hydrant to a level 12 inches above the hydrant drain opening. No hydrant drainage pit shall be connected to a sewer. Cover the drainage area with geotextile fabric. The fabric shall completely isolate the gravel or stone so that no fill material or adjacent earth comes in contact with pit material. Notify the Contracting Officer of situations where the ground water table is above the drain opening of dry barrel hydrant. If directed by Contracting Officer, plug the drain opening using a method acceptable to the hydrant manufacturer. No drainage pit is required when the hydrant drain is plugged. Mark the hydrant, in a manner acceptable to the Government, to indicate that the drain opening has been plugged. Operation of a hydrant with plugged drain leaves the hydrant barrel full of water. Pump the hydrant barrel dry after each use. Reaction or thrust blocking at the base of each hydrant must not obstruct the drainage outlet of the hydrant. The size and shape of concrete thrust backing and the number and size of tie rods, when required, shall be approved by the Contracting Officer. Use the thrust

blocking material specified in PIPE ANCHORAGE section of this specification.

E. Installation of Water Service Piping

1. Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; close such water service lines with plugs or caps.

2. Service Line Connections to Water Mains using Corporation Stops

Use experienced craftsmen familiar with installation of water service lines when tapping water mains. Make all taps with a suitable tapping machine (Mueller, Ford, Hays or Dresser type) using the proper combined drill and tap. Hand held drilling equipment is not acceptable. Before making the tap, inspect corporation stops for cleanliness, damaged threads, and proper operation of the ball valve prior to installation. Do not install corporation stops that fail this inspection. The main may be tapped along the top half of the pipe as directed by the Contracting Officer or as shown on Standard Details. Use a tapping saddle when the water main wall thickness or material (plastic, concrete or A-C pipeline material) make it unsuitable for direct tapping. Verify saddle use with Contracting Officer. In the case of multiple services of small diameter (less than 2 inches diameter), corporation stops shall be at least 12 inches apart and at least 22-1/2 degrees above or below the location of any adjacent tap(s) and curb stops and boxes shall be at least one foot apart. In the case of large diameter multiple services, tap at least 24 inches apart and at least 22-1/2 degrees above or below the location of any adjacent tap(s). Install all corporation stops so that between 2 and 3 threads extend beyond the inside wall of the main. If necessary, make a test tap with the boring bar marked to the proper depth. The corporation stop, when properly installed, will not be shouldered with the main. Do not use lubricants of any type when installing the corporation stop. Use the procedures outlined in AWWA C600 for installing taps on grey iron or ductile iron mains encased in polyethylene.

3. Service Line and Fittings

Excavate the service line trench in accordance with Specification Section 31 23 10, EXCAVATION. . Where augering or moling is permitted follow guidelines provided by the equipment manufacturer including making a proper size hole to launch and receive the unit. If moling or augering is employed, take appropriate precautions to avoid damaging other utilities and disturbing the unexcavated surface. Install service line between the tap connection and the curb stop location making only gradual changes in grade or

alignment as required. Sharp bends (greater than 15 degrees) in any direction are not allowed unless approved by the Contracting Officer. 1-1/2 inch and 2 inch service lines may be installed using three (3) 1-inch corporation stops and a 3-branch connection. This is in lieu of installing a 1-1/2 inch or 2 inch corporation stop. Installation shall be in accordance with Standard Details and in accordance with local regulators. Install all services straight and at right angles to the main. If this cannot be accomplished, provide the Government with accurate as-built dimensions to the tee or corporation stop. The Contractor may be required to attach Government supplied magnets to curb box and valve box. All trench services shall be installed with marking tape. This tape shall provide an early warning at shallow depth excavation. The non-detectable tape shall be 6 inches wide, and buried approximately 12 inches above the service pipe, but a minimum of 12 inches below finished grade. It shall consist of multiple layers of polyethylene with an overall thickness of 3 to 5 mils. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color coded background that conforms to APWA color code standards. It shall be installed continuous from the corporation stop to the curb stop. All plastic service line connections shall use insert stiffeners of the appropriate length and size.

Provide polyethylene encasement, or other protective wrap approved by the Contracting Officer, on all metal service lines and fittings (pile, valves, stops, etc.) . When the polyethylene is applied on the main, it shall extend for a minimum clear distance of 3 feet away from the main when services are not being renewed or extend from the main connection to and including the curb stop or curb meter setter for all new copper service lines. Encasement material and installation shall be per this specification and AWWA C105/A21.5.

4. Curb Stops

Install curb stops with the operating nut in the vertical position and the curb box centered over the nut. Install curb boxes plum and adjusted to be flush with finished grade. Install and lock curb boxes immediately after installation. After completion of service line installation, but prior to backfilling, open the corporation stop slowly to fill the line. When the line is full and all air has been removed, completely open the corporation and close the curb stop. Visually inspect that all piping, fittings, and taps for leaks.

F. Installation of Meters

Install meters and meter boxes at the locations shown on the drawings or as directed by the Local Water Authority. Center meters in the boxes to allow for reading and ease of removal or maintenance.

G. Disinfection

Disinfection of systems supplying nonpotable water is not required.

Prior to disinfection, provide disinfection procedures, proposed neutralization and disposal methods of waste water from disinfection procedures as part of the disinfection submittal. Disinfection procedure must be approved by the Local Water District. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive bacteriological samples from new water piping. Analyze samples by a certified laboratory, and submit the results of the bacteriological samples. Obtain approval by the Contracting Officer prior to the new water piping being placed into service.

3.03 FIELD QUALITY CONTROL

A. Field Tests and Inspections

Notify the Contracting Officer a minimum of seven days in advance of hydrostatic testing. Coordinate the proposed method for disposal of waste water from hydrostatic testing. Perform field tests, and provide labor, equipment, and incidentals required for testing, except that water needed for field tests will be furnished as set forth in "AVAILABILITY AND USE OF UTILITY SERVICES" in Section 01 50 00 TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS. Provide documentation that all items of work have been constructed in accordance with the Contract documents. Do not begin testing on any section of a pipeline where concrete thrust blocks have been provided until at least five days after placing of the concrete.

B. Pressure and Leakage Tests

1. General

Perform hydrostatic pressure and leak tests in accordance with AWWA C600, Section 4 - Hydrostatic Testing after the pipe or section of pipe has been laid, thrust blocking cured (min. 5 days), and the trench is completely or partially backfilled. Where practical, testing shall be performed fully isolated from the active distribution system. For system operating pressures of 200 psi or less, perform the hydrostatic test at a pressure of no less than 100 psi above the normal operating pressure without exceeding the rating of the pipe and appurtenances. For system operating pressures in excess of 200 psi, perform the hydrostatic test at a pressure that is 1.5 times the normal operating pressure, but no more than the design rating of the pipe and appurtenances. Valves shall not be operated in either direction at a differential pressure exceeding the rated

valve working pressure. A test pressure greater than the rated valve working pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests exceeding the rated valve working pressure, the test setup should include a provision, independent of the valve, to reduce the line pressure to the rated valve working pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or the valve can be fully opened if desired. The test pressure shall not exceed the rated working pressure or differential pressure of the valves when the pressure boundary of the test section includes closed, resilient seated gate valves or butterfly valves. Attach a tapping sleeve and valve assembly to the main. Pressure test the assembly prior to making the tap. The required test pressure shall be determined in the same manner as for pipe. The test is acceptable if there is no pressure drop in 15 minutes at test pressure.

2. Filling and Testing

Slowly fill each segregated section of pipeline with water ensuring that all air is expelled. Extreme care must be taken to ensure that all air is expelled during the filling of pipe. The line shall stand full of water for at least twenty-four hours prior to testing to allow all air to escape. If necessary, tap the main at points of highest elevation to expel air as the pipe is filled. Remove the corporation stops and plug the taps after successfully filling the pipeline and expelling all air as approved by the Contracting Officer. Apply the specified test pressure, measured at the point of lowest elevation, using a pump connected to the pipe in a manner satisfactory to the Contracting Officer. If the elevation of the high point of the pipeline being tested is such that the pressure during testing will be below 85% of the required test pressure, the Contracting Officer will require a separate test to be performed on this section of pipeline. In lieu of a separate test, the test pressure measured at the lowest elevation may be increased, within the pressure rating of the pipeline material, such that the resulting pressure at the highest point exceeds 85% of the required test pressure. The test will be conducted for at least two hours at the required test pressure ± 5 psi. Conduct a leakage test concurrently with the pressure test. Leakage is defined as the volume of the water that must be supplied into the newly laid pipeline to maintain pressure within 5 psi of the test pressure after it is filled and purged of air. Measure the volume of water using a calibrated container or meter. No pipeline installation will be accepted by the Contracting Officer if the leakage is greater than that shown in the following table:

Average Test Pressure (psi)	Nominal Pipe Diameter (inch)	
	4	6
450	0.57	0.86
400	0.54	0.81
350	0.51	0.76
300	0.47	0.70
275	0.45	0.67
250	0.43	0.64
225	0.41	0.61
200	0.38	0.57
175	0.36	0.54
150	0.33	0.50
125	0.30	0.45
100	0.27	0.41

*If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size. The table has been generated from the formula: L = S*D*P1/2 where L is the allowable leakage in gallons per hour, S is the length of 148,000 pipe in feet, D is the nominal pipe diameter in inches, and P is the test pressure in psig.

Should any test disclose damaged or defective materials or leakage greater than that permitted, the Contractor shall, at Contractor's expense, locate and repair and/or replace the damaged or defective materials. Materials used for repair must be approved by the Contracting Officer and meet the specifications. Repeat the tests until the leakage is within the permitted allowance and is satisfactory to the Contracting Officer.

C. Fire Service and Hydrant Testing

1. Special Testing Requirements for Fire Service

Test water mains and water service lines providing fire service or water and fire service in accordance with NFPA 24. The additional water added to the system must not exceed the limits given in NFPA 24

2. Fire Hydrant Testing

a. Pressure Test

(1) Open the hydrant fully and fill with water; close all outlets.
(2) To prevent caps from being blow off dry-barrel hydrants and to prevent other possible damage, vent air from the hydrant by leaving one of the caps slightly loose as the hydrant is being filled. After all air has escaped, tighten the cap before proceeding.
(3) Apply line pressure.
(4) Check for leakage at flanges, nozzles and operating stem.
(5) If leakage is noted, repair or replace components or complete hydrant until no leaks are evident.

b. Drainage Test for Dry-Barrel Hydrants

(1) Following the pressure test, close hydrant.
(2) Remove one nozzle cap and place pylon or hand over nozzle opening.
(3) Drainage rate should be sufficiently rapid to create a noticeable suction.
(4) After backfilling, operate the hydrant to flush out any foreign material.
(5) Tighten nozzle caps, them back them off slightly so that they will not be excessively tight; leave tight enough to prevent removal by hand.

D. Tracer Wire Continuity

Test tracer wire for continuity after service connections have been completed and prior to final pavement or restoration. Verify that tracer wire is locatable with electronic utility locating equipment. Repair breaks or separations and re-test for continuity.

3.04 AS-BUILTS

Contractor shall supply the Government with as-built drawings for all water utilities installed on the property including dimensional locations to at-grade features, size and type of lines, and depth.

Contractor shall supply the Local Water Authority with as-built drawings and field sketches in accordance with their requirements.

3.05 CLEANUP

Upon completion of the installation of water lines and appurtenances, remove all debris and surplus materials resulting from the work.

-- End of Section --

SECTION 33 11 54

GAUGING STATION
09/17

PART 1 GENERAL

1.01 SUMMARY

This section includes the requirement for construction of one gauging station for the continuous gauging of Bound Brook stage height.

The Contractor shall provide all necessary labor, associated materials and equipment, and other facilities and incidentals to construct the stilling tube. The requirements of this specification will take precedence for any conflicts between the specifications and regulations and/or guidance.

The location of the gauging station is shown on the Contract Drawings.This location will be confirmed in the field with the Contracting Officer prior to the start of construction.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 306	(2010; R 2015) Standard Specification for Drainage, Sewer, Utility, and Related Castings

ASTM INTERNATIONAL (ASTM)

ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A775/A775M	(2016) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM D1557	(2012; E 2015) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D6938	(2017) Standard Test Method for In-Place Density and Water Content of Soil and

	Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D5088	(2015) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM F480	(2014) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

NEW JERSEY ADMINISTRATIVE CODE (NJAC)

NJAC 7:9D	(2007) New Jersey Well Construction and Maintenance; Sealing of Abandoned Wells and Applicable NJDEP Guidance Documents

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Plan; G

Qualifications of Geologist; G

Permits And Licenses; G

SD-03 Product Data

Catalog Data For PVC Piping, Stainless Steel Screen, Flush-Mount Manhole And Traffic-Rated Manhole Covers; G

SD-06 Test Reports

Soil Analytical Results; G

SD-11 Closeout Submittals

Certification For Coating Material And Coated Steel Bars; G

Gauging Station As-Built Drawings; G

1.04 SYSTEM DESCRIPTION

A. Location

Final location of the gauging station will be established in the field by the Contracting Officer.

B. Components of Gauging Station

The gauging station shall consist of the following elements:

1. Precast polymer concrete manhole installed at the top of slope to provide sufficient access to install, retrieve, or otherwise maintain a transducer which shall be set at the end of the well screen extending into Bound Brook.

2. Buried PVC conduit from manhole to toe of slope. The buried casing pipe shall be straight, with long, sweep radius bends occurring sufficient to allow the installation of a wired transducer into the horizontal well screen in Bound Brook.

3. Cast-in-place concrete stabilization block or pipe to stabilize casing pipe and in-stream piping.

4. Stainless pipe and well screen extending into the flowing portion of Bound Brook.

5. Steel anchors grouted or epoxied into bedrock to support the in-water or casing pipe portions of the station.

6. Conduit from the manhole to the GETS building carrying instrumentation line from the transducer to the facility.

7. Manual (visual) surface water gauge shall be installed near the gauging station, securely anchored into bedrock in a location that will minimize potential damage during high water events.

C. Installation

The installation area shall be hydraulically isolated from the flowing portion of Bound Brook and dewatered to complete the installation. The construction details are shown in the Contract Drawings. The precise depth of installation will be determined upon excavation and preparation of the installation.

1.05 SUBSURFACE CONDITIONS

The gauging station manhole shall be installed in the unconsolidated overburden following removal of the asphalt cap. The top of bedrock is expected to be between 5 and 8 feet below the ground surface. From this manhole, a buried pipeline shall be extended to the transducer located in the Brook, just above the sediment layer. Rock in the Brook is located at the surface to a couple of feet below the surface. The water table is expected to be approximately 10 feet below the top of slope ground surface.

1.06 INSTALLATION PLAN

Contractor shall submit an installation plan, describing the proposed methods for excavation and construction 30 calendar days prior to the start of construction. Mobilization activities may start prior to submittal of the plan with the approval of the Contracting Officer.

The plan shall be approved and signed by a geologist experienced in hazardous waste projects as specified in the para 1.07 QUALIFICATIONS. The plan shall include, but not be limited to, discussion of the following:

A. Description of excavation methods, and installation procedures, including hydraulic isolations, dewatering of the in-brook work area, slope restoration, and soil handling and disposal methods.

B. Description of gauging materials, screen, steel anchors, anchor emplacement methods, cement or epoxy, and protective measures.

C. Description of contamination prevention.

D. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

E. List of applicable publications, including State and local regulations and standards.

F. List of personnel assignments for this project, and personnel qualifications.

Soil in the area should be considered contaminated and handled accordingly. At no time shall soil from the excavation be released into Bound Brook. Disposal of excess soil shall be in accordance with Section 02 81 00, HANDLING, TRANSPORT, AND DISPOSAL OF WASTE MATERIALS.

1.07 QUALIFICATIONS

Contractor shall provide a geologist with the appropriate baccalaureate degree from an accredited university with experience in hazardous waste projects, soil and rock logging, quantitative hydrogeology, and stilling tube or well installation. The Contractor representative shall be on site to provide oversight during the Contractor's performance, installation, and completion.

1.08 REGULATORY REQUIREMENTS

A. Permits and Licenses

Local, state, or federal permits or licenses required to perform the work included in this contract shall be obtained by the Contractor prior to commencing gauging station installation operations. All forms required by the State of New Jersey for installation of surface water gauging station shall be completed by the Contractor and returned to the appropriate agency. A copy of all permits, licenses, and other requirements necessary for execution of the work shall be furnished to the Contracting Officer prior to mobilization.

Before beginning work, Contractor shall notify the NJDEP about the type and location of gauging station to be constructed, the method of construction, and the anticipated schedule for construction. A copy of all such correspondence shall be furnished to the Contracting Officer.

B. Statutes and Regulations

Work required by this specification shall be conducted in strict

compliance with applicable local, state and federal regulations, statutes, and codes. Compliance shall be the responsibility of the Contractor.

1.09 DELIVERY, STORAGE, AND HANDLING

Gauging station materials shall be stored and maintained in a clean, uncontaminated condition throughout the course of the project.

1.10 SITE CONDITIONS AND ENVIRONMENTAL PROTECTION

The Contractor shall be responsible for clearing access restrictions for gauging station installation, including any utility clearance. Prior to the start of construction, the Contractor shall visit the proposed location with the Contracting Officer to observe any condition that may hamper work. The Contractor may propose an alternative location in the general area to the Contracting Officer for approval.

The Contractor shall take all precautions as may be required to prevent contaminated soils or water from entering Bound Brook. The Contractor also shall take all precautions necessary to prevent contamination of the ground surface or asphalt cap.

1.11 DOCUMENTATION AND QUALITY CONTROL REPORTS

Contractor shall establish and maintain documentation and quality control reports for the gauging station construction to record the desired information and to assure compliance with Government contract requirements.

A. Gauging Station As-Built Drawings

Following construction, the Contractor shall prepare the installation diagrams illustrating the as-built condition of the gauging station.

B. Field Notebook

A field notebook shall be kept by the Contractor representative present on site during construction, in accordance with USACE SOPs.

PART 2 PRODUCTS

2.01 GAUGING STATION CASING

A. All gauging station casing, and other materials shall be of compatible materials, or incompatible materials shall have dissimilar metal couplings to prevent galvanic reaction between components of the completed gauging station. With the exception of the portion extending within and in contact with the surface water, the casing shall be new, ASTM F480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, 2 inch nominal internal diameter Schedule 80 pipe, with flush threaded joint fittings. The portion of the casing extending within and in contact with the surface water shall be Type 316 stainless steel. Wrap threaded joints with

fluoropolymer tape, and provide with nitrile O-ring gaskets, where appropriate.

B. Submit catalog data for PVC piping, stainless steel screen, flush-mount manhole and traffic-rated manhole covers, bentonite, cement or epoxy. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

2.02 STAINLESS STEEL SCREEN

Provide a well screen consisting of new commercially fabricated flush-joint threaded 2 inch nominal internal diameter Type 316 stainless steel continuous wrap, non-clogging design. Use screens conforming to ASTM A312/A312M, Type 316, Schedule 40S, with continuous slot construction, wire wound, with flush threaded joint ends. Provide Schedule 40S end fittings on the continuous wrap screen. Wrap the end of the vent tube with waterproof tape. Provide a screen slot size of 0.010 inch, or other as approved by the Government, and screen length of 2 feet. Seal the bottom section of the screen watertight by means of a flush threaded end cap of the same material as the well screen.

2.03 CEMENT AND BENTONITE GROUT

Cement grout shall consist of Portland cement conforming to ASTM C150/C150M, Type I or II, sand and water. Proportion cement grout not to exceed 2 parts, by weight, of sand to 1 part of cement with not more than 6 gallons of water per 94 lb bag of Portland cement, with a mixture of such consistency that the well can be properly grouted. No more than 5 percent by weight of bentonite powder may be added to reduce shrinkage.

Bentonite grout shall consist of a mixture of Portland cement conforming to ASTM C150/C150M Type I or II, high grade bentonite powder and water. The grout mix shall contain no more than 5.3 percent bentonite by weight of cement. According to the NJDEP regulations concerning water well construction (NJAC 7:9D-2.9 and 2.10), cement/bentonite grout slurry must consist of a mixture of cement and bentonite in the following proportion: not more than 8.3 gallons of water and 5.0 pounds of bentonite per 94-pound sack of Portland cement with a target density of 13.9 lbs/gallon and an acceptable density ranging from 13.4 to 14.5 lbs/gallon.

2.04 BEDROCK ANCHORS

Submit written certification for coating material and coated steel bars with the delivery of the bars. ASTM A722/A722M, Type I or II, conforming to the coating requirements of ASTM A775/A775M, 8 mils minimum thickness. Coating at the anchorage end may be omitted over the length provided for grouting or epoxy cementing into bedrock.

2.05 SURFACE COMPLETION

Pre-cast polymer concrete flush mounted traffic-rated manhole, or approved equal, at least 12 inches by 18 inches by 12 inches deep with skid-resistant heavy duty traffic rated cover in accordance AASHTO M 306.

2.06 LUBRICANTS

Tool joint and other lubricants used during gauging station installation shall contain no petroleum products.

2.07 TRANSDUCERS

Pressure transducers will be non-vented, waterproof, and externally powered and will be design-capable of sustaining the range of pressures anticipated in the water column. Transducers capable of collecting temperature measurements, in addition to pressure readings, are acceptable but not required.

PART 3 EXECUTION

3.01 GENERAL

Notify the Contracting Officer at least 15 days prior to commencement of work. Excavation and installation of the assembly will be supervised, directed, and monitored by the Contractor's geologist in charge.

3.02 DECONTAMINATION

The equipment and materials shall be cleaned with high-pressure hot water/steam prior to starting work. Decontamination shall be done in accordance with ASTM D5088. Decontamination shall be performed at a location away from the work site.

3.03 INSTALLATION

A. Preparation

Prior to the start of construction, install a coffer dam or other devices in Bound Brook to hydraulically isolate the area of construction from the remainder of the waterway and prevent soil and contaminants from entering the Brook.

Remove sediment in Brook encountered during construction. Sediment is contaminated with PCBs and potentially other contaminants. Place sediment in excess soil stockpiles on the former CDE facility property for disposal. Do not reuse sediment for backfill.

B. Excavation

Excavate trench for installation of the PVC casing pipe to a depth of 2 1/2 feet below the existing grade. Minimum trench width is 4 feet. Excavation shall be performed in accordance with Section 31 23 10 EXCAVATION. Maintain vertical cuts on sideslopes of trench as feasible.

During excavation, all soil removed from the trench shall be considered contaminated and stockpiled on the former CDE facility for reuse or disposal.

Collect three soil samples from the base of the trench, evenly spaced along the length of the trench. The samples shall be

analyzed for PCBs in accordance with Section 01 35 45 CHEMICAL DATA QUALITY CONTROL. Submit the soil analytical results to the Contracting Officer for review and approval prior to proceeding with pipe installation.

C. Pipeline Construction

Compact the subgrade to achieve 90 percent density in accordance with ASTM D1557. Test in-place conditions in accordance with ASTM D6938.

Place and compact pipe bedding to a depth of 4 inches prior to installation of the PVC casing pipe. Place pipe bedding to a depth of 4 inches over the top of the casing pipe.

Place detectable marking tape in accordance with Section 31 23 16 BACKFILL AND COMPACTION above the PVC casing pipe on the side slope prior to backfilling, extending from the manhole at the top of the slope to the concrete stabilization block at the toe of slope.

Additional demarcation of the limits of the trench shall be coordinated with the Contracting Officer.

D. Backfill

Backfill the trench with clean soil to a depth 6 inches below the surrounding grade. Clean soil shall extend a minimum of 2 feet on either side of the casing pipe.

Compact soil in 12 inch loose lifts to achieve 90 percent density in accordance with ASTM D1557. Test in-place conditions in accordance with ASTM D6938.

E. Slope restoration

Place geotextile over areas to receive riprap in accordance with Section 31 05 19 GEOTEXTILES.

Place riprap in accordance with Section 31 23 16 BACKFILL AND COMPACTION, over the full width of the clean corridor to a minimum thickness of 16 inches measured perpendicular to the slope.

Place riprap with care so no damage is done to the geotextile. Do not drop riprap from a height greater than 12 inches.

Place riprap from the base of the slope upward. Place smaller size stones by hand to fill void from between the larger sized stones.

Install two bollards on either side other access manhole and two on either side of the concrete anchor blocks at the limits of the clean corridor.

F. Handling and Disposal of Soils

Soil and other materials removed during excavation shall be handled in accordance with Section 02 81 00 HANDLING, TRANSPORT,

AND DISPOSAL OF WASTE MATERIALS.

G. Flush-Mount Manhole Emplacement

The pre-cast polymer concrete traffic rated manhole shall be installed/constructed in accordance with the Contract Drawings.

H. Anchors

Bedrock anchors shall be installed at a minimum frequency of one anchor for every 2 feet of the lateral PVC casing pipe and the stainless steel screen that extends into Bound Brook.

I. Site Clean-Up

After completion of the work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work. Repair or replace utilities, structures, roads, fences, pavement, or any other pre-existing item damaged during construction.

3.04 SURVEYS

Coordinates and elevations shall be established by a land surveyor registered in the state of New Jersey. Horizontal coordinates shall be determined to the closest 0.01 foot and referenced to the New Jersey State Plane Coordinate System, NAD 83 and elevations to the nearest 0.01 foot using the National Geodetic Vertical Datum of 1929.

A reference elevation will be established for the manual (visual) surface water gauge, measured to the highest marked (measured) point on the gauge.

Coordinates and elevations shall be established at the following points along the gauging station: two sides of the access manhole (closest point to Bound Brook and closest point to the GETS building); top of concrete anchor; both ends of the well screen on the top of the pipe.

3.05 DOCUMENTATION AND QUALITY CONTROL REPORTS

Establish and maintain documentation and quality control reports for stilling tube installation to record the desired information and to assure compliance with Contract requirements, including, but not limited to, the following:

1. As-Built Drawings

Submit as-built drawings for the gauging station and manual (visual) gauge once installation is complete. The drawings shall be prepared and signed by the geologist present during installation operations, within 15 working days of the completion of the installation procedure. The diagram must illustrate the as-built condition and include, but not be limited to, the following items:

1) Name of the project and site.
2) Name of contractor and name and signature of the geologist preparing diagram.

3) Date of installation.
4) Description of materials of construction, including casing and screen material, diameter and schedule of casing and screen, brand name (if any), source, epoxy coated steel anchor type, specification, and installation method, grout type, epoxy type, and type of protective cover (protective casing or flush-to-ground),if used.
5) Elevations, depths, and heights of key features of the gauging station, such as top of casing or riser pipe, ground surface.
6) Limits of clean corridor.
7) Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.
8) Gauging station location by coordinates. Include a plan sheet showing the coordinate system used and the location of the installation.

2. Documentation Report

The as-built drawings shall be accompanied by a report documenting construction of the gauging station including description of the system, construction procedures, and discussion of special problems and their resolutions.

3. Regulatory Compliance

The As-built drawings and documentation report will be used to comply with any regulatory submittals associated with permits and licenses obtained for construction. In addition to the above information, any other reporting requirements included in the permits and licenses shall be addressed.

-- End of Section --

SECTION 33 23 00

GROUNDWATER EXTRACTION WELLS
09/17

PART 1 GENERAL

1.01 SUMMARY

This section includes the requirement for construction of 4 open bedrock groundwater extraction wells (EW; EW-1, EW-2, EW-4, and EW-5)).

The Contractor shall provide all necessary labor, associated materials and equipment, and other facilities and incidentals to drill, install, complete, develop, and conduct well capacity tests on four groundwater extraction wells. This work shall include installation of the pumps, motors, drop pipe, and other down-hole equipment. The wells shall be constructed in general accordance with State of New Jersey and USEPA guidelines, including, but not limited to NJAC 7:9D and EPA 670/9-75-001 and this Specification. The requirements of this specification will take precedence for any conflicts between the specifications and regulations and/or guidance.

The 4 new extraction wells shall be located along the northeastern property boundary adjacent to Bound Brook, as shown on the Contract Drawings.

The proposed extraction wells are located on the asphalt paved cap, on generally level ground in relatively easily accessible areas for drilling equipment.

The total depth and location of the open bedrock interval for each groundwater extraction well shall be dependent on the ground surface elevation (top of asphalt) at the extraction well location, and the elevation of the top of competent bedrock. The EWs shall be located no more than 10 feet from the prescribed locations detailed in the Contract Drawings, unless otherwise directed by the Contracting Officer.

The Contractor shall obtain and use a potable water supply source for the drilling of the extraction wells as described in paragraph 2.06 WATER.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A589/A589M	(2012) Standard Specification for Seamless and Welded Carbon Steel Water-Well Pipe
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D5088	(2015) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM D5299	(1999; E 2012; R 2012) Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA A100	(2015) Water Wells
AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C206	(2017) Field Welding of Steel Water Pipe

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA 530/F-93/004	(1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 670/9-75-001	(1975) Manual of Water Well Construction Practices
EPA SW-846	(Third Edition; Update IV) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

NEW JERSEY ADMINISTRATIVE CODE (NJAC)

NJAC 7:9D	(2007) New Jersey Well Construction and Maintenance; Sealing of Abandoned Wells and Applicable NJDEP Guidance Documents

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-1-4000	(1998) Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2016a) Plastics Piping System Components and Related Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Permits And Licenses; G

Qualifications for Field Oversight Staff; G

Investigation Derived Waste Plan; G

Well Installation Plan; G

SD-03 Product Data

Catalog Data for Indicated Products; G

SD-05 Design Data

Extraction Well Pump Selections; G

SD-06 Test Reports

Testing Results; G

SD-07 Certificates

Treatment And Disposal Certificates

Treatment Facility Permit

Delivery Certificates

Shipment Manifests

New Jersey Extraction Well Registrations

SD-11 Closeout Submittals

Borehole Logs; G

Well Installation Diagrams; G

Extraction Well Development Records; G

Well Decommissioning/Abandonment Records; G

1.04 SUBSURFACE CONDITIONS

The extraction wells shall be installed in fractured bedrock aquifer. The top of competent bedrock is expected to be between 10 and 13 feet below the ground surface. The water table is expected to be approximately 10 feet below ground surface. Based on the available site data, the subsurface conditions near the proposed well locations consist of approximately 5 to 8 feet of soil and fill and approximately 5 feet of weathered bedrock, underlain by competent siltstones and mudstones of the Passaic Formation. The overburden soils shall be considered a hazardous/TSCA waste unless characterization documents otherwise in accordance with Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE REQUIREMENTS. The bedrock cuttings can be considered non-hazardous unless characterization documents otherwise. Previous well installation activities at the site have been performed in Level D personal protective equipment.

Please note that all unconsolidated (soils) material must be containerized and segregated from all other drill cuttings for separate characterization and disposal. All drilling IDW will be removed from the site prior to the start of other work at the site.

Specific information obtained from the nearby monitoring wells has been used to develop the stratigraphic profile and for well design purposes.

1.05 SYSTEM DESCRIPTION

The open bedrock interval is that portion of a well which is directly open to the fractured bedrock aquifer. Each extraction well shall be constructed to the following estimated depths to allow pumping at the following maximum flow rates, which are subject to change pending results of well performance testing and final system performance characterization:

TABLE 1. EXTRACTION WELL DETAILS

Well ID	Design Pumping Rate (gpm)	Est. Max. Pumping Rate (gpm)	Est. Depth (ft bgs)
EW-1	7	13	150
EW-2	7	13	175
EW-3 (EXISTING)	7	13	200
EW-4	7	13	125
EW-5	7	13	100

1.06 PERFORMANCE REQUIREMENTS

Each new extraction well shall be installed in a manner to prevent aquifer contamination by the drilling operation and equipment.

Following well development, extraction wells shall meet the performance testing requirements as specified in Part 3 of this Specification

1.07 WELL INSTALLATION AND IDW MANAGEMENT PLAN

A. Well Installation Plan

Contractor shall prepared and submit a plan, describing the drilling methods, sampling (as appropriate), and extraction well construction and well development 30 calendar days prior to beginning drilling operations. The plan will be approved by Contracting Officer and signed by a geologist or engineer experienced in hazardous waste projects as specified in paragraph 1.08 QUALIFICATIONS. The plan shall include, but not be limited to, discussion of the following:

1. Description of well drilling methods, and installation procedures, including any temporary casing used, drill cuttings and fluids disposal, and soil/rock sample disposition.

2. Description of well construction materials, riser pipe, centralizers, tailpiece (if used), drilling fluid additives (if used), drilling water, cement, and well protective measures.

3. Include sample of forms used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, State extraction well registrations, and well abandonment records.

4. Description of contamination prevention. Describe decontamination procedures for well materials and equipment.

5. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

6. Description of well development methods to be used.

7. List of applicable publications, including State and local regulations and standards.

8. List of personnel assignments for this project, and personnel qualifications.

9. Description of well decommissioning/abandonment procedures.

10. Description of hydraulic testing/specific capacity evaluation techniques.

11. Submit catalog data for permanent steel casing, riser pipe, bentonite, cement, centralizers, chemical specifications on drill lubricants, pitless adapters, pumps, motors, drop pipe, and electric cable. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

12. Description of well drilling methods, and installation procedures, including any temporary casing used, drill cuttings and fluids disposal, and soil/rock sample disposition.

13. Description of well construction materials, riser pipe, centralizers, tailpiece (if used), drilling fluid additives (if used), drilling water, cement, and well protective measures.

14. Include sample of forms used for written boring logs, installation diagrams of wells, geophysical logs, well development records, well sampling data records, State extraction well registrations, and well abandonment records.

15. Description of contamination prevention. Describe decontamination procedures for well materials and equipment.

16. Description of protective cover surface completion procedures, including any special design criteria/features relating to frost heave prevention. Include the maximum frost penetration for the site in this description.

17. Description of well development methods to be used.

18. List of applicable publications, including State and local regulations and standards.

19. List of personnel assignments for this project, and personnel qualifications.

20. Description of well decommissioning/abandonment procedures.

21. Description of hydraulic testing/specific capacity evaluation techniques.

22. Submit catalog data for pre-cast concrete vault, permanent steel casing, riser pipe, bentonite, cement, centralizers, chemical specifications on drill lubricants, pitless adapters, pumps, motors, drop pipe, and electric cable. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

B. Investigation Derived Waste Plan

Contractor is responsible for characterizing and disposing of slurry, drill cuttings, rock core; other solid or liquid material bailed, pumped, or otherwise removed from the borehole during drilling, installation, completion, well development procedures and testing along with fluids from material and equipment decontamination activities in accordance with EPA 530/F-93/004, EPA 600/4-79/020, and EPA SW-846. Contractor shall prepare a plan for the management of IDW generated during drilling operations. The plan will be approved by Contracting Officer and signed by a geologist or engineer experienced in hazardous waste projects as specified in paragraph 1.08 QUALIFICATIONS. The plan shall include, but not be limited to, discussion of the following:

1. Identification and description of types of IDW by media, sources of IDW, volumes estimates.

2. Procedures for handling IDW as generated including containerizing, stockpiling and temporary storage, space requirements.

3. Treatment methods for on-site treatment of liquid IDW.

4. Disposal options by media including identification of disposal sites.

M. Submit treatment facility permit verifying that the proposed treatment facility is permitted to accept the contaminated materials specified, prior to the start of drilling .All disposal sites must be verified to be USEPA's Off-Site Rule list by the Region 2 OSR coordinator.

5. Name and contact information for Contractor staff responsible for IDW management.

5. To minimize the potential that the potentially non hazardous solids generated from rock cutting are contaminated by solids during excavation, all IDW generated during drilling operations must be removed from the site for disposal prior to the start of the next phase of work.

C. IDW Disposal Documentation

Submit verification that the wastes were actually delivered to the approved treatment facility, within 7 days of shipment. Furnish copies of delivery certificates, shipment manifests, treatment and disposal certificates, and other documentation required for shipment of waste materials within 24 hours after removal of waste from the site. Shipment manifests are signed by the Contracting Officer.

1.08 QUALIFICATIONS

Contractor shall provide a geologist or engineer with the appropriate baccalaureate degree from an accredited university with experience in hazardous waste projects, soil and rock logging, quantitative hydrogeology, groundwater extraction well installation, and hazardous waste handling, classification, and disposal. The Contractor's representative shall be on site to provide oversight during the drilling subcontractor's performance of drilling, well installation, and well development activities. The contractor's well drilling crew leader will have at least five years of experience drilling water wells with the drilling method being proposed by the Contractor.

1.09 REGULATORY REQUIREMENTS

A. Permits and Licenses

The Contractor shall be a licensed water well contractor in the State of New Jersey.

Local, state, or federal permits or licenses required to perform

the work included in this Contract shall be obtained by the Contractor prior to commencing drilling and well installation operations

Copies of all permits, licenses, and other requirements necessary for execution of the work shall be furnished to the Contractor prior to mobilization. Before beginning work, Contractor shall notify the NJDEP about the type and location of wells to be constructed, the method of construction, and the anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished to the Contracting Officer.

B. Statutes and Regulations

Work required by this specification shall be conducted in strict compliance with applicable local, state and federal regulations, statutes, and codes. Compliance shall be the responsibility of the Contractor.

The Contractor shall register each extraction well with the State of New Jersey Department of Environmental Protection within 60 days of completion of each well and provide copies to Contracting Officer.

C. Drill Cuttings

Drill cuttings shall be handled and disposed of in accordance with paragraph 3.04 Handling Of Development Water And Drill Cuttings and IDW Management Plan.

1.10 DELIVERY, STORAGE, AND HANDLING

Well materials shall be stored and maintained in a clean, uncontaminated condition throughout the course of the project.

1.11 SITE CONDITIONS, PROTECTION OF EXISTING FACILITIES, AND ENVIRONMENTAL PROTECTION

The Contractor shall be responsible for clearing access restrictions for each extraction well site, including any utility clearance. Furthermore, the Contractor shall visit each proposed well location with the Contracting Officer to observe any condition that may hamper transporting equipment or personnel to the site. In the unlikely event that relocation is necessary, the Contractor may propose an alternative location to the Contracting Officer for approval.

The Contractor shall protect all surface (e.g., paved cap, water tower, all benchmarks, all observation and monitoring wells, perimeter fencing, storm water inlets, etc.) and subsurface structures and surrounding areas from damage during the performance of the Work. The The Contractor shall report and repair any items damaged by the Contractor at no additional cost to the Government. Damage to property shall be repaired or replaced at no additional cost to the Government to preconstruction conditions. Contracting Officer shall have the right to approve these restoration measures.

Prior to drilling, Contractor shall obtain approval from the local utility companies to drill at each site, to avoid disturbing buried utilities, and shall perform a geophysical survey of the proposed

drilling locations to confirm the absence of buried utilities or structures. Contractor shall also obtain approval from the property owner at each site to minimize disturbances.

The Contractor shall take all precautions as may be required to prevent contaminated water or water having undesirable physical or chemical characteristics from entering the target stratum through the well bore or by seepage from the ground surface. The Contractor also shall take all precautions necessary to prevent contamination of the ground surface or of surface waters resulting from drilling of the well.

1.12 DOCUMENTATION AND QUALITY CONTROL REPORTS

Contractor shall establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with Government contract requirements. In addition, all forms required by the State of New Jersey for installation of wells shall be completed by the Contractor and returned to the appropriate agency, as well as a copy provided to Contracting Officer. The Contractor shall collect all information necessary to complete the specified documentation and quality control reports. This documentation shall conform to the requirements list in EM 1110-1-4000.

A. Borehole Logs

A borehole log shall be completed by Contractor for each boring drilled. Borehole logs shall be prepared by a qualified geologist or engineer present on site during all well drilling and installation activities. Extraction wells shall be logged by means of visual inspection of the drill cuttings. The Contractor shall assist the on-site Contractor geologist or engineer in the performance of the visual inspection and borehole logging efforts.

If the Contractor is required to complete an independent borehole log (based upon the provisions of their well driller's license or for any other reasons), a copy shall also be provided to the Contracting Officer.

B. Well Installation Diagrams

Contractor shall prepare the installation diagrams illustrating the as-built condition of the extraction wells.

C. Extraction Well Development Records

A well development record shall be prepared by Contractor for each extraction well installed.

D. Well Decommissioning/Abandonment Records

If required by the Contracting Officer, the Contractor shall prepare the decommissioning/abandonment records including, as a minimum, the following:

1. Project name.
2. Well number.
3. Well/boring location, depth and diameter.

4. Date of decommissioning/abandonment.
5. Method of decommissioning/abandonment.
6. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.
7. Casing, and or other items left in hole by depth, description, and composition.
8. Description and total quantity of grout used initially.
9. Description and daily quantities of grout used to compensate for settlement.
10. Water or mud level (specify) prior to grouting and date measured.
11. The reason for decommissioning/abandonment of the well.
12. Notice of Water Well Abandonment form, if applicable.

PART 2 PRODUCTS

2.01 WELL CASING

All extraction well casing, and other well materials shall be of compatible materials, or incompatible materials shall have dissimilar metal couplings to prevent galvanic reaction between components of the completed well. The extraction well casing(s) shall be new, 10-inch nominal internal diameter (outer) to 6-inch nominal internal diameter (inner or riser), standard weight low carbon steel pipe, conforming to ASTM A589/A589M or ASTM A53/A53M grade B, or steel pipe conforming to AWWA C200, as applicable. Extraction well casing joints shall be welded in general accordance with AWWA C206, or threaded and coupled in general accordance with AWWA A100.

2.02 CENTRALIZERS

Centralizers shall be constructed of stainless steel.

2.03 CEMENT AND BENTONITE GROUT

Cement grout shall consisting of Portland cement conforming to ASTM C150/C150M, Type I or II, sand and water. Proportion cement grout not to exceed 2 parts, by weight, of sand to 1 part of cement with not more than 6 gallons of water per 94 lb bag of Portland cement, with a mixture of such consistency that the well can be properly grouted. No more than 5 percent by weight of bentonite powder may be added to reduce shrinkage.

Bentonite grout shall consist of a mixture of Portland cement conforming to ASTM C150/C150M Type I or II, high grade bentonite powder and water. The grout mix shall contain no more than 5.3 percent bentonite by weight of cement. According to the NJDEP regulations concerning water well construction (NJAC 7:9D-2.9 and 2.10), cement/bentonite grout slurry must consist of a mixture of cement and bentonite in the following proportion: not more than 8.3 gallons of water and 5.0 pounds of bentonite per 94-pound sack of Portland cement with a target density of 13.9 lbs/gallon and an acceptable density ranging from 13.4 to 14.5 lbs/gallon.

2.04 SURFACE COMPLETION

In accordance with Section 33 05 13, MANHOLES, VAULTS, AND COVERS.

2.05 LUBRICANTS

Tool joint and other lubricants used during drilling operations shall contain no petroleum products.

2.06 WATER

The Contractor shall be responsible for obtaining water from a potable supply and for transporting it to the site, and storing it where needed.

2.07 REMOVABLE WATER LEVEL MEASUREMENT TUBE

The water level measurement tube shall be new, 2-inch nominal internal diameter, schedule 40 flush-joint threaded ASTM D1785 polyvinyl chloride (PVC) pipe. This pipe shall also meet the requirements of NSF/ANSI 14. The water level measurement tube screen shall extend 20 feet below the static water level in the well. See paragraph 3.03.G for additional information. A PVC non-locking cap, that threads or slips onto the top of the water level tube shall be provided.

2.08 WELL CONTROLS

Each extraction well shall be equipped with an electrical submersible pump, and associated electrical and control cables as specified in Section 25 01 00, MASTER CONTROL SYSTEM.

A. Pumps

Each extraction well shall be equipped with an electrical submersible pump made of 304 stainless steel (including impeller) and retrofitted with polytetrafluoroethylene seals and bearings, made for 4-inch and larger diameter wells. Pumps shall be selected based on the results of the Step-Drawdown Test for each well, as outlined in Paragraph 3.02.I. Pumps shall meet the following minimum requirements:

1. Normal operating range of 5 to 13 gpm, and minimum total dynamic head (TDH) requirements according to Table 2.
2. 1-1/4 inch national pipe thread outlet for connection to the transmission piping.
3. Controls to prevent dry-running and motor burnout and variable frequency drive to allow for remote monitoring and adjustment to support optimized operation of the system.
4. Size: Minimum pump sizes according to Table 2, but not to exceed 2 horsepower each.

TABLE 2. MINIMUM PUMP SIZE AND TOTAL DYNAMIC HEAD

Well ID	Horsepower	TDH (feet)
EW-1	1/2	75
EW-2	1/2	59
EW-3 (EXISTING)	1/3	35

TABLE 2. MINIMUM PUMP SIZE AND TOTAL DYNAMIC HEAD		
Well ID	Horsepower	TDH (feet)
EW-4	1/3	43
EW-5	1/3	53

B. Electrical and Control Cables

Electrical and control cables in accordance with pump manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

Notify the Contracting Officer at least 15 days prior to commencement of work. Well locations and coordinates are as indicated on the Contract Drawings. Drilling, installation, and development of the extraction wells will be supervised, directed, and monitored by the Contractor's geologist in charge.

3.02 DECONTAMINATION BEFORE DRILLING

The drill rig, drill rods, drill bits, temporary casing (if required), permanent casing (if required), well developing equipment, tremie pipes, grout pumping lines, pitless adapters, pumps, motors, drop pipe, and other associated equipment shall be cleaned with high-pressure hot water/steam prior to drilling at each well location. Decontamination shall be done in accordance with ASTM D5088. Decontamination shall be performed at a location approved by the Contracting Officer and away from the extraction wells. Well casing shall be cleaned with high-pressure hot water/steam immediately prior to installation in the well. The use of factory sealed (plastic wrapped) well casing does not waive this requirement for pre-installation cleaning. The water used for cleaning shall be in accordance with paragraph 2.06 WATER.

3.03 INSTALLATION

A. Drilling Method

The borehole for the wells shall be advanced by air rotary or reverse hydraulic rotary methods. Any drilling fluid shall be contained in a prefabricated steel mud pit or a roll- off during drilling. The Contractor shall provide the details of their proposed drilling method and fluid containment in the Well Installation and IDW Management Plans.

The drill rig(s) shall be free from leaks of fuel, hydraulic fluid, and oil, which may contaminate the borehole, ground surface or drill tools. During construction of the wells, precautions shall be used to prevent tampering with the well or borehole or entrance of foreign material. Runoff shall be prevented from entering the well or borehole during construction. If there is an interruption in work, such as

overnight shutdown or inclement weather, the well or borehole opening shall be closed with a watertight uncontaminated cover. The cover shall be secured in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

B. Geologic Sampling

Drill cuttings shall be logged by the Contractor geologist or engineer.

C. Borehole Diameter and Depth

The unconsolidated overburden shall be cased with a 10-inch inner diameter (minimum) steel casing, such that the drilling of the 10-inch borehole 20-feet into competent rock shall not be impeded. The open bedrock boreholes for the extraction wells shall have a minimum diameter of 6 inches. Estimated total depths are provided in the table in paragraph 1.05 of this Specification, and dimensions identified in Table 1 - Extraction Well Dimensions. Table 1 is appended to the end of this section. Depths are based on data collected from previous investigations and hydraulic testing, analyzed by Louis Berger, and approved by the Government.

D. Setting Outer Casing

The outer casing must not be less than 10 inches inner diameter. The hole must be of sufficient size to leave a concentric annular space of not less than 2 inches and not more than 6 inches between the outside of the outer casing and the walls of the hole. Fill the annular space between the outer casing and the walls of the holes with cement grout in accordance with paragraph 2.03 CEMENT AND BENTONITE GROUT. Acceptable methods of grouting are detailed in AWWA A100; select a method specifying the forcing of grout from the bottom of the space to be grouted towards the surface in accordance with paragraph 3.04.F Cement and Bentonite Grout Placement. Provide a suitable grout retainer, packer, or plug at the bottom of the outer casing so that grout will not leak into the bottom of the well. Continuously grout to ensure that the entire annular space is filled in one operation. After grouting is completed, do not resume drilling operations for at least 24 hours to allow proper setting of the grout.

E. Inner Casing/Rise Pipe Placement

A well casing will be installed 20 feet into competent bedrock to prevent contaminated overburden soils from entering the well. When steel well casing pipe is installed it shall be accomplished in a manner such that injury to the well casing pipe does not result which may affect the quality of the water supply. Steel well casing pipe shall be assembled watertight by correctly mated, recessed type couplings having the proper weights and diameters or by means of joints welded. No other means of assembly may be used without approval.

The casing/riser pipe shall extend upwards to an appropriate elevation and surface completion described in paragraph 2.04 SURFACE COMPLETION. The riser pipe shall not be dropped or

allowed to fall uncontrolled into the borehole. The well shall be plumb, and centered in the hole by the use of steel centralizers. Extraction well centralizers shall be located 10 feet below the ground surface and near the bottom of the casing.

F. Cement and Bentonite Grout Placement

In the extraction wells, cement and bentonite grout shall be placed using a side-discharging tremie pipe having an inside nominal diameter of not less than 1 inch. The grout shall be permitted to set for a minimum of 24 hours. The grout seal shall be placed in a manner which completely fills the annular space to a depth of 20 feet into competent bedrock, and prevents bridging and collapse of the borehole wall against the well casing. Additional grout shall be added from the surface to maintain the level of the grout as settlement occurs. Temporary overburden drill casing, if installed, shall be removed simultaneously with the above operation. Lifting of the riser pipe shall be minimized when withdrawing the temporary casing.

G. Water Level Measurement Tube Placement

A water level measurement tube shall be installed in the casing. The base of the water level measurement tube screen shall extend 20 feet below the static water level in the well.

The tube shall not be dropped or allowed to fall uncontrolled into the borehole. The tube shall be cleaned with high pressure hot water/steam just prior to installation; foreign material shall not remain on the casing before installation. The use of factory-sealed (plastic wrapped) PVC, free from painted markings does not waive requirements for pre- installation cleaning. Joints and fastenings shall be watertight and flush threaded; no solvent glue or set screws shall be used. The tube shall be installed directly inside the well casing. The tube shall be oriented such that it will not interfere with the future installation of pump and discharge pipe; the tube shall be securely mounted but removable to facilitate pump maintenance and repair. The tube shall be plumb and suspended from the ground surface. A loose fitting cap shall be installed on the top of the tubes.

H. Well Development

Within 10 days of completion of each well, but no sooner than 48 hours after cement grouting is completed, and after Contractor has obtained approval from Contracting Officer to begin development, the extraction wells shall be developed by the Contractor.

The Contractor shall develop the extraction well by surging (air or fluid/mechanical), bailing, intermittent pumping, or other methods approved by Contracting Officer as may be necessary to give the maximum yield of water per foot of drawdown and until the discharge yields sediment-free water (100 NTU, not to exceed 8 hours of pumping per well). The Contractor shall furnish, install, or construct the necessary discharge line to conduct, containerize, and subsequently characterize and dispose of the discharge.

Development shall be performed using a minimum of 5 cycles of agitation and pumping. Agitation may include surging or jetting as described below or other methods approved by Contracting Officer. Pumping may include the use of a submersible pump, bailer, or air lift pump or other methods approved by Contracting Officer. Intermittent pumping, consisting of rapidly drawing down the water level, and allowing the water level to rise, and repeating the process, may be used during the pumping portion of the cycle. Contracting Officer may require a change in method if the method selected does not accomplish the desired results.

Development is complete when all the following conditions are achieved:

1. Water is clear to the unaided eye.

2. Sediment thickness in the well is less than 0.1 foot.

3. Turbidity, pH, and sand content shall be measured before, twice during, and after development operations. Nephelometric turbidity shall be measured and be less than 20 NTU.

4. A minimum of three times the standing water volume in the casing plus three times the drilling fluid used or lost in the boring has been removed.

Contracting Officer may require other means of developing the well such as an intermittent pumping method, a variation of the intermittent pumping method, or use of a surge block if it appears that the development of the well is not producing the desired results. Changes to the well development procedures identified in the Well Installation and IDW Management Plan shall be approved by Contracting Officer.

Surging of the well shall require the use of a circular block which is approximately 1 inch smaller in diameter than the inside diameter of the extraction well, has rubber gaskets approximately equal to the inside diameter of the borehole, and a bailer or pump to remove materials drawn into the well. The surging shall be continued until little or no additional material from the formation can be seen in the discharge. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the well. All materials pulled into the well by the surging process shall be removed. Contracting Officer shall not permit air surging unless Contractor demonstrates the ability to containerize all discharge for proper characterization and disposal.

A development record shall be maintained by Contractor. At completion of well development, approximately 1 pint of well water shall be collected in a clear glass jar. The jar shall be labeled with project name, well number and date; and photographed using a digital camera. The photograph shall be a suitably backlit close-up which shows the clarity of the water and any suspended sediment. The photograph (or electronic file) shall become a part of the well development record.

I. Step-Drawdown Test

To ensure that a functioning extraction well has been installed and to identify potential production problems, a step-drawdown test shall be performed 24 hours after well development.

The minimum acceptable specific capacity of the well shall be 1 gpm/ft, and shall not exceed 3 gpm/ft. If the well cannot achieve the required pumping rate or minimum specific capacity, additional development shall be performed until it is demonstrated through pumping that the well can achieve the required pumping rate and minimum specific capacity or it is demonstrated that further development will not increase the pumping rate or specific capacity. If at the end of development the well cannot meet the required pumping rate or falls outside the acceptable specific capacity range, measures including replacing the well, reducing the open interval (packer grouting), or raising the pumping rates of adjacent wells to compensate will be considered.

The Contractor assumes all liability for damage to his pump from sand entering the well. The Contractor shall furnish accessories necessary to accurately measure the flow from the pump. A mechanical flow meter with an indicator and totalizer register or an orifice plate and piezometer tube style meter may be used. All results shall be summarized and submitted to Contracting Officer.

1. Conduct a 2 to 4-hour step-drawdown test to determine the specific capacity of each extraction well. The step-drawdown test shall be up to 4 hours in length, with 4 discrete pumping rate steps.

2. Furnish and install a temporary test pump, approved by the Contracting Officer, with discharge piping of sufficient size and length to convey the water being pumped to the point of discharge without creating back pressure that interferes with control of the pumping rate. Install an in-line (totalizing) water meter and an orifice and manometer of sufficient size to accurately measure the pumping rate at the well head. Install a gate valve, at the well head, to control the pumping rate. Install the intake 10 feet above the top of the screen, or as approved by the Contracting Officer.

3. Install transducers and data loggers, or equivalent, in the test well stilling tube to automatically collect water levels during the step drawdown test. The transducer shall be sufficiently designed to handle the anticipated pressure.

4. Collect automated water level measurements from the test well at 1 minute intervals during the step drawdown test. Set up the data logger according to the manufacturer's instructions to collect water level measurements, set the Reference Level to zero and the display shall be set to collect the measurements in English units measured from the top of casing. The data logger's calibration history shall be confirmed with the manufacturer and vendor prior to installation in the wells. Download the data from the data logger at the end of the step drawdown test using the

computer program provided by the manufacturer and submit to the Contracting Officer.

5. Conduct the step test with four consecutive steps of increasing pumping rates, each step consisting of 30 to 60 minutes of continuous pumping at the prescribed rate. The pumping rates are expected to be up to 200 percent of the designed extraction rate. The pumping rates for each step will be determined by the Contracting Officer. The pumping rate will be measured with a flow meter and an orifice and manometer and controlled with a gate valve. A constant pumping rate shall be maintained for each step. Water level measurements shall be collected with a manual water level meter at the frequency outlined below from the start of each step from the test well.

Elapsed Time (minutes)	Frequency of Measurements (minutes)
1 to 10	1
10 to 30	2
30 to 60	5

6. Measure the pumping rate before collecting each water level measurement. If the pumping rate has decreased or increased from the desired rate of the step, then the pumping rate shall be adjusted and the water level allowed to stabilized before the water level measurement is re-collected and recorded.

7. Plot the data on semi-log paper as the test progresses and deliver the plot to the Contracting Officer at the end of the step-drawdown test. Drawdown data shall be used by the Contractor to calculate the specific capacity of the test well, in accordance with generally accepted practices and methods. Contractor will review report, calculate well capacity, and submit documentation to Contracting Officer.

J. Plumbness and Alignment Testing

The plumbness and alignment test for the extraction wells shall be conducted in the presence of Contracting Officer no sooner than 48 hours after placement of the grout, and prior to development.

The purpose of the alignment test is to demonstrate that the designed pump and shroud can be installed in the well. The alignment test shall consist of slowly lowering a 10 foot length of pipe into the well down to the total depth of the well. The outside diameter of the pipe shall have similar dimensions as the proposed pump shroud, and shall be no more than 2 inches smaller than the inside diameter of the casing/riser pipe. Casing/riser pipe misalignment resulting in failure of the 10 foot length of pipe to pass freely through any part of the entire length of the casing/riser pipe and open bedrock borehole shall be corrected at

no additional cost to the Government. If casing misalignment cannot be corrected, the well will be disapproved by Contracting Officer and replaced at no additional cost to the Government.

The alignment tests shall be documented on the well installation diagram that is described in paragraph 1.12.B Well Installation Diagrams of this specification.

K. Protective Cover Placement

Protective covers for the extraction wells shall be constructed in accordance with the Contract Drawings.

L. Drilling Waste Disposal

In accordance with Well Installation and IDW Management Plan.

M. Well Identification

A corrosion resistant metal tag stamped with the well identification number shall be affixed to the exterior and interior of the protective cover by Contractor.

N. Extraction Pump Selection

Following the well installation and pump capacity testing, the Contractor shall select the five extraction well pumps (EW-1 through EW-5) based on site specific conditions encountered in the field.

Each extraction well shall be equipped with an electrical submersible pump made of stainless steel with polytetrafluoroethylene seals and bearings, made for 4-inch and larger diameter wells. The pumps shall come equipped with a built-in check valve and an estimated minimum 1/3 to 1/2 horsepower (HP) motor depending on location and well depth. Final pump selection shall be based on the results of the Step-Drawdown Test for each well, as outlined in Section 3.02.I.

Contractor shall submit extraction well pump selections including calculations, product data (manufacturer's information, catalog cut sheets, well curves), and shop drawings for approval prior to procurement of the wells.

O. Pump Installation

Pumps shall be installed in accordance with manufacturer's instructions to the depths specified in Supplemental Table 1 Extraction Well Dimensions.

P. Electrical and Control Cables

1. Electrical and control cables shall be installed as shown on the Contract Drawings.

2. Earthwork shall be in accordance with Section 31 23 10 EXCAVATION and Section 31 23 16 BACKFILL AND COMPACTION

3.04 HANDLING OF DEVELOPMENT WATER AND DRILL CUTTINGS

Water removed during development and testing operations, drilling water, and cuttings from the drilling operations shall be containerized in D.O.T approved drums, containers or vessels, and staged in a location approved by Contracting Officer for subsequent disposal in accordance with section 02 81 00 HANDLING, TRANSPORTATION AND DISPOSAL OF WASTE MATERIALS. The Contractor shall have the ability to transport the development water through a hose or pipe up to approximately 700 feet from the well location to reach the drilling waste staging area. Mark each drum or vessel label in accordance with 49 CFR 172 in addition to the following information:

1. Drum number
2. Site name
3. Well name and number
4. Contents and date
5. Approximate depth of material contained in each drum
6. The name and phone number of the person responsible for managing IDW at the Site.

3.05 SURVEYS

Coordinates and elevations for each extraction well (both new extraction wells and existing test well to be converted to an extraction well) shall be established by land surveyor registered in the State of New Jersey retained by Contractor. Horizontal coordinates shall be determined to the closest 0.01 foot and referenced to the New Jersey State Plane Coordinate System, NAD 83. A ground elevation to the closest 0.01 foot shall be obtained at each well. The north side on the top of the casing riser pipe will serve as a measurement point and shall be permanently and clearly marked. The elevation of the well shall reference this point, and shall be surveyed to the nearest 0.01 foot using the National Geodetic Vertical Datum of 1929.

3.06 FIELD QUALITY CONTROL

A. Well Decommissioning/Abandonment

Any extraction well disapproved by Contracting Officer, or any extraction well or piezometer decommissioned/abandoned by the Contractor for any reason, shall be decommissioned/abandoned according to the requirements of the State of New Jersey, ASTM D5299, and the requirements of these Specifications. Well decommissioning/abandonment includes the removal of all materials left in the borehole/well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole/well.

Extraction well boring holes decommissioned/abandoned for any reason shall be grouted from the bottom to within 3 feet of the top of the ground surface. The top 3 feet shall be backfilled with material appropriate for the intended land use. The Contractor shall maintain a well decommissioning/abandonment record as specified in paragraph 1.12.D Well Decommissioning/Abandonment Records and paragraph 3.06.B, below. Groundwater levels, if encountered before the decision is made

for decommissioning/abandonment, shall be measured in all borings prior to backfilling. These water levels shall be included in the well decommissioning/abandonment records. No well or piezometer shall be decommissioned/abandoned without the approval of Contracting Officer.

B. Documentation and Quality Control Reports

Establish and maintain documentation and quality control reports for well construction, development, and testing to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

1. Borehole Logs

Complete a borehole log for each boring drilled. Borehole logs must be prepared by the geologist or engineer present onsite during all well drilling and installation activities. Keep copies of complete well logs current in the field at each well site and make available at all times for inspection by the Contracting Officer. As a minimum, provide the follow information on the logs:

a. Name of the project and site.
b. Boring or well identification number.
c. Location of boring (coordinates, if available).
d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.
e. Date boring was drilled.
f. Reference data for all depth measurements.
g. Name of driller and name and signature of geologist or engineer preparing log.
h. Nominal hole diameter and depth at which hole diameter changes.
i. Total depth of boring.
j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use. If measured, record mud viscosities and weight.
k. Depth of each change of stratum. State if location of strata change is approximate.
l. Depth of any observed fractures, weathered zones, or any abnormalities encountered.
m. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.
n. Submit 3 prints of the graphic boring log prepared to scale showing the required details, within 5 working days after completion of the test well. Use this drawing to aid in determining the well design.

2. Installation Diagrams

The well will not be accepted before the geologic logs and installation diagrams are received. Submit As-built

installation diagram for each well installed, prepared by the geologist or engineer present during well installation operations, within 5 working days of the completion of the well installation procedure. The diagram must illustrate the as-built condition of the well and include, but not be limited to, the following items:

a. Name of the project and site.
b. Well identification number.
c. Name of driller and name and signature of the geologist or engineer preparing diagram.
d. Date of well installation.
e. Description of material from which the well is constructed, including well casing or riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground),if used.
f. Total depth of well.
g. Nominal hole diameter.
h. Depth to top and bottom of screen, and filter pack.
i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).
j. Type of cement and bentonite used, mix ratios of grout, method of placement and quantities used.
k. Elevations, depths, and heights of key features of the well, such as top of well casing or riser pipe, top and bottom of protective casing (if used), ground surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.
l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.
m. Well location by coordinates. Include a plan sheet showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.
n. Static water level upon completion of the well.
o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.
p. Description of surface completion.

3. Extraction Well Development Records

Prepare a well development record for each well, within 5 working days of the completion of development under the supervision of the geologist or engineer present during well installation operations. Include, as a minimum, the following information on the well development record:

a. Date, time, and elevation of water level in the well, before development.

b. Depth to bottom of well, name of project and site, well identification number, and date of development.
c. Method used for development, to include size, type and make of equipment, bailer, and pump used during development.
d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.
e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.
f. Volume of water added to the well, if any.
g. Volume and physical character of sediment removed, to include changes during development in color, and odor.
h. Source of any water added to the well.
i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.
j. Total depth of well and the static water level from top of the casing, immediately after pumping or development, and 24 hours after development.
k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.
l. Name and job title of individual developing well.
m. Name and description of the disposal facility or area, for the waters removed during development.

4. Tests

Prepare and submit a copy of all testing results from the well installation process. Include results of drawdown, well yield,specific capacity, plumbness or alignment, etc. as well as any other test results in this submittal.

3.07 WELL ACCEPTANCE

It is the responsibility of the Contractor to properly construct, install, and develop all wells according to the requirements of this specification so that they are suitable for the intended purpose. If the Contractor installs wells that are not functional or not in accordance with these specifications, Contracting Officer will disapprove the well and direct the Contractor to repair or replace it at no additional cost to the Government, and to abandon any disapproved well that cannot be repaired in accordance with this specification, also at no additional cost to the Government.

3.08 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. Table 1 - Extraction Well Dimensions.

-- End of Section --

SECTION 33 23 00 - SUPPLEMENTAL TABLE 1
EXTRACTION WELL DIMENSIONS

Well ID	Pilot Hole	Screen Model Layer(s)	Estimated Elevation Ground Surface[1,2] (ft AMSL)	Estimated Elevation Top of Casing[1,2] (ft AMSL)	Estimated Elevation Maximum Drawdown Water Level (ft AMSL)	Estimated Depth Bottom of Steel Casing (ft bgs)	Steel Casing Diameter (inches)	Well Diameter (inches)	Depth Bottom of Open Borehole (ft bgs)	Depth Pump Intake[3] (ft bgs)
EW-1		2 - 5	68.8	66.3	59.8	35.0	10	8	150	100
EW-2		2 - 5	71.0	68.5	60.0	35.0	10	8	175	125
EW-3	TW-1	2 - 5	72.8	70.3	60.4	35.0	10	8	200	150
EW-4		2 - 4	70.3	67.8	60.2	35.0	10	8	125	75
EW-5		2 - 4	71.3	68.8	60.2	35.0	10	8	100	50

Notes:

[1] Elevations based on North American Vertical Datum of 1988 (NAVD88).

[2] Ground surface elevations are based upon site land survey.

[3] Depths correspond to "Extraction Well Schedule" on Sheet 5, C-02

AMSL = Above Mean Sea Level
bgs = Below Ground Surface
EW = Extraction Well
ft = Feet
gpm = Gallons per Minute

SECTION 33 51 39

GROUNDWATER OBSERVATION WELLS
08/17

PART 1 GENERAL

1.01 SUMMARY

This section includes the requirement for construction of 2 open bedrock groundwater observation wells (OW; OW-1 and OW-5). In addition, three existing monitoring wells (MW-02A, MW-03 and MW-04) will be converted to serve as observation wells.

The Contractor shall provide all necessary labor, associated materials and equipment, and other facilities and incidentals to drill, install, complete, and develop 2 groundwater observation wells. The wells shall be constructed in general accordance with State of New Jersey and USEPA guidelines, including, but not limited to NJAC 7:9D and EPA 600-4-89-034 and in accordance with the specifications listed below. The requirements of this specification will take precedence for any conflicts between the specifications and regulations and/or guidance.

In addition, Contractor shall remove temporary borehole liners from two existing bedrock boreholes (OBS-1 and OBS-2) and abandon the boreholes in accordance with NJAC 7:9D.

The observation wells are located generally along the northeastern property boundary adjacent to Bound Brook as shown on the Contract Drawings. The total depth and location of the open bedrock interval for each groundwater observation well shall be dependent top of asphalt at the extraction well location, and the elevation of the top of competent bedrock. The OWs shall be located no more than 10 feet from the prescribed locations detailed in in the Contract Drawings unless otherwise directed by the Contracting Officer.

The Contractor shall obtain and use a potable water supply source for the drilling of the observation wells as described in paragraph 2.06 WATER. The observation well surface casing depths and open intervals are presented on the Contract Drawings.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA A100	(2015) Water Wells
AWWA C206	(2017) Field Welding of Steel Water Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2012) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A589/A589M	(2012) Standard Specification for Seamless and Welded Carbon Steel Water-Well Pipe
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D5088	(2015) Decontamination of Field Equipment Used at Nonradioactive Waste Sites
ASTM D5092	(2016) Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers
ASTM D5299	(1999; E 2012; R 2012) Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
ASTM F480	(2014) Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80

NEW JERSEY ADMINISTRATIVE CODE (NJAC)

NJAC 7:9D	(2007) New Jersey Well Construction and Maintenance; Sealing of Abandoned Wells and Applicable NJDEP Guidance Documents

NSF INTERNATIONAL (NSF)

NSF/ANSI 14	(2016a) Plastics Piping System Components and Related Materials

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600-4-89-034	(1990) Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the

following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Permits and Licenses; G

Qualifications; G

SD-03 Product Data

Catalog Data for Indicated Items; G

SD-06 Test Reports

Testing Results; G

SD-07 Certificates

New Jersey Observation Well Registrations

SD-11 Closeout Submittals

Borehole Logs; G

Observation Well Development Records; G

Well Installation Diagrams; G

Monitoring Well Modification Records; G

Well Decommissioning/Abandonment Records; G

1.04 SUBSURFACE CONDITIONS

The observation wells shall be installed in a fractured bedrock aquifer, in general accordance with ASTM D5092. The top of competent bedrock is expected to be between 10 and 13 feet below the ground surface. The water table is expected to be approximately 10 feet below ground surface. Based on the available site data, the subsurface conditions near the proposed well locations consist of approximately 5 to 8 feet of soil and fill and approximately 5 feet of weathered bedrock, underlain by competent siltstones and mudstones of the Passaic Formation. The overburden soils shall be considered a hazardous/TSCA waste unless characterization documents otherwise in accordance with Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE REQUIREMENTS. The bedrock cuttings can be considered non-hazardous unless characterization documents otherwise. Previous well installation activities at the site have been performed in Level D personal protective equipment.

Please note that all unconsolidated (soils) material must be containerized and segregated from all other drill cuttings for separate characterization and disposal. All drilling IDW will be removed from the site prior to the start of other work at the site.

Specific information obtained from the nearby monitoring wells has been used to develop the stratigraphic profile and for well design purposes.

1.05 SYSTEM DESCRIPTION

The open bedrock interval is that portion of a well which is directly open to the fractured bedrock aquifer. Each observation well shall be constructed to the following design depths to allow hydraulic head observations of the extraction system, with open intervals focused on the most transmissive fracture zones of the nearest extraction wells. The construction details are shown on the Contract Drawings and were based on information and observations collected during the installation of the extraction wells. Construction details may change based on conditions encountered in the field.

Well ID	Casing Depth (ft bgs)	Open Interval (ft)	Design Depth (ft bgs)
OW-1	60	20	80
OW-2 (existing	24	25	49
OW-3 (existing MW-03)	17	15	32
OW-4 (existing MW-04)	29	20	49
OW-5	60	20	80

1.06 PERFORMANCE REQUIREMENTS

Each new observation well shall be installed in a manner to prevent aquifer contamination by the drilling operation and equipment. Following well development, observation wells shall meet the performance requirements as specified in Part 3 of this specification.

1.07 WELL INSTALLATION AND IDW MANAGEMENT PLAN

Well installation will be performed in accordance with the Well Installation Plan and IDW Management Plan prepared under Section 33 23 00 GROUNDWATER EXTRACTION WELLS except as noted herein.

1.08 QUALIFICATIONS

Contractor shall provide a geologist or engineer with the appropriate baccalaureate degree from an accredited university with experience in hazardous waste projects, soil and rock logging, quantitative hydrogeology, and groundwater extraction and observation well installation. Contractor's representative shall be on site to provide oversight during the subcontractor's performance of drilling, well installation, and well development activities.

The Contractor's well drilling crew leader will have at least five years of experience drilling water wells with the drilling method being proposed by the Contractor.

1.09 REGULATORY REQUIREMENTS

A. Permits and Licenses

The Contractor shall be a licensed water well contractor in the

State of New Jersey.

Local, state, or federal permits or licenses required to perform the work included in this Contract shall be obtained by the Contractor prior to commencing drilling and well installation operations.

Copies of all permits, licenses, and other requirements necessary for execution of the work shall be furnished to the Contracting Officer prior to mobilization. Before beginning work, Contractor shall notify the NJDEP about the type and location of wells to be constructed, the method of construction, and the anticipated schedule for construction of the wells. A copy of all such correspondence shall be furnished to the Contracting Officer.

B. Statutes and Regulations

Work required by this specification shall be conducted in strict compliance with applicable local, state and federal regulations, statutes, and codes. Compliance shall be the responsibility of the Contractor.

The Contractor shall register each observation well with the State of New Jersey Department of Environmental Protection within 60 days of completion of each well and provide copies of the observation well registrations to Contracting Officer.

When applicable, monitoring well modification records shall be submitted to NJDEP and Contracting Officer.

C. Drill Cuttings

Drill cuttings shall be handled and disposed of in accordance with the IDW Management Plan prepared under Section 33 23 00 GROUNDWATER EXTRACTION WELLS.

1.10 DELIVERY, STORAGE, AND HANDLING

Well materials shall be stored and maintained in a clean, uncontaminated condition throughout the course of the project.

1.11 SITE CONDITIONS, PROTECTION OF EXISTING FACILITIES, AND ENVIRONMENTAL PROTECTION

The Contractor shall be responsible for clearing access restrictions for each observation well site, including any utility clearance. Furthermore, the Contractor shall visit each proposed well location with the Contracting Officer to observe any condition that may hamper transporting equipment or personnel to the site. In the unlikely event that relocation is necessary, the Contractor shall propose a suitable alternative location to the Contracting Officer for approval.

The Contractor shall protect all surface (e.g., paved cap, water tower, all benchmarks, all observation and monitoring wells, perimeter fencing, storm water inlets, etc.) and subsurface structures and surrounding areas from damage during the performance of the Work. The The Contractor shall report and repair any items damaged by the Contractor at no additional cost to the Government. Damage to property shall be repaired or replaced at no additional cost to the

Government to preconstruction conditions. Contracting Officer shall have the right to approve these restoration measures.

Prior to drilling, Contractor shall obtain approval from the local utility companies to drill at each site, to avoid disturbing buried utilities, and shall perform a geophysical survey of the proposed drilling locations to confirm the absence of buried utilities or structures. Contractor shall also obtain approval from the property owner at each site to minimize disturbances.

The Contractor shall take all precautions as may be required to prevent contaminated water or water having undesirable physical or chemical characteristics from entering the target stratum through the well bore or by seepage from the ground surface. The Contractor also shall take all precautions necessary to prevent contamination of the ground surface or of surface waters resulting from drilling of the well.

1.12 DOCUMENTATION AND QUALITY CONTROL REPORTS

Contractor shall establish and maintain documentation and quality control reports for well construction and development to record the desired information and to assure compliance with Government contract requirements. In addition, all forms required by the State of New Jersey for installation of wells shall be completed by the Contractor and returned to the appropriate agency, as well as a copy provided to Contracting Officer. The Contractor shall collect all information necessary to complete the specified documentation and quality control reports. This documentation shall conform to the requirements list in EM 1110-1-4000.

A. Borehole Logs

A borehole log shall be completed by Contractor for each boring drilled. Borehole logs shall be prepared by a qualified geologist or engineer present on site during all well drilling and installation activities. Observation wells shall be logged by means of visual inspection of the drill cuttings. The Contractor shall assist the on-site Contractor geologist or engineer in the performance of the visual inspection and borehole logging efforts.

If the Contractor is required to complete an independent borehole log (based upon the provisions of their well driller's license or for any other reasons), a copy shall also be provided to the Contracting Officer.

B. Well Installation Diagrams

Contractor shall prepare the installation diagrams illustrating the as-built condition of the observation wells.

C. Observation Well Development Records

A well development record shall be prepared by Contractor for each observation well installed.

D. Well Decommissioning/Abandonment Records

If required by the Contracting Officer, the Contractor shall

prepare the decommissioning/abandonment records including, as a minimum, the following:

1. Project name.
2. Well number.
3. Well/boring location, depth and diameter.
4. Date of decommissioning/abandonment.
5. Method of decommissioning/abandonment.
6. All materials used in the decommissioning/abandonment procedure and the interval in which test materials were placed.
7. Casing, and or other items left in hole by depth, description, and composition.
8. Description and total quantity of grout used initially.
9. Description and daily quantities of grout used to compensate for settlement.
10. Water or mud level (specify) prior to grouting and date measured.
11. The reason for decommissioning/abandonment of the well.
12. Notice of Water Well Abandonment form, if applicable.

PART 2 PRODUCTS

2.01 Product Data

Submit catalog data for permanent steel casing, riser pipe, bentonite, cement, centralizers, chemical specifications on drill lubricants, pitless adapters and drop pipe as applicable. Catalog data shall include any information, written or otherwise, supplied by the manufacturers or suppliers of the above listed items.

2.02 WELL CASING

All observation well casing, and other well materials shall be of compatible materials, or incompatible materials shall have dissimilar metal couplings to prevent galvanic reaction between components of the completed well. The observation well casing shall be new, ASTM F480, Type 1, Grade 1, PVC 12454, NSF wc or NSF pw, Schedule 80 pipe, with flush threaded joint fittings. Wrap threaded joints with fluoropolymer tape, and provide with nitrile O-ring gaskets, where appropriate.

Outer casings, where required, shall be standard weight low carbon steel pipe, conforming to ASTM A589/A589M or ASTM A53/A53M grade B, as applicable. observation well casing joints shall be welded in general accordance with AWWA C206, or threaded and coupled in general accordance with AWWA A100.

2.03 CENTRALIZERS

Centralizers shall be constructed of stainless steel.

2.04 CEMENT AND BENTONITE GROUT

Cement grout shall consist of Portland cement conforming to ASTM C150/C150M, Type I or II, sand and water. Proportion cement grout not to exceed 2 parts, by weight, of sand to 1 part of cement with not more than 6 gallons of water per 94 lb bag of Portland

cement, with a mixture of such consistency that the well can be properly grouted. No more than 5 percent by weight of bentonite powder may be added to reduce shrinkage.

Bentonite grout shall consist of a mixture of Portland cement conforming to ASTM C150/C150M Type I or II, high grade bentonite powder and water. The grout mix shall contain no more than 5.3 percent bentonite by weight of cement. According to the NJDEP regulations concerning water well construction (NJAC 7:9D-2.9 and 2.10), cement/bentonite grout slurry must consist of a mixture of cement and bentonite in the following proportion: not more than 8.3 gallons of water and 5.0 pounds of bentonite per 94-pound sack of Portland cement with a target density of 13.9 lbs/gallon and an acceptable density ranging from 13.4 to 14.5 lbs/gallon.

2.05 SURFACE COMPLETION

In accordance with Section 33 05 13, MANHOLES, VAULTS, AND COVERS.

2.06 LUBRICANTS

Tool joint and other lubricants used during drilling operations shall contain no petroleum products.

2.07 WATER

The Contractor shall be responsible for obtaining water from a potable supply and for transporting it to the site, and storing it where needed.

2.08 REMOVABLE WATER LEVEL MEASUREMENT TUBE

The water level measurement tube shall be new, 2-inch nominal internal diameter, schedule 40 flush-joint threaded ASTM D1785 polyvinyl chloride (PVC) pipe, to protect the transducer. This pipe shall also meet the requirements of NSF/ANSI 14. The water level measurement tube screen shall extend 20 feet below the static water level in the well. See paragraph 3.02.G for additional information. A PVC non-locking cap, that threads or slips onto the top of the water level tube shall be provided.

2.09 WELL CONTROLS

Each observation well shall be equipped with a pressure transducer and associated and control cables as specified in Section 25 01 00, MASTER CONTROL SYSTEM.

A. Pressure Transducers

Pressure transducers will be non-vented, waterproof, and externally powered and will be design-capable of sustaining the range of pressures anticipated in the water column. The emplacement depth will be sufficient to capture the range of anticipated drawdown in the aquifer. Transducers capable of collecting temperature measurements, in addition to pressure readings, are acceptable but not required.

PART 3 EXECUTION

Notify the Contracting Officer at least 15 days prior to commencement of work. Well locations and coordinates are as indicated on the Contract Drawings. Drilling, installation, and development of the monitoring wells is supervised, directed, and monitored by the Contractor's geologist or engineer in charge.

3.01 DECONTAMINATION BEFORE DRILLING

The drill rig, drill rods, drill bits, temporary casing (if required), permanent casing (if required), well developing equipment, tremie pipes, grout pumping lines, and other associated equipment shall be cleaned with high-pressure hot water/steam prior to drilling at each well location. Decontamination shall be done in accordance with ASTM D5088. Decontamination shall be performed at a location away from the observation wells in a location approved by the Contracting Officer. Well casing shall be cleaned with high-pressure hot water/steam immediately prior to installation in the well. The use of factory sealed (plastic wrapped) well casing does not waive this requirement for pre-installation cleaning. The water used for cleaning shall be in accordance with paragraph 2.06 WATER.

3.02 INSTALLATION

A. Drilling Method

The borehole for the wells shall be advanced by air rotary or reverse hydraulic rotary methods. Any drilling fluid shall be contained in a prefabricated steel mud pit or a roll-off during drilling. The Contractor shall provide the details of their proposed drilling method and fluid containment in the Well Installation and IDW Management Plans.

The drill rig(s) shall be free from leaks of fuel, hydraulic fluid, and oil, which may contaminate the borehole, ground surface or drill tools. During construction of the wells, precautions shall be used to prevent tampering with the well or borehole or entrance of foreign material. Runoff shall be prevented from entering the well or borehole during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, the well or borehole opening shall be closed with a watertight uncontaminated cover. The cover shall be secured in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

B. Geologic Sampling

Drill cuttings shall be logged by the Contractor's geologist or engineer.

C. Borehole Diameter and Depth

The unconsolidated overburden shall be cased with a 6-inch inner diameter (minimum) steel casing, such that the drilling of the 6-inch borehole into competent rock shall not be impeded. The bedrock boreholes for the observation wells shall have a minimum diameter of 6 inches, and the open portion of the borehole shall

have a minimum diameter of 2 inches. Estimated total depths are provided in the table in paragraph 1.05 of this Specification, and dimensions provided in Table 1 - Observation Well Dimensions. Table 1 is appended to the end of this section. Final depths will be based on data collected during the Extraction Well installation and hydraulic testing, analyzed by Contractor, and approved by the Government.

D. Setting Outer Casing

The outer casing must not be less than 6 inches inner diameter. The hole must be of sufficient size to leave a concentric annular space of not less than 2 inches and not more than 6 inches between the outside of the outer casing and the walls of the hole. Fill the annular space between the outer casing and the walls of the holes with cement grout in accordance with paragraph 2.03 CEMENT AND BENTONITE GROUT. Acceptable methods of grouting are detailed in AWWA A100; select a method specifying the forcing of grout from the bottom of the space to be grouted towards the surface in accordance with paragraph 3.02.F Cement and Bentonite Grout Placement. Provide a suitable grout retainer, packer, or plug at the bottom of the outer casing so that grout will not leak into the bottom of the well. Continuously grout to ensure that the entire annular space is filled in one operation. After grouting is completed, do not resume drilling operations for at least 24 hours to allow proper setting of the grout.

E. Inner Casing/Riser Pipe Placement

A well casing will be installed in the upper 20 feet of the well to prevent contaminated overburden soils from entering the well. When PVC well casing pipe is installed it shall be accomplished in a manner such that injury to the well casing pipe does not result which may affect the quality of the water supply. Steel well casing pipe shall be assembled watertight by correctly mated, recessed type couplings having the proper weights and diameters or by means of joints welded. No other means of assembly may be used without approval.

Fill the annular space between the inner casing and the walls of the holes with cement grout in accordance with paragraph 2.03 CEMENT AND BENTONITE GROUT. Acceptable methods of grouting are detailed in AWWA A100; select a method specifying the forcing of grout from the bottom of the space to be grouted towards the surface in accordance with paragraph 3.02.F Cement and Bentonite Grout Placement. Provide a suitable grout retainer, packer, or plug at the bottom of the inner casing so that grout will not leak into the bottom of the well. Continuously grout to ensure that the entire annular space is filled in one operation. After grouting is completed, do not resume drilling operations for at least 24 hours to allow proper setting of the grout.

The 2-inch PVC casing/riser pipe shall extend upwards to an appropriate elevation and surface completion described in paragraph 2.04 SURFACE COMPLETION. The riser pipe shall not be dropped or allowed to fall uncontrolled into the borehole. The well shall be plumb, and centered in the hole by the use of steel centralizers. Observation well centralizers shall be located 10 feet below the ground surface and near the bottom of the casing.

F. Cement and Bentonite Grout Placement

In the observation wells, cement and bentonite grout shall be placed using a side-discharging tremie pipe having an inside nominal diameter of not less than 1 inch. The grout shall be permitted to set for a minimum of 24 hours. The grout seal shall be placed in a manner which completely fills the annular space, and prevents bridging and collapse of the borehole wall against the well casing. Additional grout shall be added from the surface to maintain the level of the grout as settlement occurs. Temporary overburden drill casing, if installed, shall be removed simultaneously with the above operation. Lifting of the riser pipe shall be minimized when withdrawing the temporary casing.

G. Well Development

Within 10 days of completion of each well, but no sooner than 48 hours after cement grouting is completed, and after Contractor has obtained approval from Contracting Officer to begin development, the observation wells shall be developed by the Contractor.

The Contractor shall develop the observation well by surging (air or fluid/mechanical), bailing, intermittent pumping, or other methods approved by Contracting Officer in Well Installation and IDW Management Plan (refer to Section 33 23 00 GROUNDWATER EXTRACTION WELLS) as may be necessary to give the maximum yield of water per foot of drawdown and until the discharge yields sediment-free water (100 NTU, not to exceed 8 hours of pumping per well). The Contractor shall furnish, install, or construct the necessary discharge line to conduct, containerize, and subsequently characterize and dispose of the discharge.

Development shall be performed using a minimum of 5 cycles of agitation and pumping. Agitation may include surging or jetting as described below or other methods approved by Contracting Officer. Pumping may include the use of a submersible pump, bailer, or air lift pump or other methods approved by Contracting Officer. Intermittent pumping, consisting of rapidly drawing down the water level, and allowing the water level to rise, and repeating the process, may be used during the pumping portion of the cycle. Contracting Officer may require a change in method if the method selected does not accomplish the desired results.

Development is complete when all the following conditions are achieved:

1. Water is clear to the unaided eye.

2. Sediment thickness in the well is less than 0.1 foot

3. Turbidity, pH, and sand content shall be measured before, twice during, and after development operations. Nephelometric turbidity shall be less than 20 NTU.

4. A minimum of three times the standing water volume in the casing plus three times the drilling fluid used or lost in the boring has been removed.

Contracting Officer may require other means of developing the well such as an intermittent pumping method, a variation of the intermittent pumping method, or use of a surge block if it appears that the development of the well is not producing the desired results. Changes to the well development procedures identified in the Well Installation and IDW Management Plan shall be approved by Contracting Officer.

Surging of the well shall require the use of a circular block which is approximately 1 inch smaller in diameter than the inside diameter of the observation well, has rubber gaskets approximately equal to the inside diameter of the borehole, and a bailer or pump to remove materials drawn into the well. The surging shall be continued until little or no additional material from the formation can be seen in the discharge. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be removed from inside the well. All materials pulled into the well by the surging process shall be removed. Contracting Officer shall not permit air surging unless Contractor demonstrates the ability to containerize all discharge for proper characterization and disposal.

A development record shall be maintained by Contractor. At completion of well development, approximately 1 pint of well water shall be collected in a clear glass jar. The jar shall be labeled with project name, well number and date; and photographed using a digital camera. The photograph shall be a suitably backlit close-up which shows the clarity of the water and any suspended sediment. The photograph (or electronic file) shall become a part of the well development record.

H. Flush-Mount Handhole Emplacement

The pre-cast polymer concrete traffic rated handhole shall be installed/constructed in accordance with the Contract Drawings.

I. Protective Cover Placement

Water tight, traffic-rated protective covers for the observation wells shall be constructed in accordance with the Contract Drawings and with Section 33 05 13, MANHOLES, VAULTS, AND COVERS. Provide a locking well cap on top of the well casing, which terminates inside the vault as indicated.

J. Site Clean-up

After completion of the work, remove tools, appliances, surplus materials, temporary drainage, rubbish, and debris incidental to work. Repair or replace utilities, structures, roads, fences, pavement, or any other pre-existing item damaged due to the Contractor's negligence; this must be accomplished prior to completion of this contract.

K. Drilling Waste Disposal

In accordance with the IDW Management Plan (refer to Section 33 23 00 GROUNDWATER EXTRACTION WELLS).

L. Well Identification

A corrosion resistant metal tag stamped with the well identification number shall be affixed to the exterior and interior of the protective cover by Contractor.

M. Pressure Transducers

Pressure transducers shall be installed in accordance with manufacturer's instructions.

N. Control Cables

1. Control cables shall be installed as shown on the Contract Drawings.

2. Earthwork shall be in accordance with Section 31 23 10 EXCAVATION and Section 31 23 16 BACKFILL AND COMPACTION.

3.03 HANDLING OF DEVELOPMENT WATER AND DRILL CUTTINGS

Water removed during development operations, drilling water, and cuttings from the drilling operations shall be containerized in D.O.T approved drums, containers or vessels, and staged in a location approved by Contracting Officer for subsequent disposal in accordance with section 02 81 00 HANDLING, TRANSPORTATION AND DISPOSAL OF WASTE MATERIALS and the IDW Management Plan.

The Contractor shall have the ability to transport the development water through a hose or pipe up to approximately 700 feet from the well location to reach the drilling waste staging area. Mark each drum or vessel label in accordance with 49 CFR 172 in addition to the following information:

A. Drum number

B. Site name

C. Well name and number

D. Contents and date

E. Approximate depth of material contained in each drum

F. The name and phone number of the person responsible for managing IDW at the Site.

3.04 SURVEYS

Coordinates and elevations shall be established by a land surveyor registered in the State of New Jersey retained by Contractor for each observation well (both the new observation wells and the existing monitoring wells that are converted to monitoring wells). Horizontal coordinates shall be determined to the closest 0.01 foot and referenced to the New Jersey State Plane Coordinate System, NAD 83. A ground elevation to the closest 0.01 foot shall be obtained at each well. The north side on the top of the casing riser pipe will serve as a measurement point and shall be permanently and clearly marked.

The elevation of the well shall reference this point, and shall be surveyed to the nearest 0.01 foot using the National Geodetic Vertical Datum of 1929.

3.05 FIELD QUALITY CONTROL

A. Well Decommissioning/Abandonment

Any observation well disapproved by Contracting Officer, or any well decommissioned/ abandoned by the Contractor for any reason, shall be decommissioned/ abandoned according to the requirements of the State of New Jersey, ASTM D5299, and the requirements of these specifications. Well decommissioning/abandonment includes the removal of all materials left in the borehole/well, excluding the filter pack, and including backfill materials, casing, screen, and any other material placed into the hole before the decision was made to abandon the borehole/well.

Observation well boring holes decommissioned/abandoned for any reason shall be grouted from the bottom to within 3 feet of the top of the ground surface. The top 3 feet shall be backfilled with material appropriate for the intended land use. The Contractor shall maintain well decommissioning/abandonment records as specified in paragraphs 1.12.D Well Decommissioning/Abandonment Records and 3.05.B, below. Groundwater levels, if encountered before the decision is made for decommissioning/abandonment, shall be measured in all borings prior to backfilling. These water levels shall be included in the well decommissioning/abandonment records. No well or piezometer shall be decommissioned/abandoned without the approval of Contracting Officer.

B. Documentation and Quality Control Reports

Establish and maintain documentation and quality control reports for well construction, development, and testing to record the desired information and to assure compliance with contract requirements, including, but not limited to, the following:

1. Borehole Logs

Complete a borehole log for each boring drilled. Borehole logs must be prepared by the geologist or engineer present onsite during all well drilling and installation activities. Keep copies of complete well logs current in the field at each well site and make available at all times for inspection by the Contracting Officer. As a minimum, provide the follow information on the logs:

a. Name of the project and site.
b. Boring or well identification number.
c. Location of boring (coordinates, if available).
d. Make and manufacturer's model designation of drilling equipment and name of drilling firm.
e. Date boring was drilled.
f. Reference data for all depth measurements.
g. Name of driller and name and signature of geologist or engineer preparing log.
h. Nominal hole diameter and depth at which hole

diameter changes.

i. Total depth of boring.
j. Method of drilling, including sampling methods and sample depths, including those attempted with no recovery. Include a description of any temporary casing used, drill fluids and fluid additives used, if any, including brand name and amount used, along with the reason for and start (by depth) of its use. If measured, record mud viscosities and weight.
k. Depth of each change of stratum. State if location of strata change is approximate.
l. Depth of any observed fractures, weathered zones, or any abnormalities encountered.
m. Depth and estimated percent of drill fluid loss or lost circulation. Measures taken to regain drill water circulation. Significant color changes in the drilling fluid return.
n. Submit 3 prints of the graphic boring log prepared to scale showing the required details, within 5 working days after completion of the test well. Use this drawing to aid in determining the well design.

2. Installation Diagrams

The well will not be accepted before the geologic logs and installation diagrams are received. Submit As-built installation diagram for each well installed, prepared by the geologist or engineer present during well installation operations, within 5 working days of the completion of the well installation procedure. The diagram must illustrate the as-built condition of the well and include, but not be limited to, the following items:

a. Name of the project and site.
b. Well identification number.
c. Name of driller and name and signature of the geologist or engineer preparing diagram.
d. Date of well installation.
e. Description of material from which the well is constructed, including well casing or riser pipe and screen material, centralizer composition, if used, diameter and schedule of casing and screen, gradation of filter pack, lithologic description, brand name (if any), source, and processing method, and method of placement of the filter pack, bentonite seal type (pellets, granules, chips, or slurry), grout type (cement or high-solids bentonite) and type of protective cover (protective casing or flush-to-ground),if used.
f. Total depth of well.
g. Nominal hole diameter.
h. Depth to top and bottom of screen, and filter pack.
i. Depth to top and bottom of any seals installed in the well boring (grout or bentonite).
j. Type of cement and bentonite used, mix ratios of grout, method of placement and quantities used.
k. Elevations, depths, and heights of key features of the well, such as top of well casing or riser pipe, top and bottom of protective casing (if used), ground

surface, the depth of maximum frost penetration (frost line), bottom of well screen, top and bottom of filter pack, and top and bottom of seal.

l. Other pertinent construction details, such as slot size and percent open area of screen, type of screen, and manufacturer of screen.
m. Well location by coordinates. Include a plan sheet showing the coordinate system used and the location of each well. A plan sheet is not required for each well installation diagram; multiple wells may be shown on the same sheet.
n. Static water level upon completion of the well.
o. Special problems and their resolutions; e.g., grout in wells, lost casing, or screens, bridging, etc.
p. Description of surface completion.

3. Observation Well Development Records

Prepare a well development record for each well, within 5 working days of the completion of development under the supervision of the geologist or engineer present during well installation operations. Include, as a minimum, the following information on the well development record:

a. Date, time, and elevation of water level in the well, before development.
b. Depth to bottom of well, name of project and site, well identification number, and date of development.
c. Method used for development, to include size, type and make of equipment, bailer, and pump used during development.
d. Time spent developing the well by each method, to include typical pumping rate, if pump is used in development.
e. Volume and physical character of water removed, to include changes during development in clarity, color, particulates, and odor.
f. Volume of water added to the well, if any.
g. Volume and physical character of sediment removed, to include changes during development in color, and odor.
h. Source of any water added to the well.
i. Clarity of water before, during, and after development. Nephelometric turbidity unit (NTU) measurements.
j. Total depth of well and the static water level from top of the casing, immediately after pumping or development, and 24 hours after development.
k. Readings of pH, specific conductance, DO, ORP, and temperature taken before, during, and after development.
l. Name and job title of individual developing well.
m. Name and description of the disposal facility or area, for the waters removed during development.

4. Tests

Prepare and submit a copy of all testing results from the well installation process. Include results of drawdown, well yield, specific capacity, etc. as well as any other test

results in this submittal.

3.06 WELL ACCEPTANCE

It is the responsibility of the Contractor to properly construct, install, and develop all wells according to the requirements of this Specification so that they are suitable for the intended purpose. If the Contractor installs wells that are not functional or not in accordance with these specifications, Contracting Officer will disapprove the well and direct the Contractor to repair or replace it at no additional cost to the Government, and to abandon any disapproved well that cannot be repaired in accordance with this Specification and at no additional cost to the Government.

3.07 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification:

1. Table 1 - Observation Well Dimension.

-- End of Section --

SECTION 33 51 39 - SUPPLEMENTAL TABLE 1
OBSERVATION WELL DIMENSIONS

Well ID	Notes	Estimated Elevation Ground Surface[1,2] (ft AMSL)	Estimated Elevation Top of Casing[1,2] (ft AMSL)	Estimated Depth Bottom of Steel Casing (ft bgs)	Steel Casing Diameter (inches)	Well Diameter (inches)	Depth Bottom of Open Borehole (ft bgs)
OW-1		69.9	68.4	60.0	6	2	80
OW-2	Existing MW-02A	70.4	68.9	24.0	2	2	49
OW-3	Existing MW-03	71.5	70.0	17.0	2	2	32
OW-4	Existing MW-04	73.9	72.4	29.0	2	2	49
OW-5		71.8	70.3	60.0	6	2	80

Notes:
[1] Elevations based on North American Vertical Datum of 1988 (NAVD88).
[2] Ground surface elevations are based upon site land survey.
[3] Depths correspond to "Extraction Well Schedule" on Sheet 5, C-02

AMSL = Above Mean Sea Level
bgs = Below Ground Surface
ft = Feet
gpm = Gallons per Minute
MW = Monitoring Well
OW = Observation Well

SECTION 33 71 73

ELECTRICAL UTILITY SERVICES
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Division 26 Electrical.

1.02 SUMMARY

A. This section includes coordination with Utility Company for relocation of existing overhead power distribution to underground conduit and installation of new electrical service; payment of Utility Company service charges; service provisions; and utility meter.

1.03 SYSTEM DESCRIPTION

A. Utility Company: PSE&G, New Jersey.

B. System Characteristics: 480/277V Secondary, three phase, four-wire, 60 Hertz.

C. Underground Service Provisions:

1. Utility Raceway Connections: At Utility Company's pad-mounted transformer.

2. Utility Service-Entrance Conductor Connection: At Utility Company's service-entrance and metering equipment.

1.04 FIELD MEASUREMENTS

A. All measurements shall be field verified and coordinated with all trades prior to any site work.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

PSE&G Prepared Drawings Of Equipment; G

1.06 QUALITY ASSURANCE

A. Work under this section shall be performed in accordance with

Utility Company requirements.

B. Maintain one copy of each document on site.

C. PSE&G prepared drawings of equipment

PART 2 PRODUCTS

2.01 UTILITY METER

A. Meter to be furnished by PSE&G.

2.02 METER HOUSING

A. Meter housing shall be furnished by Contractor per PSE&G requirements.

2.03 CURRENT TRANSFORMER CABINET

A. CT Cabinet shall be furnished by Contractor per PSE&G requirements.

B. Connection between the utility meter and the service disconnect switch shall be furnished by the Contractor in coordination with PSE&G requirements.

2.04 TRANSFORMER PAD

A. Transformer Pad shall be provided by the Contractor in coordination with PSE&G requirements.

B. Location of Transformer Pad shall be coordinated with Contracting Officer.

2.05 TRANSFORMER

A. Medium voltage Transformer (150 KVA, 4kV-480Y/277V, 3Ph, 4W) will be furnished and installed by PSE&G.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify service equipment is ready to be connected and energized.

3.02 INSTALLATION

A. All material and equipment shall be installed in a neat and workmanlike manner.

B. Install service entrance conduit from pad-mounted utility transformer to building service entrance disconnect. PSE&G will connect service lateral conductors to utility transformer.

-- End of Section --

SECTION 33 79 00

SITE IMPROVEMENT GROUNDING
09/17

PART 1 GENERAL

1.01 SUMMARY

A. This section includes electrodes, connectors, conductors, grounding wells, and treatment wells.

1.02 RELATED DOCUMENTS

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

B. Division 26 Electrical

1.03 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer Qualifications; G

SD-02 Shop Drawings

Grounding And Installation Details; G, AE

SD-03 Product Data

Grounding Electrodes And Connectors; G, AE

SD-06 Test Reports

Test Reports; G, AE

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

SD-11 Closeout Submittals

Project Record Documents; G

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Products: Finish products listed and classified by Underwriters Laboratories Inc., as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 MATERIALS

A. Rod Electrodes: Chemical Rod.

1. Diameter: 3/4 inch.

2. Length: 10 feet (1.5 m).

B. Exothermic Connections.

C. Wire: Stranded Copper:

1. For Horizontal Electrodes: 4/0 AWG, minimum size.

2. For Connections to Electrodes: 3/0 AWG, minimum size.

3. For Bonding other objects: 2/0 AWG, minimum size.

4. Mechanical Connectors: Bronze.

2.02 PRODUCT INFORMATION

Submit the following product information:

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

B. Product Data: Provide for grounding electrodes and connectors.

C. Shop Drawings: Indicate layout of grounding and installation details.

D. Test Reports: Indicate overall resistance to ground at each system.

E. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation and installation of exothermic connectors.

F. Project Record Documents: Locations of electrodes and connections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify completion of filling and backfilling before beginning grounding work.

B. Verify that trenching is completed before installing horizontal electrodes.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 45 00 - CONTRACTOR QUALITY CONTROL.

B. Make final grounding systems measurements three or four days after chemical treatment.

C. Test Procedures: IEEE 142, fall of potential method.

3.03 CLOSEOUT ACTIVITIES

A. Demonstrate to facility operation and maintenance personnel the location of each accessible grounding connection.

-- End of Section --

SECTION 33 80 00

COMMUNICATION UTILITIES
09/17

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Division 26 Electrical

C. Division 27 Communications

1.02 SUMMARY

A. This section includes conduit, ducts, duct accessories for direct-buried and concrete-encased duct banks, handholes and boxes, and manholes.

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1037	(2016) Standard Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM C858	(2010; E 2012) Standard Specification for Underground Precast Concrete Utility Structures

1.04 DEFINITIONS

A. RNC: Rigid Nonmetallic Conduit.

1.05 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Data: For Professional Engineering And Testing Agency; G

SD-02 Shop Drawings

Duct-Bank Coordination Drawings; G

Precast Or Factory-Fabricated Underground Utility Structures; G

Factory-Fabricated Handholes And Boxes Other Than Precast Concrete; G

SD-03 Product Data

Product Data For Indicated Products; G

SD-06 Test Reports

Field Quality-Control Test Reports; G

Source Quality-Control Test Reports; G

SD-07 Certificates

Concrete And Steel; G, AE

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to the Project Site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project Site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Contracting Officer no fewer than 7 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Contracting Officer's written permission.

B. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

PART 2 PRODUCTS

2.01 CONDUIT

Rigid Steel Conduit: Galvanized.

2.02 SOURCE QUALITY CONTROL

Test and inspect precast concrete utility structures according to ASTM C1037.

2.03 PRODUCT INFORMATION

Submit the following product information:

A. Product data, including but not limited to the following:

1. Duct-bank materials, including separators and miscellaneous components.

2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.

3. Accessories for manholes, handholes, boxes, and other utility structures.

4. Warning tape.

5. Warning planks.

B. Shop drawings for precast or factory-fabricated underground utility structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Reinforcement details.

3. Frame and cover design and manhole frame support rings.

4. Ladder details.

5. Grounding details.

6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.

7. Joint details.

C. Shop Drawings for factory-fabricated handholes and boxes other than precast concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.

2. Cover design.

3. Grounding details.

4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Informational Submittals

1. Duct-Bank coordination drawings: show duct profiles and coordination with other utilities and underground structures.

   a. Include plans and sections, draw to scale, and show bends and locations of expansion fittings.
   b. Drawings shall be signed and sealed by a qualified professional engineer.

2. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

3. Qualification Data: For professional engineering and testing agency.

4. Source quality-control test reports.

5. Field quality-control test reports.

PART 3 EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

A. Underground ducts for telephone, communications, or data utility service cables: PVC schedule 40 conduit. Locate communication duct at least 12-inches away from other utilities.

3.02 UNDERGROUND ENCLOSURE APPLICATION

Handholes and Boxes for 600V and less: Use precast concrete for units in roadways and other deliberate traffic paths.

3.03 EARTHWORK

A. Restore surface at disturbed areas and reestablish original grades unless otherwise indicated. Refer to Division 31 EARTHWORK and Division 32 ASPHALT PAVING for additional information and requirements.

3.04 GROUNDING

Ground underground ducts and utility structures in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

3.05 FIELD QUALITY CONTROL

A. Test and Inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

B. Correct deficiencies and retest as specified above to demonstrate

compliance.

-- End of Section --

DIVISION 40 – PROCESS INTERCONNECTIONS

SECTION 40 05 15

PIPING SUPPORT SYSTEMS
09/17

PART 1 GENERAL

1.01 DEFINITIONS

Wetted or submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.02 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B31.1	(2016; Errata 2016) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Revisions To Support Systems; G

Each Support, Sway Brace, Seismic Brace, Hanger, Guide, Component, And Anchor For All Piping 2 Inches And Larger; G

SD-03 Product Data

Piping Support System; G

SD-10 Operation and Maintenance Data

Maintenance Information; G

1.04 DESIGN REQUIREMENTS

A. General

1. Design, size, and locate piping support systems throughout facility, whether shown or not.

2. Piping smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

3. Meet requirements of MSS SP-58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.

2. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP-58 Table 3 and Table 4.

a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.

b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

C. Anchoring Devices

Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing

10 foot maximum centers or as shown.

PART 2 PRODUCTS

2.01 GENERAL

When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated. Special support and hanger details may be required for cases where standard catalog supports are not available. Materials shall be 305 Stainless Steel or FRP, no exceptions, for indoor areas.

2.02 HANGERS

A. Clevis: MSS SP-58, Type 1:

1. Anvil; Figure 260 for steel pipe and Figure 590 for

ductile-iron pipe, sizes 1/2 inch through 30 inches.
2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
3. B Line; Figure B3100, sizes 1/2 inch through 30 inches.
4. Or approved equal.

B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP-58, Type 6:

1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
2. B Line; Figure B3171, sizes 3/4 inch through 8 inches.
3. Or approved equal.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket: MSS SP-58, Type 33 (heavy-duty):

1. Anvil; Figure 199, 3,000 pound rating.
2. B Line; Figure B3067, 3,000 pound rating.
3. Or approved equal.

B. Adjustable "J" Hanger: MSS SP-58, Type 5:

1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
2. B Line; Figure B3690, sizes 1/2 inch through 8 inches.
3. Or approved equal.

C. Offset Pipe Clamp

1. Anvil; Figure 103, sizes 3/4 inch through 8 inches.
2. Or approved equal.

D. Channel Type

1. Unistrut.
2. Anvil; Power-Strut.
3. B Line; Strut System.
4. Aickinstrut (FRP).
5. Or approved equal.

2.04 PIPE SADDLES

A. Saddles

1. Provide 90 degree to 120 degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type

1. Adjustable Saddle: MSS SP-58, Type 38 without clamp.

a. Anvil; Figure 264, sizes 2 1/2 inches through 36 inches with Figure 62C base.
b. B Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.
c. Or approved equal.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size

12 gauge, 1 5/8 inch wide minimum steel, or 1 1/2 inch wide, minimum FRP.

B. Members and Connections

Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners

Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products

1. B Line; Strut System.
2. Unistrut.
3. Anvil; Power-Strut.
4. Aickinstrut (FRP System).
5. Enduro-Durostrut (FRP Systems).
6. Or approved equal.

2.06 FRP PIPE SUPPORT SYSTEMS

A. General

1. FRP with UV additive, protective veil, and vinyl ester resins resistent to chemicals.

2. Fire Retardant: ASTM E84.

3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers

1. Factor of Safety: 3 to 1.

2. Minimum Design Load: 200 pounds.

C. Design

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.

2. Identify and highlight non-FRP fasteners or components in Shop Drawing.

D. Manufacturers

1. Aickinstrut.
2. Enduro.
3. Century Composite.
4. Or approved equal.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP-58, Type 8

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B Line; Figure B3373, sizes 1/2 inch through 30 inches.
3. Or approved equal.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow and Adjustable Stanchion

Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow and Nonadjustable Stanchion

Sizes 2 1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base

Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Hold Down Pipe Guide

B Line(Manufacturer); Figure B3552, 1 1/2 inches through 30 inches.

B. U-bolts: MSS SP 58, Type 24

1. U bolts with double nuts to provide nominal 1/8 inch to 1/4 inch clearance around pipe.
2. Anvil; Figure 137 and Figure 137S.
3. B Line; Figure B3188 and Figure B3188NS.
4. Or approved equal.

2.10 PIPE ALIGNMENT GUIDES

A. Spider Type Guide

1. Manufacturers and Products

1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
2. B Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.
3. Or approved equal.

2.11 ACCESSORIES

A. Anchor Bolts

1. Size and Material: 1/2 inch minimum diameter, and as specified in Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS .

2. Bolt Length (Extension Above Top of Nut):

a. Minimum Length: Flush with top of nut preferred. If not

flush, shall be no more than one thread recessed below top of nut.

b. Maximum Length: No more than a full nut depth above top of nut.

B. Dielectric Barriers

1. Plastic coated hangers, isolation cushion, or tape.

2. Manufacturer and Products:

a. B Line; B1999 Vibra Cushion.
b. B Line; Iso Pipe, Isolation Tape.
c. Or approved equal.

C. Insulation Shields

1. Type: Galvanized steel or stainless steel, MSS SP-58, Type 40.

2. Manufacturers and Products:

a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
b. B Line; Figure B3151, sizes 1/2 inch through 24 inches.
c. Or approved equal.

D. Plastic Pipe Support Channel

1. Type: Continuous support for plastic pipe and to increase support spacing.

2. Manufacturer and Product: B Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger or approved equal.

E. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles

In accordance with MSS SP-58.

F. Attachments

1. Concrete Insert: MSS SP-58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2. U Channel Concrete Inserts: As specified in Section 05 50 13, Miscellaneous Metal Fabrications .

3. Concrete Attachment Plates:

a. Anvil; Figure 47, Figure 49, or Figure 52.
b. B Line; Figure B3084, Figure B3085, or Figure B3086.
c. Or approved equal.

2.12 PRODUCT INFORMATION

Submit the following product information for selected equipment:

A. Catalog information and drawings of piping support system,

locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for all piping 2 inches and larger. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

B. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

C. Maintenance information for piping support systems.

PART 3 EXECUTION

3.01 INSTALLATION

A. General

1. Install support systems in accordance with MSS SP-58, unless shown otherwise.

2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, startup or operations.

3. Support piping connections to equipment by pipe support and not by equipment.

4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

5. Support no pipe from pipe above it.

6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

7. Do not use adhesive anchors for attachment of supports to walls.

8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.

10. Install lateral supports for seismic loads at changes in direction.

11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports

1. Horizontal Piping Supported from Walls:

a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.

b. Stacked Piping: Wall mounted framing system and "J" hangers acceptable for pipe smaller than 3 inch.

c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

2. Horizontal Piping Supported from Floors:

a. Saddle Supports:

1) Pedestal Type, elbow and flange.
2) Provide minimum 1 1/2 inch grout beneath baseplate.

b. Floor Mounted Channel Supports:

1) Use for pipe smaller than 3 inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
2) Attach channel framing to floors with baseplate on minimum 1 1/2 inch nonshrink grout and with anchor bolts.
3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

3. Insulated Pipe:

a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.

b. Provide precut 120 degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).

c. Wall-mounted pipe clips not acceptable for insulated piping.

4. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments

Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.

D. Intermediate and Pipe Alignment Guides

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.

2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.

3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

E. Accessories

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.

2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.

3. Dielectric Barrier:

a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.

b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, PAINTING AND COATING.

-- End of Section --

SECTION 40 27 00

PROCESS PIPING - GENERAL
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B36.10M	(2015; Errata 2016) Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A240/A240M	(2016) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes

1.02 DELIVERY, STORAGE, AND HANDLING

In accordance with 01 61 00, COMMON PRODUCT REQUIREMENTS, and the following:

A. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.

B. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.

C. Linings and Coatings: Prevent excessive drying.

D. Cold Weather Storage: Locate products to prevent coating from freezing to ground.

E. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 PIPING

A. As specified on Piping Data Sheet(s) located at the end of this section as Supplements.

B. Diameters Shown:

1. Standardized Products: Nominal size.

2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.

3. Cement-Lined Steel Pipe: Lining inside diameter.

2.02 JOINTS

A. Flanged Joints

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.

2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

B. Threaded Joints

NPT taper pipe threads in accordance with ASME B1.20.1.

C. Flexible Mechanical Compression Joint Coupling

1. Stainless steel, ASTM A276/A276M, Type 305 bands.

2. Manufacturers:

a. Pipeline Products Corp.
b. Fernco Joint Sealer Co.
c. Or approved equal.

D. Mechanical Connections

Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:

1. A polyethylene stub end thermally butt-fused to end of pipe.

2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125 pound, ASME B16.1 standard. Use insulating flanges where shown.

3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.

4. Gaskets as specified on the attached Piping and Fitting Data

Sheet.

2.03 PIPE CORROSION PROTECTION

A. Heat Shrink Wrap

1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.

2. Manufacturer and Product: Raychem; WPC or TPS or approved equal.

2.04 VENT AND DRAIN VALVES

A. Pipeline 2 Inch Diameter and Smaller: 1/2 inch vent, 1 inch drain, unless shown otherwise.

B. Pipelines 2 1/2 Inch Diameter and Larger: 3/4 inch vent, 1 inch drain unless shown otherwise.

2.05 FINISHES

A. Galvanizing

1. Hot-dip applied, meeting requirements of ASTM A153/A153M.

2. Electroplated zinc or cadmium plating is unacceptable.

3. Stainless steel components may be substituted where galvanizing is specified.

2.06 PRODUCT INFORMATION

Submit the following product information for selected equipment:

A. Piping layout drawings showing pipe sizes, location of key appurtenances, and pipe supports.

B. Pipe material data sheets on each product to demonstrate compliance with this Specification.

PART 3 EXECUTION

3.01 EXAMINATION

Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

See Section 09 90 00, PAINTING AND COATING, for additional requirements. Notify Government at least 2 weeks prior to field fabrication of pipe or fittings. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside. For damaged coatings and linings, repair using original coating and lining materials in accordance with

manufacturer's instructions.

3.03 INSTALLATION GENERAL

A. General

1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

2. Remove foreign objects prior to assembly and installation.

B. Flanged Joints

1. Install perpendicular to pipe centerline.

2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.

3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.

5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.

6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.

7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.

9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.

10. Manufacturer: Same as pipe manufacturer.

C. Threaded and Coupled Joints

1. Conform to ASME B1.20.1.

2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.

3. Countersink pipe ends, ream and clean chips and burrs after threading.

4. Make connections with not more than three threads exposed.

5. Lubricate male threads only with thread lubricant or tape as specified on the attachedPiping Data Sheets.

D. Soldered Joints

1. Use only solder specified for particular service.

2. Cut pipe ends square and remove fins and burrs.

3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.

4. Wipe excess solder from exterior of joint before hardened.

5. Before soldering, remove stems and washers from solder joint valves.

E. Pipe Connections at Concrete Structures

1. As specified in Article Piping Flexibility Provisions in Section 40 27 01, PROCESS PIPING SPECIALTIES.

F. PVC and CPVC Piping

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

3. Do not thread Schedule 40 pipe.

G. High-Density Polyethylene Piping

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.

2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.

3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

H. Fiberglass Reinforced Piping

1. Cut, fabricate, and install in accordance with manufacturer's written instructions.

2. Provide manufacturer's representative for instructing workers on proper installation and jointing methods.

3. Installation shall be made by workers experienced in FRP pipe lay-up techniques.

3.04 INSTALLATION - EXPOSED PIPING

A. Piping Runs

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports

As specified in Section 40 05 15, PIPING SUPPORT SYSTEMS.

C. Layout

1. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

2. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

D. Unions or Flanges

Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Piping Clearance, unless otherwise shown:

1. Over Walkway: Minimum of 7 feet 6 inches, measured from walking surface to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

3. From Adjacent Work: Minimum 3 inches from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.

6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.

7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.05 PIPE CORROSION PROTECTION

A. Copper Pipe

Exposed: As specified in Section 09 90 00, PAINTING AND COATING.

B. PVC and CPVC Pipe

Exposed: As specified in Section 09 90 00, PAINTING AND COATING.

C. Piping Accessories, Exposed:

1. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, PAINTING AND COATING, as applicable to base metal material.

2. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.

D. Tape Costing System

As specified in Section 09 90 00, PAINTING AND COATING.

3.06 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

Application and Installation: As specified in Section 40 27 01, PROCESS PIPING SPECIALTIES.

3.07 BRANCH CONNECTIONS

Do not install branch connections smaller than 1/2 inch nominal pipe size, including instrument connections, unless shown otherwise. When line of lower pressure connects to a line of higher pressure, requirements of the applicable Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

A. Threaded Pipe Tap Connections

Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.

3.08 VENTS AND DRAINS

Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.09 FIELD FINISHING

Notify Government at least 3 days prior to start of any surface preparation or coating application work. Perform as specified in Section 09 90 00, PAINTING AND COATING.

3.10 PIPE IDENTIFICATION

As specified in Section 09 90 00, PAINTING AND COATING.

3.11 FIELD QUALITY CONTROL

Pressure Leakage Testing: As specified in Section 40 80 01, PROCESS PIPING LEAKAGE TESTING. Submit pressure leakage testing reports.

3.12 CLEANING

Following assembly and testing, and prior to final acceptance:

1. Flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

2. Blow clean of loose debris all vapor lines with compressed air at 4,000 fpm; do not flush with water.

3. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

4. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

5. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.13 SUPPLEMENTS

The supplements listed below, following "End of Section", are part of this specification.

A. 40 27 00 Data Sheet 1 - Stainless Steel Pipe and Fittings-General Service

B. 40 27 00 Data Sheet 2 - Polyvinyl Chloride (PVC) Pipe and Fittings

C. 40 27 00 Data Sheet 3 - Copper and Copper Alloy Pipe, Tubing, and Fittings

-- End of Section --

SECTION 40 27 00 – DATA SHEET 1 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 304seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A778, “as-welded” grade, Type 304L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A778, “as-welded” grade, Type 304L, pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F304 6 or cast Class 150, ASTM A351/A351M, Grade CF8/304.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A774/A774M Grade 304Lconforming to MSS SP 43, “as-welded” grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.

SECTION 40 27 00 – DATA SHEET 1 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240 Type 304L"as-welded grade", conforming to MSS SP 43, wall thickness same as pipe. Carbon steel backer flanges shall be painted by epoxy. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 304stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Van Stone Flanges and Anywhere Mating Flange on Equipment is Cast Iron and Gasket is Flat Ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00 – DATA SHEET 1 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas, and Sewage Services: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.

SECTION 40 27 00 - DATA SHEET 2 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

SECTION 40 27 00 - DATA SHEET 2 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656 and as recommended by pipe and fitting manufacturer.
Thread Lubricant	All	Teflon Tape.

SECTION 40 27 00 – DATA SHEET 3 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance.
Tubing	Seamless, conforming to ASTM B88 as follows: Water (buried) — Type K, soft or hard temper Water (exposed) — Type L, hard drawn Domestic hot water — Type L, hard drawn Sample line service — Type L, hard drawn
Fittings	ASTM B75 commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Class 150, ASTM B75 commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	1/16-inch thick non-asbestos compression type, full face, Cranite, John Manville.
Solder	Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.

SECTION 40 27 01

PROCESS PIPING SPECIALTIES
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout Drawings; G

SD-03 Product Data

Manufacturer's Data On Materials, Construction, End Connections, Ratings, Overall Lengths, And Live Lengths; G

SD-08 Manufacturer's Instructions

Installation And Operation; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

PART 2 PRODUCTS

2.01 GENERAL

Provide required piping specialty items, whether shown or not shown on Contract Drawings, as required by applicable codes and standard industry practice.

2.02 CONNECTORS

A. Teflon Bellows Connector

1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.

2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.

3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.

4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.

5. Manufacturers and Products:

a. Garlock; Style 214.
b. Resistoflex; No.R6904.
c. Unisource Manufacturing, Inc.; Style 112.
d. Proco Products, Inc.; Series 442.
e. Or approved equal.

B. Elastomer Bellows Connector

1. Type: Fabricated spool, with single filled arch.

2. Materials: Nitrile tube and wrap-applied neoprene cover.

3. End Connections: Flanged, drilled 125 pound ASME B16.1 standard, with full elastomer face and steel retaining rings.

4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.

5. Thrust Restraint: Control rods to limit travel of elongation and compression.

6. Manufacturers and Products:

a. Goodall Rubber Co.; Specification E 1462.
b. Garlock; Style 204.
c. Unisource Manufacturing, Inc.; Style 1501.
d. Proco Products, Inc.; Series 220.
e. Or approved equal.

C. Quick Connect Couplings for Chemical Services

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.

2. Materials: Glass-filled polypropylene or PVDF with EPDM,

Viton A or Teflon gaskets as recommended for the service by manufacturer.

3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.

4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.

5. Pressure Rating: 125 psi, minimum, at 70 degrees F.

6. Manufacturers and Products:

   a. OPW; Kamlock.
   b. Ryan Herco; 1300 Series.
   c. Or approved equal.

2.03 EXPANSION JOINTS

A. Elastomer Bellows

1. Type: Reinforced molded wide arch.

2. End Connections: Flanged, drilled 125 pound ASME B16.1 standard, with split galvanized steel retaining rings.

3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.

4. Thrust Protection: Control rods to protect the bellows from overextension.

5. Bellows Arch Lining: Buna-N, nitrile, or butyl.

6. Rated Temperature: 350 degrees F.

7. Rated Deflection and Pressure:

   a. Lateral Deflection: 3/4 inch, minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	**Deflection (inch)**	**Pressure (psig)**
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:

   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E 711.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.
   f. Or approved equal.

2.04 SERVICE SADDLES

A. Nylon-Coated Iron

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.

2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

3. Materials:

a. Body: Nylon-coated iron.
b. Seal: Buna-N.
c. Clamps and Nuts: Stainless steel.

4. Manufacturer: Smith-Blair; Style 315 or 317 or approved equal.

2.05 PIPE SLEEVES

A. Steel Pipe Sleeves

1. Minimum Thickness: 3/16 inch.

2. Seep Ring:

a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16 inch minimum thickness.
b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
c. Continuously fillet weld on each side all around.

3. Factory Finish:

a. Galvanizing:
1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
2) Electroplated zinc or cadmium plating is unacceptable.
b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, PAINTING AND COATING.

B. Molded Polyethylene Pipe Sleeve

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.

2. Provided with end caps for support during concrete placement.

3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal or approved equal.

C. Insulated and Encased Pipe Sleeve

Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB CS and CW Series, as applicable, or approved equal.

D. Modular Mechanical Seal

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.

2. Fabrication:

a. Assemble interconnected rubber links with ASTM A276/A276M, Type 316 stainless steel bolts and nuts.
b. Pressure plates shall be reinforced nylon polymer.

3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.

4. Manufacturer: Thunderline Corp., Link-Seal Division, or approved equal.

2.06 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Steel or Stainless Steel Wall Pipe

1. Same material and thickness as connecting pipe, except 1/4 inch minimum thickness.

2. Lining: Same as connecting pipe.

3. Thrust Collar:

a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
b. Continuously fillet welded on each side all around.

2.07 MISCELLANEOUS SPECIALTIES

A. Water Hose

1. Furnish two 50 foot lengths of 1 inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.

2. Rated minimum working pressure of 200 psi.

3. Manufacturers:

a. Goodyear.
b. Boston.
c. Or approved equal.

B. Hose Nozzles

1. Furnish two 1 inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.

2. Manufacturers:

a. Croker.
b. Elkhart.
c. Or approved equal.

2.08 PRODUCT INFORMATION

Submit the following product information for selected equipment:

A. Layout drawings showing pipe sizes, location of specialty items, pipe supports and other necessary information for installation.

B. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable). Material data sheets on each product as necessary to demonstrate compliance with this Specification.

C. Operation and Maintenance data as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

D. Manufacturer's installation and operation instruction for product.

PART 3 EXECUTION

3.01 GENERAL

Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

Install flexible couplings to facilitate piping installation, in accordance with approved Shop Drawings.

3.03 PIPING EXPANSION

A. Piping Installations

Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.

2. Nonmetallic Pipe: Teflon bellows expansion joint.

3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.

4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.

5. Pipe Run Offset: Flexible metal hose.

C. Anchors and Anchor Walls

Install as specified in Section 40 05 15, PIPING SUPPORT SYSTEMS, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.04 SERVICE SADDLES

Plastic Piping: Nylon-coated iron.

3.05 OUTLET/TAPPING SADDLE

Install in accordance with manufacturer's written instructions.

3.06 COUPLINGS

Install in accordance with manufacturer's written instructions.

3.07 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

Install to prevent piping from being supported by equipment, for vibration isolation, and where shown or recommended by manufacturer.

A. Product Applications, unless shown otherwise:

1. Nonmetallic Piping: Teflon bellows connector.

2. Copper Piping: Flexible metal hose connector.

3. Compressor and Blower Discharge: Metal bellows connector.

4. All Other Piping: Elastomer bellows connector.

B. Limit Bolts and Control Rods

Tighten snug prior to applying pressure to system.

3.08 PIPE SLEEVES

A. Application

1. As specified in Section 40 27 00, PROCESS PIPING - GENERAL.

2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.

2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications

with wall penetration seal.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Applications

1. Watertight and Below Ground Penetrations:

a. Wall pipes with thrust collars.
b. Provide taps for stud bolts in flanges to be set flush with wall face.

2. Nonwatertight Penetrations: Pipe sleeves with seep ring.

3. Existing Walls: Rotary drilled holes.

4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, PAINTING AND COATING.

2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

-- End of Section --

SECTION 40 27 02

PROCESS VALVES AND OPERATORS
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C504	(2015) Standard for Rubber-Seated Butterfly Valves
AWWA C511	(2007) Standard for Reduced-Pressure Principle Backflow Prevention Assembly
AWWA C512	(2007) Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service

ASME INTERNATIONAL (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASTM INTERNATIONAL (ASTM)

ASTM B127	(2005; R 2014) Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip
ASTM B139/B139M	(2001; R 2017) Standard Specification for Phosphor Bronze Rod, Bar, and Shapes
ASTM B164	(2003; R 2014) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B194	(2008) Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar
ASTM B584	(2014) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B61	(2015) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2017) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes

ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D429	(2014) Rubber Property-Adhesion to Rigid Substrates

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(2013) Bronze Gate, Globe, Angle and Check Valves

NEW JERSEY ADMINISTRATIVE CODE (NJAC)

NJAC 7:10	New Jersey Safe Drinking Water Act

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Product Data Sheets; G

Catalog Information, Descriptive Literature, Specifications, And Identification Of Materials Of Construction; G

SD-07 Certificates

Manufacturer's Certificate Of Proper Installation

SD-06 Test Reports

Test Results; G

Inspection Records; G

SD-08 Manufacturer's Instructions

Manufacturer's Recommendations Or Instructions On Installation; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Data; G

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and

accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Contract Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

2.02 MATERIALS

Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: ASTM B61, ASTM B62, ASTM B98/B98M (Alloy UNS No. C65100, C65500, or C66100), ASTM B139/B139M (Alloy UNS No. C51000), ASTM B584 (Alloy UNS No. C90300 or C94700), ASTM B164, ASTM B194, and ASTM B127.

2. Stainless steel Alloy 18 8 may be substituted for bronze.

2.03 VALVES

A. Gate Valves

1. Type V100 Gate Valve 3 Inches and Smaller:

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

b. Manufacturers and Products:

1) Crane; Figure 438, NPT threaded ends.
2) Stockham; Figure B103, NPT threaded ends.
3) Crane; Figure 1324, soldered ends.
4) Stockham; Figure B104, soldered ends.
5) Or approved equal.

2. Type V102 Gate Valve 3 Inches and Smaller:

a. All-bronze, screwed bonnet, packed gland, NPT threaded

ends, single solid wedge gate, nonrising stem, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 1.

b. Manufacturers and Products:

1) Crane; Figure 437.
2) Stockham; Figure B 128.
3) Or approved equal.

B. Globe Valves

1. Type V200 Globe Valve 3 Inches and Smaller:

a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.

b. Manufacturers and Products:

1) Stockham; Figure B 22T, NPT threaded end.
2) Crane Co.; Figure 7TF, NPT threaded end.
3) Milwaukee; Model 1590T, soldered ends.
4) NIBCO; Figure S 235 Y, soldered ends.
5) Or approved equal.

2. Type V201 Angle Pattern Valve 2 Inches and Smaller:

a. All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.

b. Manufacturers and Products:

1) Stockham; Figure B 222T.
2) Crane Co.; Figure 17TF.
3) Or approved equal.

3. Type V234 Angle Type Hose Valve 1/2 Inch to 3/4 Inch:

a. In accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE

b. Bronze or manufacturer's standard brass, angle sillcock type body, threaded or solder inlet as applicable, pressure rating 125 psi cold water.

c. Manufacturer and Product: Nibco; QTX Series or approved equal.

C. Ball Valves

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

a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem,

adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600 pound WOG, 150 pound SWP, complies with MSS SP 110.

b. Manufacturers and Products:

1) Threaded:

a) Conbraco Apollo; 70-100.
b) Nibco; T-580-70.
c) Or approved equal.

2) Soldered:

a) Conbraco Apollo; 70-200.
b) Nibco; S-580-70.
c) Or approved equal.

2. Type V330 PVC Ball Valve 2 Inches and Smaller:

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

b. Manufacturers and Products:

1) Nibco; Chemtrol Tru-Bloc.
2) ASAHI/America; Type 21.
3) Spears; True Union.
4) Or approved equal.

3. Type V331 PVC Ball Valve 3 Inches and 4 Inches:

a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1.

b. Manufacturers and Products:

1) Nibco; Chemtrol Tru-Bloc.
2) ASAHI/America; Type 21.
3) Or approved equal.

D. Butterfly Valves

1. General: In full compliance with AWWA C504 and following requirements:

a. Suitable for throttling operations and infrequent operation after periods of inactivity.
b. Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75 pound pull in accordance with ASTM D429, Method B.

c. Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
d. No travel stops for disc on interior of body.
e. Self-adjusting V type or O ring shaft seals.
f. Isolate metal-to-metal thrust bearing surfaces from flowstream.
g. Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
h. Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
i. Provide linings and coatings per AWWA, unless otherwise indicated on Contract Drawings or specified herein.

2. Non-AWWA butterfly valves to meet the following actuator requirements:

a. For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

3. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 20 Inches for Low Pressure Process Air Service:

a. Lug style cast-iron body, aluminum bronze discs, Type 304 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure rating, bubble-tight at 50 psi differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.

b. Manufacturers and Products:

1) Bray Controls; Series 31.
2) Tyco/Keystone; Model AR2.
3) Or approved equal.

E. Check and Flap Valves

1. Type V600 Check Valve 2 Inches and Smaller:

a. All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 125 pound SWP, 200 pound WOG.

b. Manufacturers and Products:

1) Stockham; Figure B 319, threaded ends.
2) Milwaukee; Figure 509, threaded ends.
3) Stockham; Figure B 309, soldered ends.
4) Milwaukee; Figure 1509, soldered ends.
5) Or approved equal.

2. Type V630 PVC Ball Check Valve 4 Inches and Smaller:

a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.

b. Manufacturers and Products:

1) Nibco; Chemtrol Tru Union.
2) ASAHI/America.
3) Spears; True Union.
4) Or approved equal.

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

a. In accordance with Section 22 00 00 PLUMBING, GENERAL PURPOSE

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

c. Manufacturers and Products:

1) FEBCO; Model 860.
2) Danfoss Flomatic; Model RPZE/RPZ.
3) Watts; Series 009/909.
4) Or approved equal.

F. Self-Regulated Automatic Valves

1. Type V710 Pressure-Reducing Valve 2 1/2 Inches and Smaller:

a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200 psig rated minimum.

b. Size/Rating: As required to reduce incoming pressure from potable water to acceptable level.

c. Manufacturers and Products:

1) Fisher; Type 75A.
2) Watts; Series 223.
3) Or approved equal.

2. Type V722 PVC Pressure Regulating Valve, 1/2 Inch to 1 1/2 Inches:

a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.

b. PVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, non-rising stem, locknut, and fasteners.

c. Designed to regulate downstream pressure closing when pressure reaches set point; set pressure adjustable from 5 psi to 50 psi. Factory set pressure setting at 15 psi.

d. Manufacturers and Products:

1) Plast-O-Matic, Series PRH.
2) Hayward; Pressure Regulator.
3) Or approved equal.

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

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

b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512. Operating pressure is 25 psi.

c. Manufacturers and Products:

1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
2) Val-Matic Valve; Series 15A to 45.6.
3) Or approved equal.

2.04 OPERATORS

A. Manual Operators

1. General:

a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
c. Operator self-locking type or equipped with self-locking device.
d. Position indicator on quarter-turn valves.
e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.

2. Exposed Operator:

a. Galvanized and painted handwheel.
b. Cranks on gear type operator.
c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.

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

3. Buried Operator:

a. Buried service operators on valves larger than 2 1/2 inches shall have a 2 inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.05 PRODUCT INFORMATION

Submit the following product information for selected equipment:

A. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.

B. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

C. Manufacturer's recommendations or instructions on installation.

D. Operation and Maintenance Data as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

E. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, MANUFACTURERS' FIELD SERVICES.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flanged Ends

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.

2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends

1. Clean threads by wire brushing or swabbing.

2. Apply joint compound.

C. PVC and CPVC Valves

Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation

1. General:

a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
b. Install valves in location for easy access for routine operation and maintenance.
c. Install valves per manufacturer's recommendations.

2. Gate, Globe, and Ball Valves:

a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

3. Butterfly Valves:

a. Unless otherwise restricted or shown on Contract Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.

4. Check Valves:

a. Install valve in horizontal or vertical flow (up) flow piping only for liquid services.
b. Install valve in vertical flow (up) piping only for gas services.
c. Install swing check valve with shaft in horizontal position.

E. Maintenance Valves

1. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

2. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

F. Chain Wheel and Guide

Install chain wheel and guide assemblies or chain lever

assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Backflow preventers to be tested and inspected as required by NJAC 7:10 and certified to be in compliance with this regulation.

B. Valve may be either tested while testing pipelines, or as a separate step.

C. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

D. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

E. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

F. Set, verify, and record set pressures for relief and regulating valves.

G. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Government.

H. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

I. Submit test results and inspection records.

-- End of Section --

SECTION 40 42 13

PROCESS PIPING INSULATION
09/17

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 90.1 - IP	(2016; ERTA 1-4 2017; INT 1-2 2017) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1136	(2017) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1729	(2017) Standard Specification for Aluminum Jacketing for Insulation
ASTM C177	(2013) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C518	(2015) Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C534/C534M	(2016) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C585	(2010) Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
ASTM E84	(2016) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2016) Standard Test Methods for Water Vapor Transmission of Materials

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions; G

SD-10 Operation and Maintenance Data

Maintenance Information; G

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1-Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.

2. Temperature Rating: Minus 297 degrees F to 220 degrees F.

3. Nominal Density: 3 pcf to 6 pcf.

4. Conductivity in accordance with ASHRAE 90.1 - IP and maximum numerical value of 0.25 Btu in/hr square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.

5. Maximum water vapor transmission of 0.06 perm inch per ASTM E96/E96M, Procedure A.

6. Joints: Manufacturer's adhesive.

7. Flame Spread Rating: Less than 25 per ASTM E84.

8. Smoke Developed Index: Less than 50 per ASTM E84.

9. Manufacturers and Products:

a. Nomaco; K-Flex.
b. Armacell; AP Armaflex.
c. Or approved equal.

B. Type 2-Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.

2. Insulation Temperature Rating: 0 to 850 degrees F.

3. Conductivity in accordance with ASHRAE 90.1 - IP and maximum numerical value of 0.23 Btu in/hr square foot degrees F at 75 degrees F.

4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.

5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.

6. Flame Spread Rating: Less than 25 per ASTM E84.

7. Smoke Developed Index: Less than 50 per ASTM E84.

8. Manufacturers and Products:

   a. Owens Corning Fiberglass; ASJ/SSL 11.
   b. John Manville; Micro-Lok with Jacket.
   c. Or approved equal.

2.02 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, PIPING SUPPORT SYSTEMS.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.03 INSULATION FINISH SYSTEMS

A. Type F3-Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H 14 temper, in accordance with ASTM C1729, minimum 0.016 inch thickness, with smooth mill finish.

2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.

3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.

4. Manufacturers:

   a. RPR Products; Insul-Mate.
   b. ITW, Pabco-Childers.
   c. Or approved equal.

2.04 PRODUCT INFORMATION

Submit the following product information for all products selected:

1. Manufacturer's Installation Instructions

2. Product Maintenance Information

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.

2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

3. Do not insulate flexible pipe couplings and expansion joints.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer's installationinstructions and as specified herein.

2. Install after piping system has been pressure tested and leaks corrected.

3. Install over clean dry surfaces.

4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

5. Do not allow insulation to cover nameplates or code inspection stamps.

6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.

7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

C. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of

same material.

2. Seal and tape joints.

D. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.

2. Install vapor barrier jackets with pipe hangers and supports outside jacket.

3. Do not use staples and screws to secure vapor sealed system components.

E. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.

2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

4. Do not use screws or rivets to fasten fitting covers.

5. Install removable prefabricated aluminum covers on exterior flanges and unions.

6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):

1. Aluminum or color coded PVC jacketing does not require painting.

2. If insulated piping system is indicated to be painted in Section 40 27 00, PROCESS PIPING - GENERAL, piping shall receive the following:

a. Prime coat in accordance with Section 09 90 00, PAINTING AND COATING.
b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, PAINTING AND COATING.

-- End of Section --

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING
10/17

PART 1 GENERAL

1.01 REFERENCES

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

ASME INTERNATIONAL (ASME)

ASME B31.3	(2016) Process Piping

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Testing Plan; G

SD-06 Test Reports

Test Report Documentation; G

SD-07 Certificates

Certificates Of Calibration

1.03 TESTING PLAN

Contractor shall submit a testing plan prior to testing that shall include, but not limited to, the following elements:

1. Testing dates.
2. Piping systems and section(s) to be tested.
3. Test type, in accordance with ASME B31.3 and other applicable references.
4. Method of isolation.
5. Calculation of maximum allowable leakage for piping section(s) to be tested.
6. Testing equipment and certificates of calibration.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.

B. Pressure Piping:

1. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

2. Items that do not require testing include equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.

3. Test Pressure: 50 psig for all liquid pipelines.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Potable water. Contractor shall supply water and provide documentation on the source of the water.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.

5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.

7. Empty pipe of water prior to final cleaning or disinfection. Prior to testing, make arrangements for the disposal of test water.

C. Buried Piping:

1. Testing for buried transmission piping in accordance with Section 33 05 01.10 HIGH DENSITY POLYETHYLENE PIPE AND FITTINGS.

2. Test after backfilling has been completed.

3. Expel air from piping system during filling.

4. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

5. Maintain hydrostatic test pressure continuously for 4 hours minimum, reopening isolation valve only as necessary to restore test pressure.

6. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

7. Maximum Allowable Leakage:

   Calculated using the following formula:

   $L=S*D*(P)^{(1/2)}/133200$

   where:

   L = Allowable leakage, in gallons per hour.
   S = Length of pipe tested, in feet.
   D = Nominal diameter of pipe, in inches.
   P = Test pressure during leakage test, in pounds per square inch.

8. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

   1. PVC or CPVC pipe.

   2. Piping larger than 18 inches.

   3. Buried and other non-exposed piping.

B. Perform on vapor phase carbon vessels and vapor piping to 15 psi test pressure.

C. Piping between air stripper and blower inlet shall also be vacuum tested to minus 10 inches water column.

D. Fluid: Oil-free, dry air.

E. Procedure:

   1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.

   2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

5. Correct visible leakage and retest as specified.

F. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.

2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

a. Leaks (type, location).
b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contracting Officer to represent that test has been satisfactorily completed.

-- End of Section --

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

SECTION 43 13 13.13

VAPOR PHASE ACTIVATED CARBON ADSORPTION UNITS
10/07

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

Furnish all labor, materials, equipment and incidentals required to ship and make ready for connection two approximately 2,000 pound capacity vapor phase granular activated carbon (GAC) adsorption units and all associated flexible ductwork and appurtenances. The system shall be capable of reducing the levels of estimated influent volatile organic contaminants (VOCs) to achieve final permit equivalent requirements.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B604	(2012) Granular Activated Carbon

ASTM INTERNATIONAL (ASTM)

ASTM D2652	(2011) Activated Carbon
ASTM D2854	(2009; R 2014) Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D2866	(2011) Total Ash Content of Activated Carbon
ASTM D2867	(2009; R 2017) Moisture in Activated Carbon
ASTM D3802	(2016) Standard Test Method for Ball-Pan Hardness of Activated Carbon
ASTM D4607	(2014) Determination of Iodine Number of Activated Carbon
ASTM D5228	(2016) Standard Test Method for Determination of the Butane Working Capacity of Activated Carbon

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910 Occupational Safety and Health Standards

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings Of The Proposed Units; G

SD-03 Product Data

Data Sheets On The Proposed Carbon; G

Weights Of Each Vessel, Empty And Full Of Carbon; G

Type Of Activated Carbon With Isotherms For The Selected Carbon; G

SD-04 Samples

Vapor Phase Gac Media; G

SD-05 Design Data

Minimum Requirements For Relative Humidity And Temperature For Optimum Operation; G

Structural And Other Calculations For ASME Certified Tank; G

Estimated Carbon Usage Based On Estimated Contaminants; G

Anchoring And Bracing Calculations; G

Design Calculations Or Vendor Computer Models To Estimate The Mass Of Carbon Required; G

SD-06 Test Reports

Field Quality Control; G

SD-07 Certificates

Manufacturer's Certificates

Certificate Of Proper Installation

System Supplier Testing Verifying Conformance with Specifications

Certificates Attesting That The Activated Carbon Furnished Meets The Specified Requirements

SD-08 Manufacturer's Instructions

Installation Instructions For Vessels; G

Installation Instructions For Vapor Phase GAC; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Manuals; G

1.04 QUALIFICATIONS

A. Supplier

Supplier shall have at least 10 years of experience in the manufacture, supply, installation, and maintenance/changeout of vapor phase GAC systems.

B. Single Source Supplier

Assign to a single supplier full responsibility for providing both the vapor phase GAC vessels and vapor phase GAC.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Flange faces shall be protected from damage. All openings shall be covered to prevent entrance of dirt, water and debris. Properly protect all parts so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and until the units and equipment are ready for operation. Properly protect finished iron or steel surfaces to prevent rust and corrosion. Protect all equipment, delivered and designated for storage, from the weather (humidity and temperature), dirt and dust, and other contaminants.

B. Granular activated carbon shall be packaged, marked, and shipped in accordance with AWWA B604. Ship VPGAC for delivery two weeks prior to startup and testing; do not allow early delivery for on-site storage without approval of Contracting Officer. Materials delivered to the site must be accompanied by a copy of the safety data sheet. Submit the safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for activated carbon. Submit instructions for any required preparation for receiving shipment of activated carbon at the facility.

1.06 SPECIAL TOOLS

Provide special tools necessary for adjustment, operation, maintenance, and disassembly for each type of equipment furnished.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide a vapor phase activated carbon adsorption system as a complete once-through forced flow system that will be able to run in series or parallel operation. Both vapor phase GAC units shall

be connected by a sturdy flex piping or rubber-lined galvanized steel hoses with quick connect coupling, and valves on the influent and effluent connections, to allow any unit to operate and function as a lead or lag unit, or on stand-by.

B. The system shall be capable of removing a minimum of 99 percent of contaminants listed in Table 1 to achieve final Air Pollution Control (APC) Pre-Construction Permit (PCP) permit equivalency requirements prior to discharging to the atmosphere through a 6-inch diameter stainless steel exhaust stack to the atmosphere in conformance with Section 40 27 00 Data Sheet 1 STAINLESS STEEL PIPE AND FITTINGS, GENERAL SERVICE. Stack to be located in general proximity of VPGAC canisters as shown on Contract Drawings.

Table 1

Contaminant	**Expected maximum vapor phase influent loading (lb/hr)**
1,2-DCE	0.13
PCE	0.0004
TCE	0.12

C. Performance Requirements. Fill the unit with virgin coconut shell granular activated carbon for removal of organic contaminants from air stripping air/gas. Equipment shall include, but shall not be limited to, vessels containing activated carbon, supporting equipment and accessories. Terminology is in conformance with ASTM D2652. The system shall be designed to operate continuously, 24 hours per day, 7 days per week.

D. The following requirements shall be met:

1. Minimum equipment design life: 30 years.
2. Vessel type: permanent with carbon, vertical units not to exceed 8 feet in height.
3. Capable of efficiently utilizing vapor phase carbon at air flow rates up to 500 cfm at a maximum pressure of 12 psig.
4. Intervals between carbon replacements shall not be less than 90 days at the maximum expected contaminant concentrations and air flow rates.

2.02 VAPOR PHASE ACTIVATED CARBON

Material shall conform to the following list:

1. The carbon adsorption system shall be capable of reducing emissions for individual compounds to below 0.01 lb/hr.

2. Volatile organic composition of the vapor stream shall be based on estimated influent component levels as specified in System Description.

3. Minimum butane working capacity of new activated carbon of 23.5 percent by weight shall be as determined by ASTM D5228.

4. Minimum iodine number of virgin or reactivated carbon of 1000 shall be as determined by ASTM D4607.

5. Maximum moisture content of 2 percent by weight shall be as determined by ASTM D2867.

6. Maximum total ash content of 10 percent by weight shall be as determined by ASTM D2866.

7. Minimum hardness number of 95 necessary for the required life in vapor phase applications shall be as determined by ASTM D3802.

8. Activated carbon particle size shall be uniform for consistent pressure drop characteristics. Maximum particle size shall be 0.2 inch diameter as determined by ASTM D2862.

9. The granular activated carbon shall be of the type that can be accepted for offsite regeneration of the spent activated carbon by an approved carbon regeneration facility.

10. Minimum apparent density of 0.45 g/cc shall be as determined by ASTM D2854.

11. Maximum pressure drop shall be 3 inches of water per foot of bed depth, measured in air at 70 degrees F.

12. US Sieve size shall be 4 x 8.

13. Material shall be free from impurities that affect the serviceability and appearance of the finished product.

14. Submit manufacturer's certificates, including the name and address of the production facility, attesting that the activated carbon furnished meets the specified requirements.

15. Submit the following product information on the vapor phase GAC:

    a. Data sheets on the proposed carbon to be used for vapor phase, including adsorption capacity and estimated headloss between 0 and 500 scfm.
    b. Estimated carbon usage based on estimated contaminants in vapor phase. Include actual isotherm information and detailed calculations used to estimate carbon usage.
    c. Minimum requirements for relative humidity and temperature for incoming vapor phase to prevent damage or inefficient use of the vapor phase carbon.
    d. Sample of vapor phase GAC media from the same lot before shipment that is analyzed by the supplier to demonstrate compliance with the media specifications.
    e. Submit certificates attesting that the activated carbon furnished meets the specified requirements.
    f. Submit the type of activated carbon, with isotherms for the selected carbon, with each of the VOCs listed in the effluent requirements for the anticipated temperature range at 50 percent relative humidity.
    g. Design calculations or vendor computer models to estimate the mass of carbon required and the breakthrough curves for the listed organic compounds in the carbon bed at average and maximum mass loading.

2.03 ACTIVATED CARBON ADSORPTION UNITS

A. Operation

Units shall be capable of operating in series or parallel. Normal operation will be in series.

B. Vapor Distribution/Collection Systems

Vapor distribution/collection systems shall provide effective distribution across the bed throughout the stated capacity range. A system shall be provided to minimize short circuiting or channeling of contaminated air/gas through the carbon vessel. The system shall be designed to evenly distribute the controlled contaminated air/gas flow across the cross section, with the nominal velocity under design conditions not exceeding 20 fpm (0.10 m/sec) for up-flow systems. Design of the inlet and outlet shall be adequate to prevent local pressurization in excess of the vessel rating or design.

C. Vessel Design

1. Corrosion Prevention: A carbon steel shell with a high solids epoxy lining shall be provided. The lining system shall have a corrosion resistant epoxy or phenolic resin coating. Paint kits shall be furnished for use after assembly and finishing.

2. Manways: Minimum manway requirements, for access, addition and removal of carbon shall be 1 per adsorber and 20-inch minimum nominal diameter. All vessels will be marked as permitted confined space for all work under the requirements of Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES and EM 385-1-1.

3. Insulation: Insulation to prevent cooling of the air/gas in the system shall be installed according to manufacturer's instructions. All outside surfaces of the pipes and fittings shall be insulated as specified in Section 40 42 13, PROCESS PIPING INSULATION.

4. Vessel: Comply with the following requirements

    a. Minimum Number of Vessels: Two.
    b. Material of Construction: carbon steel.
    c. Maximum Allowable Working Pressure: 12 psig.
    d. Carbon Quantity per Vessel: 1,800 pounds (minimum) to 2,000 pounds (maximum).
    e. Minimum Carbon Bed Depth: 36 inches.
    f. Flow Direction: Upflow.
    g. Inlet Distributor: Integral.
    h. Inlet/Outlet: 8 inches diameter.

5. Each unit shall be equipped with lifting lugs and pre-piped internally.

6. Lifting lugs shall be designed for use as tie-off locations for personnel during maintenance activities.

7. Each vessel shall be secured to a structural steel frame suitable for shipment or transport with a forklift or crane and set on a level area for operation. Exterior structural steel surfaces shall be coated with a suitable primer and top coat to resist corrosion due to water spray. Each unit shall have a minimum of one ground connection. Each unit shall be provided with an inlet air/gas distributor, if required. Sampling ports shall be provided on the inlet and outlet pipes of each vessel to allow independent sampling and measurement of breakthrough for each unit.

8. Anchoring Requirements: Adsorption units shall be supported and braced to resist loads as specified in Section 01 88 15, SEISMIC ANCHORING AND BRACING.

9. Sampling Ports and Valves: Sampling ports and valves shall be provided at the inlet and outlet of each carbon unit.

10. Supplier shall provide two welded ladder supports located at the knuckle of the shell to provide ladder support and stability for maintenance activities.

    a. Ladder supports sizing listed below shall be verified by supplier, suitable for providing support and tie off for personnel and ladders.

    b. Ladder supports shall be 24-inches apart, aligned to the center of the room for access.

    c. Ladder supports shall be a minimum of 1/2-inch steel plate, 3-inches long by 3 inches wide.

    d. Ladder supports shall have a 1-inch drilled hole for a tie off location.

11. All fasteners shall be galvanized steel.

D. Differential Pressure Transmitter

Supplier shall provide instrument taps (one in the inlet and one in the outlet) for one differential pressure transmitter per vessel. This unit will measure the differential pressure between the inlet and outlet of each vessel. The differential pressure transmitter will be supplied as specified in the Component Specifications Section 25 01 00, MASTER CONTROL SYSTEM.

E. Product Data

Contractor shall submit the following information on the vapor phase adsorption units:

1. Detailed fabrication drawings of the proposed units, including dimensions, inlet/outlet size and configuration, and any appurtenances.
2. Weights of each vessel, empty and full of carbon.
3. Structural and other calculations for ASME certified tank stamped by a professional engineer.
4. Anchoring and bracing calculations as required by Section

01 88 15, SEISMIC ANCHORING AND BRACING.
5. Installation instructions for vessels including lifting/hoisting instructions.
6. System Supplier Testing: Submit certificate from system supplier showing that the equipment has been tested and has passed all quality control criteria.
7. Installation instructions for vapor phase GAC.
8. Certificate of Proper Installation.
9. Operation and Maintenance manuals.

PART 3 EXECUTION

3.01 EXAMINATION

After becoming familiar with the details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work.

GAC depletes oxygen from air and can be hazardous in a confined area. Contractor shall be responsible for workers safety and follow all local, State, and Federal guidelines during GAC installation and startup.

3.02 EQUIPMENT INSTALLATION

Install equipment as shown and in accordance with written instructions of the manufacturer. Each vessel shall be anchored to the floor slab. Provide anchor brackets, anchor rods or straps to hold the shell to anchors in the footing. Grout shall be applied as necessary for a level of secure installation in accordance with Section 03 30 00.00 CAST-IN-PLACE CONCRETE.

GAC media shall be installed according to all manufacturer's instructions. GAC shall be loaded into vessel after vessel installation and inspection. GAC media shall be loaded only via vacuum methods. Direct dump of supersacs into vessels is prohibited.

3.03 PAINTING FOR CORROSION PREVENTION

The paint system applied to the outside of the tank shall be in accordance with Section 09 90 00 PAINTING AND COATING. Surfaces that have not been factory primed shall be primed and top coated with the manufacturer's standard factory finish. Factory painting shall conform to manufacturer's standard factory finish. All defects in the finish prior to or during installation of the equipment shall be repaired as specified in Section 09 90 00 PAINTING AND COATING. All exposed ferrous surfaces not painted in the factory shall be painted in accordance with Section 09 90 00 PAINTING AND COATING. Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required, unless otherwise specified. All ferrous surfaces shall be coated or painted. Color shall be as indicated on the paint schedule or as otherwise approved by the Government.

3.04 FIELD QUALITY CONTROL

Submit reports on tests performed to show compliance with instructions. Include in the test reports all field tests performed

to adjust each component and all field tests performed to prove compliance with the specified performance criteria. Indicate in each test report the final position of all controls. Performance test data shall be reflected in the operating instructions.

A. Equipment Tests

After installation of the carbon adsorption system is complete, operating tests shall be carried out to ensure that the unit installed operates properly. All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of all equipment; all operating mechanisms shall be tested to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced. Tests shall assure that there is no vibration, or noise from any parts. The supplier and contractor shall certify that the installation is complete and ready for system startup.

B. Performance Tests

As defined in Section 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP and in Section 01 92 00, FIRST YEAR OPERATIONS AND MAINTENANCE. All testing shall be in accordance with the requirements of Section 01 35 45 CHEMICAL DATA QUALITY CONTROL.

3.05 MANUFACTURER'S FIELD SERVICE

Provide the services of the manufacturer's representative, who is experienced in the installation, adjustment and operation of the equipment specified. Prior to startup, the equipment shall be inspected for alignment and connections by a factory representative. The manufacturer's representative shall inspect the final installation and supervise the adjustment and testing of the equipment in accordance with Section 01 43 33, MANUFACTURER'S FIELD SERVICES.

1. One (1) day for system inspection and initial GAC loading.

2. Two (2) days for manufacturer's certificate of proper installation and startup.

-- End of Section --

SECTION 43 31 13.14

LIQUID-PHASE GRANULAR ACTIVATED CARBON ADSORPTION UNITS (LPGAC)
10/07

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

Furnish all labor, materials, equipment and incidentals required to ship and make ready for connection. Provide two approximately 2,000 pound downflow liquid-phase, granular activated carbon (GAC) pressure vessels, GAC material, manifold piping/valve system, and appurtenances, for the removal of polychlorinated biphenyls (PCBs), low levels of semi-volatile organic compounds (SVOCs),low levels of chlorinated organic compounds (VOCs) and other organic contaminants in effluent from the air stripper to meet the applicable discharge to surface water standards.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B604	(2012) Granular Activated Carbon
AWWA D100	(2011) Welded Steel Tanks for Water Storage
AWWA D102	(2014) Coating Steel Water-Storage Tanks

ASME INTERNATIONAL (ASME)

ASME B1.1	(2003; R 2008) Unified Inch Screw Threads (UN and UNR Thread Form)
ASME BPVC SEC VIII D1	(2015) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2016) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A530/A530M	(2012) Standard Specification for General

	Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A666	(2015) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM D2652	(2011) Activated Carbon
ASTM D2854	(2009; R 2014) Apparent Density of Activated Carbon
ASTM D2862	(2016) Standard Test Method for Particle Size Distribution of Granular Activated Carbon
ASTM D4607	(2014) Determination of Iodine Number of Activated Carbon
ASTM E1067/E1067M	(2011) Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Process Flow Diagram And Piping Diagram For Pipe/Valve Manifold System; G

Dimensions, Weight, Layout, And Anchoring Locations; G

SD-03 Product Data

Catalog Cut Sheets And Technical Descriptions; G

Material Data Sheetfor GAC; G

SD-04 Samples

Liquid-Phase GAC Media; G

SD-05 Design Data

Anchorage And Bracing Calculations; G

Structural Calculations For The Adsorber Shells, Tanks And Mounting And Support Details; G

Headloss Properties Of Supplied GAC Material; G

Model Results Documenting Usage Rates for GAC; G

SD-06 Test Reports

Factory Pressure Test; G

Field Test Results; G

SD-07 Certificates

ASTM Pressure Vessel Stamp Information

Manufacturer's Certificates On Source And Chemical Composition Of GAC; G

Manufacturers Certificate Of Proper Installation

SD-08 Manufacturer's Instructions

Vessel Lifting And Hoisting Instructions; G

GAC Change Out Instructions; G

Initial Preparations And GAC Loading Instructions; G

SD-10 Operation and Maintenance Data

Operation And Maintenance Manuals; G

1.04 QUALIFICATIONS

A. Regulatory Requirements

Pressure rated adsorption shells shall bear the ASME BPVC SEC VIII D1 code stamp.

B. Single Source Supplier

Assign full responsibility for the furnishing of the adsorption system to a single supplier, including GAC, manifold system, and vessels.

C. Manufacturer's Representative

Provide the services of a manufacturer's field service representative who is experienced in the installation, adjustment, and operation of the equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Services shall be in accordance with 01 43 33 MANUFACTURER'S FIELD SERVICES.

D. Welding

Welding qualifications of welding procedures, welders, and welding operators shall be in accordance with Sections 8.2 and 8.8 of AWWA D100.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Granular Activated Carbon

Granular activated carbon shall be packaged, marked, and shipped in accordance with AWWA B604. Ship GAC for delivery two weeks prior to startup and testing; do not allow early delivery for on-site storage without approval of Contracting Officer. Materials delivered to the site must be accompanied by a copy of the safety data sheet. Submit the safety data sheet in conformance with 29 CFR 1910 Section 1200(g) for activated carbon. Submit instructions for any required preparation for receiving shipment of activated carbon at the facility.

B. Equipment and Accessories

Flange faces shall be protected from damage. All openings shall be covered to prevent entrance of dirt, water and debris. Properly protect all parts so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and until the units and equipment are ready for operation. Properly protect finished iron or steel surfaces to prevent rust and corrosion. Protect all equipment, delivered and designated for storage, from the weather (humidity and temperature), dirt and dust, and other contaminants.

1.06 SPECIAL TOOLS

Provide special tools necessary for adjustment, operation, maintenance, and disassembly for each type of equipment furnished.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

Provide an activated carbon adsorption unit system as a complete process for removal of organic and inorganic contaminants from groundwater as specified herein. Equipment shall include, but shall not be limited to, vessels containing activated carbon, activated carbon media, manifold piping/valves, and supporting equipment and accessories. Terminology shall be in conformance with ASTM D2652.

A. Design Requirements

1. General

a. Minimum design life, modular unit: 30 years.
b. Number of units: Two.
c. Configuration: Downflow
d. Operational Arrangement: Normal operation will be in series, with ability to run in parallel.
e. Adsorption system dimensions:

1) Maximum vertical projection: 9 ft.
2) Maximum ground surface coverage: 4 ft diameter.
3) Carbon Quantity per Vessel: 1,800 pounds (minimum) to 2,000 pounds (maximum).

2. Performance Requirements

a. Flow rate (in series):

1) Minimum: 35 gpm.
2) Maximum: 65 gpm.

b. Water temperature: 55 degrees F (average).
c. Headloss less than 30 in under clean bed conditions per vessel at 65 gpm. This includes GAC media and underdrain losses.
d. Hydraulic loading rate of approximately 2 to 6 gpm/ft^2.
e. Empty bed contact time of at least 15 minutes and less than 40 minutes.

3. Effluent

Effluent quality from GAC adsorption shall meet all NJDEP Effluent discharge criteria, which is the NJ Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) Effluent Standards for FW-2 Waters.

B. Influent Chemical Conditions

Upstream air stripper shall be capable of removing VOCs from the liquid-phase to below discharge permit equivalency standards. However, to allow operational flexibility in the future, the system shall be capable of meeting discharge standards without the air stripper operational.

The maximum expected influent concentrations remaining in the liquid-phase for GAC adsorption are listed in this section. Under design conditions, the GAC adsorption must remove all target contaminants to concentrations below the New Jersey Discharge standards.

COMPOUND	MAXIMUM EXPECTED GAC INFLUENT CONCENTRATION (WITHOUT AS OPERATIONAL) (ug/L)	NJPDES DSW EFFLUENT STDS FOR FW-2 (ug/L)
PCBs	88	1
1,2-DCE (TOTAL)	7320	54
TCE	6822	5
PCE	26	16

COMPOUND	MAXIMUM EXPECTED GAC INFLUENT CONCENTRATION (WITHOUT AS OPERATIONAL) (ug/L)	NJPDES DSW EFFLUENT STDS FOR FW-2 (ug/L)
* Source: Design Influent Concentrations, Appendix B, Design Analysis Report (DAR), January 2018.		

2.02 MATERIALS AND EQUIPMENT

Provide materials and equipment which are new and unused.

A. Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Materials and equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

B. Nameplates

Adsorption shells shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the shell.

C. Adsorption Shell

Each adsorber shell shall have a minimum effective cross sectional area of 13 square feet with a minimum straight shell (tangent line to tangent line) height of 8.5 feet.

1. Adsorption shells not equipped with an open vent or overflow shall be steel, designed, fabricated, and erected in accordance with ASME BPVC SEC VIII D1 for a gauge working pressure of 75 psi and shall be so stamped. Shell shall have supports of cast-iron or steel. Supporting structures and shells shall be fabricated for the seismic and wind loads listed in the design requirements, plus live and dead loads of the shell full of water.

2. Connections: Each adsorber shall have provisions for carbon fill and removal and with permanent connections for water inlet, outlet, backwash supply and backwash waste.

3. Openings: Each shell shall be provided with an access opening 14 by 18 inches or larger. Openings shall be provided with closure and positive seal adequate for the tank pressure rating. All vessels will be marked as permitted confined spaces for all work under the requirements of Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES and EM 385-1-1.

4. Hardware: Bolts and attaching hardware shall be galvanized steel.

5. Lifting Lugs: Provide at least two lugs per vessel for lifting purposes. These lugs shall be sized and connected to allow for use for personnel tie-off during operation and maintenance.

6. Supplier shall provide two welded ladder supports located at the knuckle of the shell to provide ladder support and stability for maintenance activities.

    a. Ladder supports sizing listed below shall be verified by supplier, suitable for providing support and tie off for personnel and ladders.

    b. Ladder supports shall be 24-inches apart, aligned to the center of the room for access.

    c. Ladder supports shall be a minimum of 1/2-inch steel plate, 3-inches long by 3 inches wide.

    d. Ladder supports shall have a 1-inch drilled hole for a tie off location.

D. Instrument Taps

Provide instrument taps (one in the inlet and one in the outlet) for one differential pressure transmitter per vessel. This unit will measure the differential pressure between the inlet and outlet of each vessel. The differential pressure transmitter will be supplied as specified in the Component Specifications Section 25 01 00, MASTER CONTROL SYSTEM.

E. Collection/Underdrain System

Underdrain system within the shell for collecting treated water shall be as specified below and shall distribute the backwash water uniformly over the entire bed cross-section at velocities that will prevent channeling of the carbon bed. Under actual operating conditions the activated carbon shall not be washed out of the apparatus regardless of the change of demand rate up to the maximum on the apparatus.

1. Header-Lateral-Distributor Head Type:
Header-lateral-distributor head type shall consist of a circular, square or branched manifold or header, connected to laterals provided with strainer heads or strainers with openings placed radially so as to discharge horizontally or downward. Headers and laterals shall be stainless steel, conforming to ASTM A312/A312M and ASTM A530/A530M. Strainer heads and strainers shall be manufactured of materials compatible with the header-lateral system, and shall be polyethylene, polypropylene, polyvinyl chloride or stainless steel. Laterals and strainer heads, after being placed, shall not protrude into the header or laterals. System shall be supported by a steel plate or steel angles conforming to ASTM A666 with nontoxic epoxy linings directly on the bottom of the shell.

F. PRODUCT INFORMATION

Contractor shall provide the following information on the proposed liquid-phase GAC pressure vessels:

1. Catalog cut sheets and technical descriptions on vessel construction including materials of construction, coatings and liners, and performance.

2. Shop drawings including dimensions, weight, layout, and anchoring locations.

3. Process flow diagram and piping diagram for pipe/valve manifold system for connection of liquid-phase GAC pressure vessels.

4. Structural calculations for the adsorber shells, tanks and mounting and support details. Verification from a Registered Professional Engineer, licensed to practice mechanical or structural engineering, as appropriate, in the State in which the system was fabricated, stating that the fabrication drawings and pressure calculations for the shells and tanks were designed for the listed conditions in accordance with the appropriate codes and standards.

5. ASTM pressure vessel stamp information.

6. Anchorage and bracing calculations as required by Section 01 88 15, SEISMIC ANCHORAGE AND BRACING.

7. Vessel lifting and hoisting instructions.

8. Manufacturers Certificate of Proper Installation.

9. Operation and Maintenance Manuals for applicable equipment in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA.

2.03 MEDIA

A. Granular Activated Carbon

Material shall be free from impurities that affect the serviceability and appearance of the finished product. Activated carbon shall not require dosing or addition of a chemical mixture or solution to the water to be treated or to the water used for backwashing.

a. Quantity: approximately 4,000 total pounds of 100 percent virgin GAC (approximately 2,000 pounds per vessel).

b. Coconut shell 100 percent virgin carbon, 12 by 30 mesh. Thermally or chemically regenerated GAC material is unacceptable.

c. Adsorptive capacity, iodine number as determined by ASTM D4607, not less than 1,100 milligrams per gram.

d. Apparent density, as determined by ASTM D2854 0.4 to 0.6

grams per cc, corrected for moisture.

e. Effective size 0.6 - 0.85 mm and uniformity coefficient not greater than 2.0 as determined by ASTM D2862.

f. Water soluble ash content no greater than 2 percent.

g. Minimum abrasion number of 85.

h. Submit manufacturer's certificates on source and chemical composition of GAC, including the name and address of the production facility, attesting that the activated carbon furnished meets the specified requirements.

i. Submit the following manufacturer's product instructions.

1) GAC change out instructions.
2) Initial preparations and GAC loading instructions.

B. Material Evaluation

1. Sample of liquid-phase GAC media from the same lot before shipment that is analyzed by the supplier to demonstrate compliance with the media specifications.

2. Material data sheet to demonstrate compliance with specifications and all applicable physical and chemical properties.

3. Headloss properties of supplied GAC material at depth proposed for the pressure vessels to meet the minimum weight requirements.

4. Model results to demonstrate expected life of GAC under average and maximum mass loading conditions.

2.04 MODE OF OPERATION

A. Serial Operation

Each unit shall have an integrated pipe rack system with valves on the influent, effluent and backwash connections to allow any unit to operate and function as the lead or lag unit or stand-by as required.

B. Parallel Operation (if necessary)

The pipe rack system valves on the influent, effluent and backwash connections at each of the parallel unit shall be in an order to allow the unit to be taken out of service to backwash or change out the activated carbon in the unit without affecting the operation of the other units.

C. Parallel or Serial Operation

The pipe rack system shall have valves on the connections for each unit that allow switching between series and parallel modes of operation without disconnecting any of the piping.

2.05 SAMPLING COCKS

Sampling Cocks and Valves brass ground key, lever handle, faucet type sampling cocks or ball valves shall be provided upstream of the adsorbers and on the downstream side of each unit for sampling the influent and the effluent of each of the individual adsorbers. Additional sampling cock shall be provided on the piping manifold between the two GAC vessels as shown on the Contract Drawings.

2.06 VALVES AND PIPING MANIFOLD SYSTEM

A. Valves

1. Design of the valve operators and mechanisms shall avoid initial surges and sudden inrushes of influent or backwash by gradually allowing flows to increase as ports are opened. A dial pointer shall indicate each step of the operation.

2. Valves shall be provided in accordance with Section 40 27 02, PROCESS VALVES AND OPERATORS.

B. Piping

1. Piping shall be designed in accordance with Section 40 27 00, PROCESS PIPING - GENERAL.

2. All valves and piping shall be properly supported to prevent movement or deflection of piping. See Section 40 05 15, PIPING SUPPORT SYSTEMS, for acceptable methods of support.

C. Dielectric Fittings

Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

2.07 BOLTS, NUTS, AND FASTENERS

Bolts, anchor bolts, nuts, washers, plates, bolt sleeves, and all other types of supports necessary for the installation of the equipment shall be furnished with the equipment and shall be galvanized unless otherwise indicated. Where indicated, specified, or required, anchor bolts shall be provided with square plates at least 4 by 4 by 3/8 inch thick or shall have square heads and washers and be set in the concrete forms with suitable sleeves. Expansion bolts shall have malleable-iron and lead composition elements. Unless otherwise specified, stud, tap, and machine bolts shall be of refined bar iron. All threads shall conform to ASME B1.1. Bolts, anchor bolts, nuts, and washers specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A123/A123M or ASTM A153/A153M. Bolts, anchor bolts, nuts, and washers indicated to be stainless steel shall be Type 316 stainless steel.

2.08 FACTORY TESTS

The adsorption system equipment shall be assembled in the shop to the

maximum practical extent. A factory pressure test shall be made at 125 percent of the rated pressure of the equipment. Fiberglass tanks shall be examined in accordance with ASTM E1067/E1067M. Test reports shall be furnished to the Contracting Officer prior to shipment of the equipment.

PART 3 EXECUTION

3.01 SAFETY

GAC depletes oxygen from air and can be hazardous in a confined situation. Contractor shall be responsible for workers safety and follow all local, State, and Federal guidelines pertaining to confined space entry procedures.

The GAC shall be installed as a wet slurry to minimize dust and abrasion, unless otherwise approved by Contracting Officer.

3.02 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.03 EQUIPMENT INSTALLATION

Each adsorber shell or tank shall be anchored to the floor slab. Anchor brackets, anchor rods or straps shall be provided to hold the shell to anchors in the footing. Skids shall be fabricated from steel channels and shall be designed to support the equipment and to distribute the weight in transit and in service filled with water without point loading on the tank or concrete slab.

3.04 PIPE, VALVES, FITTINGS AND APPURTENANCES

Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with Section 40 27 00, PROCESS PIPING. Differing metals shall be provided with isolation devices.

A. Strainers

Strainer heads and strainers shall be protected while concrete fill provided for support of the header-lateral-distributor head is being placed.

3.05 PAINTING/CORROSION PREVENTION

All ferrous surfaces shall be coated or painted.

A. Exterior Surfaces

Factory primed surfaces shall be solvent-cleaned before painting. Surfaces that have not been factory primed shall be prepared and primed in accordance with the paint manufacturer's recommendations. The paint system applied to the outside of the tank shall be in accordance with Section 09 90 00 PAINTING AND COATING. Color shall be as indicated on the paint schedule or as otherwise approved.

B. Interior Surfaces

Tank interior surfaces shall be coated with the coating conforming to Section 3.2, 3.3, 3.4, 3.5, 3.6, or 3.7 of AWWA D102. System of three coats, 3.9 to 5.9 mils dry film thickness (DFT) per coat, for total of 11.7 to 17.7 mils minimum DFT.

C. Touch-Up Painting

Factory painted items shall be touched up as needed. Factory painted items requiring touching up in the field shall be thoroughly cleaned of all foreign material, primed and top-coated with the manufacturer's standard factory finish.

D. Field Painting

Equipment which did not receive a factory finish shall be painted as specified in Section 09 90 00 PAINTING AND COATING.

E. Corrosion Resistant Metals

Painting of corrosion resistant materials such as copper, brass, bronze, copper-nickel, and stainless steel is not required unless otherwise specified.

3.06 FIELD TESTS

All products shall be carefully inspected for defects in workmanship and material; debris and foreign matter shall be cleaned out of valve openings and seats; all operating mechanisms shall be operated to check their proper functioning; and all nuts and bolts shall be checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

A. Hydrostatic Tests

After installation, all tanks shall be tested for water tightness. Testing plugs or caps, all necessary pressure pumps, pipe connections, gauges, other equipment, and all labor required shall be included. Test pressures shall be 75 psi. Piping systems shall be isolated from the tanks for pressure testing at the specified test pressures.

B. Performance Tests

As defined in Section 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP and in Section 01 92 00, FIRST YEAR OPERATIONS AND MAINTENANCE. All testing shall be in accordance with the requirements of Section 01 35 45 CHEMICAL DATA QUALITY CONTROL.

C. Activated Carbon Sampling and Analyses

Sampling and analyses of the activated carbon media shall be performed in accordance with requirements of the RCRA permitted treatment, storage and disposal facility.

D. Discharge

During the capacity test, treated water shall stored as necessary to maintain the required flow rate. Submit reports for discharge permit compliance.

E. Utilities

The obtaining of water, electric power and other utility items as well as the disposal of water drainage are the responsibility of the Contractor.

3.07 MANUFACTURER'S SERVICES

Provide the services of a representative of the manufacturer who is experienced in the installation, adjustment, and operation of the equipment specified. The representative shall supervise the installing, adjusting, and testing of equipment in accordance with Section 01 43 33, MANUFACTURER'S FIELD SERVICES.

1. One (1) day for initial GAC loading.
2. Two (2) days for the manufacturer's certificate of proper installation and startup.

-- End of Section --

SECTION 43 41 45

FIBERGLASS REINFORCED TANKS (EQ AND TREATED WATER)
09/17

PART 1 GENERAL

1.01 DESCRIPTION

A single manufacturer shall provide two (2) 3,200 to 3,500 gallon capacity fiberglass reinforced plastic tanks as follows:

1. Influent Flow Equalization (EQ) Tank (Tank No. 100).

2. Treated Water Tank (Tank No. 700)

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA D120	(2009) Thermosetting Fiberglass-Reinforced Plastic Tanks

NSF INTERNATIONAL (NSF)

NSF/ANSI 61	(2016) Drinking Water System Components - Health Effects

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety and Health Requirements Manual

UNDERWRITERS LABORATORIES (UL)

UL 1316	(1994; Reprint May 2006) Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Each Tank And Accessories; G

SD-03 Product Data

Anchoring and bracing calculations; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation And Operating Guidelines; G

Manufacturer's Installation Manual And Operating Guidelines; G

Storage And Handling Requirements And Recommendations; G

Installation Preparation And Recommendations; G

SD-11 Closeout Submittals

Warranty; G

1.04 QUALITY ASSURANCE

A. Regulatory Requirements

Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction.

1.05 DELIVERY, STORAGE AND HANDLING

Comply with tank manufacturer's installation and operating guidelines recommendations for delivery, storage, and tank handling.

1.06 WARRANTY

Provide manufacturer's standard limited warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Acceptable Manufacturer's and Products:

1. Xerxes Corporation Fiberglass Aboveground Tanks.
2. GEI Works Fiberglass Water Storage Tanks.
3. Nationwide Tank and Pipe Fiberglass Tank.
4. Or approved equal.

2.02 EQUIPMENT

A. Tank Design - Fiberglass reinforced plastic (FRP) tanks

1. Tank Design: Single-Wall vessel as specified and shown on the Contract Drawings.

2. Tank Configuration: Aboveground Storage Tank Vertical (AST-V) configurations shall be as specified and shown on the

Contract Drawings.

3. The tank size, fittings and accessories shall be as shown on the drawings.

4. Tank Type: Vertical Flat-Bottom.

5. Tank Diameter: 8 to 9 feet.

6. Tank Height: 8 to 9 feet.

7. Tank Capacity: 3,200 to 3,500 gallons

8. Tank shall be manufactured with structural ribs which are fabricated as an integral part of the tank wall.

9. Tank shall be manufactured with a laminate consisting of resin and glass fiber reinforcement only. No sand/silica fillers or resin extenders shall be used.

10. Tank shall be vented through the vapor phase granular activated carbon units.

11. Tank shall be capable of handling liquids with specific gravity up to 1.1.

12. Tank shall be compatible with liquids identified in the manufacturer's standard limited warranty.

B. Insulation

On both EQ and treated water tanks, furnish and install closed-cell, nonwicking flexible elastomeric insulation; 1-inch thickness and 4.2 R-value, minimum.

1. Insulation shall be antimicrobial with water vapor transmission no greater than 0.05 perm-inch.

2. Install insulation over 100 percent of tank surfaces.

3. Adhesive shall be compatible with insulation material and applied to 100 percent of tank surface.

4. Seal longitudinal seams and end joints.

5. Clean tank surfaces to be insulated before insulation installation.

C. Loading Conditions

AST-V tanks shall be designed to withstand a full hydrostatic load with a 2:1 safety factor.

D. Accessories - Aboveground Tank Applications

1. Piping and Fittings

a. Tanks shall be equipped with factory-installed threaded fittings, or fiberglass nozzles.

b. PVC piping shall at a minimum meet the requirements of ANSI Schedule 40.

c. All flanged nozzles shall be flanged and flat-faced, and conform to Class 150 bolting patterns as specified in ASME B16.5.

d. Carbon steel and stainless steel NPT fittings shall withstand a minimum of 150 foot-pounds of torque and 1,000 foot-pounds of bending, both with a 2:1 safety factor.

2. Manway Openings: The standard manway shall be flanged, 22 inches I.D. and complete with gaskets, bolts and cover. All tanks will be marked as permitted confined spaces for all work under the requirements of Section 01 35 29 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES and EM 385-1-1.

3. Ladders: Ladders shall be the standard FRP, aluminum or NSF/ANSI 61 approved ladder as supplied by tank manufacturer.

4. Tank Anchoring:

a. Number and location of tie-down lugs to be standard.
b. Tank shall be supported and braced to resist loads as specified in Section 01 88 15, SEISMIC ANCHORING AND BRACING.

E. Industrial Wastewater Applications

1. Governing Standards, as applicable:

a. AWWA D120 - Thermosetting Fiberglass-Reinforced Plastic Tanks.
b. Tank manufacturer shall be recognized by Underwriters Laboratories (UL) as a manufacturer of tanks listed to the UL 1316 standard.

F. Product Information

1. Shop Drawings of each tank and accessories.

2. Storage and handling requirements and recommendations.

3. Installation preparation and recommendations.

4. Anchoring and bracing calculations as specified in Section 01 88 15, SEISMIC ANCHORING AND BRACING.

PART 3 EXECUTION

3.01 TESTING

Tanks shall be tested according to the tank manufacturer's installation manual and operating guidelines in effect at time of installation.

3.02 INSTALLATION

Tanks shall be installed according to the tank manufacturer's installation manual and operating guidelines in effect at time of installation.

-- End of Section --

DIVISION 44 – POLLUTION AND WASTE CONTROL EQUIPMENT

SECTION 44 42 10

AIR STRIPPER AND BLOWER
09/17

PART 1 GENERAL

1.01 DESCRIPTION

The air stripper shall be low profile, with six trays, designed for the removal of volatile organic compounds (VOCs) from liquids by incorporating fresh air flowing through multiple perforations in the bottom of one or more trays from an induced draft blower, in a single-pass counter-current liquid stream flowing across each tray.

1.02 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 211	(2013; Rev 2016) Certified Ratings Program Product Rating Manual for Fan Air Performance

UNDERWRITERS LABORATORIES (UL)

UL 508	(1999; Reprint Oct 2013) Industrial Control Equipment

1.03 QUALITY ASSURANCE

A. Product Stewardship

Manufacturer shall provide name and phone number of reference familiar with performance, operation, and customer support provided by manufacturer on identical technology in operation over minimum of 10 years.

1.04 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Power And Control Wiring Diagrams; G

Equipment Fabrications And Interface With Other Items; G

SD-03 Product Data

Make, Model, Weight, And Horsepower Of Each Piece Of Equipment;

G

Manufacturer's Catalog Information; G

Instrument Cut Sheets And Ranges; G

Shop And Field Painting Systems; G

SD-05 Design Data

Anchorage And Bracing Calculations; G

Pressure Drop Calculations; G

External Utility Requirements; G

SD-06 Test Reports

Factory Test Results; G

Field Test Results; G

SD-07 Certificates

Calibration Certificates

Manufacturer's Certificate Of Compliance

Manufacturer's Certificate Of Proper Installation

SD-08 Manufacturer's Instructions

Special Shipping, Storage And Protection, And Handling Instructions; G

Manufacturer's Written/Printed Installation Instructions; G

SD-10 Operation and Maintenance Data

Routine Maintenance Requirements; G

Operation And Maintenance Data; G

SD-11 Closeout Submittals

Special Tools For AS Operations; G

Warranty; G

1.05 EXTRA MATERIALS

A. Provide list of recommended spare parts.

B. Provide any necessary tools required for tray disassembly and removal.

1.06 WARRANTY

Manufacturer shall supply as part of proposal package a copy warranty

documenting formal warranty coverage for 1 year from date of shipment.

1.07 PROJECT CONDITIONS

A. Location: South Plainfield, Middlesex County, NJ.

B. Ambient air temperature range: 0 to 100 degrees Fahrenheit.

C. Relative Humidity: Up to 100 percent.

PART 2 PRODUCTS

2.01 GENERAL

Stripper, blower, and all appurtenances shall be skid-mounted on a modular steel painted frame with the exception of the in-line duct heater. The skid shall have provisions for lifting by forklift and crane. Skid shall be suitable for direct anchoring to the floor slab.

A. Performance

1. At a maximum influent liquid flowrate of 65 gpm, the air stripper shall be able to remove 99 percent of the primary volatile organic compounds in the contaminated water as listed in Table 1.

Table 1

Compound	Maximum Expected Concentration (ug/L)	NJPDES DSW EFFLUENT STDS FOR FW-2 (ug/L)
cis-1,2-DCE	7290	1
trans-1,2-DCE	30	54
PCE	26	5
TCE	6822	16

2. Performance projection shall be provided for the specific operating conditions listed above and based on operational data interpreted by modeler software.

2.02 EQUIPMENT

A. Air Stripper

1. Materials of construction of sump, trays, and cover shall be Type 304 stainless steel. Standard product design shall include one low-profile aeration unit shell with the following specifications:

a. The shell shall accommodate slide-out removable, interchangeable sieve trays for easy cleaning.

b. Access to the individual trays shall be provided via a removable hatch, without requiring removal of influent, effluent, or air discharge piping. The hatch shall be constructed of transparent material to allow visual observation of stripper operation. Optional hinged door(s) allows tray access without the need to fully remove hatch(s).

c. The air stripper shell dimension shall be no smaller than 37 inches D by 27 inches W by 102 inches H, with operational clearance of no smaller than 35 inches.

d. The shell shall be of one piece welded construction; to minimize seal and gasket requirements, 5 sides shall be imperforate except for welded or flanged fittings used for air, liquid, or sensor connections.

e. The air stripper shall be equipped with integral sump, tray support tracks, and a high efficiency demister, plus an external sump gauge to allow visual observation of water level, plus a high efficiency polypropylene demister. Demister shall effectively remove 98 percent of water droplets (at 10 microns size) at air flow velocity greater than stripper blower maximum capacity.

f. Shell construction shall be of Type 304 uncoated stainless steel, with nominal wall thickness of 10 GA (0.14 inches). Construction must be suitable for all loads placed on shell, including but not limited to: loads resulting from internally supported parts, weight of operating liquid, piping, structural supports, internal or external pressure.

g. Shell design shall include mounting brackets suitable for holddown on a skid or floor, plus forklift cutouts and/or lifting lugs to allow the unit to be moved easily without damage.

2. Standard product design shall include removable sieve trays with the following specifications:

a. Trays shall be constructed of stainless Type 304 steel with a slide-out design.

b. Trays shall have latches designed to hold them in position on the shell slide tracks.

c. Trays shall include a mechanical flow control device which will regulate water volume in each tray, preventing air short circuiting.

d. Trays shall be supplied with engineered perforations, sized and located to maintain not less than 3.8 square feet of active area of optimum mass transfer (not including seal pot or downcomer area).

e. Design shall allow the option of purchasing a set of spare trays. (This option reduces system downtime by

allowing operation to resume without a delay for tray cleaning. It may also permit easier tray cleaning {i.e., by setting trays aside, calcium or iron fouling can dry on them so it can simply be cracked off.})

f. Design shall allow the option of purchasing two part trays. (This option reduces tray weight to allow easier removal during tray cleaning.)

g. Tray design shall be such that stainless steel down comers can be lifted out of trays during tray removal. Down comers will be sealed to tray surface by single piece neoprene gasket to prevent air bypass.

h. Tray design shall provide for use of removable seal pot pans which provide a self-regulating down comer seal during start-up.

i. Standard product design shall include piping connections.

3. Nominal air flow of at least 320 cubic feet per minute (cfm).

4. Minimum air to water ratio of 31:1.

5. High efficiency demister to remove water droplets

B. Induced Draft Air Stripper Blower

The blower shall be a direct drive pressure blower (or a direct drive regenerative type blower).

1. Blower design and performance shall meet requirements as specified below.

2. Equipment Design Requirements - Direct Drive Blower

a. Standard product design shall include one pressure blower with all-welded steel housing and aluminum wheel, with the following specifications:

1) Blower shall be an industrial quality model rated for continuous duty, certified and licensed to bear the AMCA (Air Movement and Control Association, Inc.) Seal, in accordance with AMCA 211.
2) Blower shall be factory balanced and motor-coupled.
3) Blower shall be supplied with an air flow throttle, factory installed preset to match stripper system requirements, and labeled to indicate settings for clean operation, turn-up range, and overload conditions.
4) Blower inlet shall be equipped with a 90 degree elbow serving as an inlet safety guard, ready for connection to an air inlet duct if desired.
5) Blower shall include a built-in water drain.

b. Standard product design shall include one industrial quality (such as Baldor, GE or approved equal) electric motor, with the following specifications:

1) Blower-motor unit shall be a compact, direct-drive arrangement with the blower wheel mounted directly on motorshaft, to minimize the number of moving parts and for ease of maintenance.
2) Motor must meet the system's electrical voltage/phase and explosion-proof requirements (if applicable).

c. Standard product design shall include outlet ducting to connect the blower outlet flange to the stripper inlet ducting. Duct size and design shall be sufficient to allow the blower to operate at full capacity. Duct design shall include a section routed high to prevent water from reaching the blower in the event of a system shutdown.

d. Blower/motor unit shall be primed and painted.

3. Equipment Design Requirement-Regenerative Blower

a. Standard product design shall include one regenerative blower with cast rather than fabricated aluminum impeller (for ruggedness), housing and cover, meeting the following specifications:

1) Blower shall be an industrial quality model rated for continuous duty at the required workload.
2) Blower shall be factory balanced and motor-coupled. Blower shall be equipped with a Teflon shaft seal, final assembly leak tested to less than 1 cc/sec at 3 psi.
3) Blower shall be supplied with an air flow throttle, factory installed preset to match stripper system requirements, and labeled to indicate settings for clean operation, turn-up range, and overload conditions.
4) Blower shall be equipped with an inlet filter and integral intake and exhaust mufflers, held in place with a screen (spring or wire hold-down is not acceptable), to minimize operating noise levels.
5) Inlet and outlet flanges shall be of cast iron; soft metals, such as aluminum are not allowed.

b. Standard product design shall include one industrial quality UL and CSA approved electric motor, with the following specification:

1) Blower-motor unit shall be a maintenance-free, compact direct-drive arrangement.
2) Motor must meet the system's electrical voltage/phase and explosion-proof requirements (if applicable).
3) Motor must be rated for continuous duty and carry full rated load at temperatures below insulation limits; motor ball bearings shall be double sealed with a rated life of not less than 20,000 hours continuous duty at the maximum rated blower load.

c. Standard product design shall include outlet ducting to connect the blower outlet flange to the stripper inlet ducting. Duct size and design shall be sufficient to allow the blower to operate at full capacity. Duct design

shall include a section routed high to prevent water from reaching the blower in the event of a system shutdown.

d. Blower/motor unit shall be primed and painted.

4. Operation and Performance Parameters

a. Blower shall be sized to allow turn-up to overcome fouling of the stripper, extending the time between cleanings.

C. Auxillary Induced Draft Blower

1. Provide an inline auxiliary induced draft blower on the exhaust piping from the air stripper, if deemed necessary, to provide adequate total pressure for the downstream vapor phase GAC units.

2. The auxiliary blower shall also meet the requirements of an induced draft blower as outlined in paragraph 2.02B above.

D. Process Sensors

1. Provide differential pressure switches, gauges, liquid level sensors, liquid flow sensors, and air flow sensors for installation at appropriate points in the air stripper process and linked to a control panel to provide system monitoring capabilities and input for automatic control. Design and performance of all process sensors shall meet requirements listed in this specification.

2. Equipment Design Requirements:

a. A sump differential pressure gauge shall be provided as standard equipment to monitor air stripper performance and indicate when cleaning is necessary due to fouling of stripper tray orifices. It shall meet the following specifications:

1) Gauge shall be diaphragm-actuated dial type, 4 3/4 inches O.D., with white dial, black graduations, and pointer zero adjustment. Case shall be die cut aluminum with anti-corrosion coating and break-resistant, clear plastic face. Gauge shall operate with an accuracy of plus or minus 2 percent of full scale over a temperature range of 20 to 140 F. Gauge shall provide a working pressure range of 0 to 50 inches of water.

b. A sump sight gauge shall be provided as standard equipment, to meet the following specifications:

1) Gauge shall be constructed of clear plastic tube connected to the sump water drain to allow continuous visual sump water level monitoring.

c. Sump high level switch and discharge pump on/off switch shall be available separately or together as an air stripper system option. (Note: sump high level switch is

highly recommended to prevent stripper overflow and blower damage in the event of a drain or discharge pump malfunction.) They shall meet the following specifications:

1) These switches shall be UL and CSA listed, capable of operating with an adjustable liquid level differential, from a minimum of plus or minus 12 inches or greater. Design shall prevent false tripping due to turbulence. PVC jacketing shall provide a resistance to chemical attack. Mercury switches shall not be used.

d. Sump low pressure and high pressure switches shall be available as air stripper system options. (Note: low pressure switch is highly recommended to provide process system shutdown in the event of blower or gasket failure.) They shall meet the following specifications:

1) These switches shall be diaphragm operated, explosion-proof differential pressure switches, UL and CSA listed, approved for use in Class I Groups C and D, Class II Groups E, F and G, and Class III hazardous atmospheres.

e. An air flow indicator shall be available as a system option, to meet the following specifications:

1) Air flow sensor shall be a Pitot Tube type. Design shall meet AMCA and ASHRAE codes and require no calibration. Construction shall be of type 304 stainless steel.

2) Air flow gauge shall be a differential pressure gauge, diaphragm-actuated dial type, 4-3/4 inches O.D., with white dial, black graduations, and pointer zero adjustment. Case shall be die cut aluminum with anti-corrosion coating and break-resistant, clear plastic face. Gauge shall operate with an accuracy of plus or minus 2 percent of full range over a temperature range of 20 to 140 degrees F.

f. A liquid flow meter shall be available as a system option. Liquid flow meter shall be either an in-line electronic meter with digital readout or a mechanical nutating disc meter, to meet the following specifications:

1) Electronic meter shall sense the rotation of an internal turbine and convert it into flow measurements via an on-board microprocessor. It must be capable of accuracy to within plus or minus 1.5 percent. Flow shall be displayed on a 6-digit LCD panel, with operation accessed via two buttons.

2) A nutating disc meter shall measure flow via positive displacement; it must be accurate to within plus or minus 1.5 percent over full range, with an extended 50:1 flow range. Housing shall be of bronze, with only three moving parts to simplify maintenance.

E. Control Panels

1. Provide one Control Panel for air stripper controls, instruments, etcetera as shown on the Contract Drawings. The control panel fabrication and components, including quality and certification requirements shall be in accordance with Section 25 01 00, MASTER CONTROL SYSTEMS.

2. Control panel shall be designed and built to UL 508 Industrial Control Panel requirements.

3. Control panel shall be manufactured in a listed Industrial Control Panel Manufacturing Facility.

4. Control panel enclosure shall be a Type 4 as required for the application.

5. Control panel components shall be industrial quality:

   a. IEC style motor starters.
   b. Fuses.
   c. Transformers.
   d. Timing relays.
   e. Intrinsically safe components (as required).

6. Control panel shall include the following list of features as standard equipment:

   a. Control panel transformer (if required).
   b. Green illuminated selector switch for control and run indicator for each motor.
   c. Red pilot light for each alarm condition.
   d. Main disconnect switch, externally accessible.
   e. IEC-style motor starters.
   f. Mounting kit.
   g. Alarm interlock dry contacts.
   h. Intrinsically safe components and circuits if site conditions require.

7. The following options shall be available:

   a. Alarm beacon and/or horn.
   b. Blank front panel.
   c. Control interlocks for other on-site equipment.
   d. Lightning/surge protection.
   e. Motor elapsed-time meters.
   f. Panel heater.

F. Acceptable Manufacturers and Products

1. QED EZTray Model 6.6.
2. Carbonair Environmental Systems Model STAT 80.
3. Hydroquip ShallowTray Model 2661.
4. Or approved equal.

2.03 PRODUCT INFORMATION

Submit the following information on the selected equipment:

A. Product information including make, model, weight, and horsepower of each piece of equipment.

B. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.

C. Detailed Drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work such as piping and instrumentation.

D. Pressure drop calculations for all components provided by Supplier to confirm blower pressure requirements.

E. External utility requirements such as air, water, power, drain, etc., for each component.

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

G. Shop and Field Painting Systems Proposed: Include Manufacturer's descriptive technical catalog literature and specifications.

H. Instrument cut sheets and ranges.

I. Anchorage and bracing calculations as required by Section 01 88 15, SEISMIC ANCHORAGE AND BRACING.

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

K. Calibration certificates for all instruments.

L. Manufacturer's written/printed installation instructions.

M. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, MANUFACTURERS' FIELD SERVICES.

N. Routine maintenance requirements prior to plant startup.

O. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Fields Services.

P. Operation and Maintenance Data: As specified in Section 01 78 23, OPERATIONS AND MAINTENANCE DATA.

PART 3 EXECUTION

3.01 FABRICATION AND ASSEMBLY

A. Skid Construction

Modular skid construction of frame shall be of painted steel, with provisions for fork lift access.

B. Air Stripper, and appurtenances:

Shall be factory assembled to the greatest extent permitted by shipping constraints.

C. Shipping

A minimum number of shipping sub-assemblies shall be provided, with each supported and contained in a weather-resistant film-sealed shipping cocoon. Loose accessories, fittings, gauges, and documents shall be consolidated in a sealed shipping carton and include as part of shipment. Manufacturer shall select best available freight company for most reliable, timely transfer of system to jobsite.

3.02 INSTALLATION

A. Install skid level and plumb using steel wedges, anchoring skid directly to the floor slab. Grout space between bottom of skid with non-shrink grout as specified in Section 03 30 00.00, CAST-IN-PLACE CONCRETE.

B. Connect suction and discharge piping without imposing strain to flanges or equipment.

C. Accurately place anchor bolts using equipment templates and as specified in Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS.

D. Control panel shall be installed in accordance with manufacturer's recommendations, including but not limited to the following:

1. The control panel shall be installed by a licensed electrician. The National Electrical Code and all applicable state and local codes shall be followed when installing this equipment. This includes but is not limited to any provisions for intrinsically safe or explosion-proof wiring. The installation shall be executed in a neat and workmanlike manner.

2. At no time shall any individual tamper with or change any of the wiring in the control panel without the knowledge and consent of the manufacturer. The installer shall only land wires on the field terminals provided and install or remove any jumpers as shown and indicated on the control schematics to achieve proper operation. Any changes made to the panel wiring other than those just mentioned or those approved by the manufacturer, in writing, will result in the voiding of any warranty associated with the control panel or any of the connected equipment.

3. Provide one air flow meter as shown on the Contract Drawings with remote mount loop powered transmitter display and a 4 to 20 mA analog output for plant PLC. Range 0 to 400 scfm.

4. Provide one pressure gauge, and one low pressure switch for monitoring the discharge of the blower as shown on the Contract Drawings. The pressure gauge shall have a range of 0 to 100 inches WC. The low pressure switch shall be adjustable and set for 20 inches WC to disable the blower and a have a 120 VAC rated dry contact.

5. Provide one Variable Frequency Drive for Blower as shown on the Contract Drawings, including the VFD signal interface and local keypad mounting shall be in accordance with Section

26 29 23, VARIABLE-FREQUENCY MOTOR CONTROLLERS. The VFD shall be mounted in the control panel.

3.03 TESTING

A. Factory Tests

1. Factory test individual components and the completed air stripper skid prior to delivery to the Site.

2. All instruments shall be factory calibrated prior to installation and factory test.

3. Factory test shall include verifying blower operation is within specified flow, pressure, and noise limits.

4. Hydrostatically test stripper sump for leakage.

5. Other tests as per manufacturer's standard testing.

6. Provide results of testing to the Government prior to release for shipping to the Site.

B. Field Tests

1. Functional Test:

a. Inspect after all piping, electrical, and instruments are connected.

b. Verify proper operation of blower, instruments, heater, and other control components.

c. Verify that blower can supply required air flow with vapor phase GAC carbon and piping connected.

d. Verify sound at 3 feet free field is within these Specifications.

e. Liquid test system to verify no leaks are present and water is evenly distributed to the trays.

2. Performance Test: In accordance with Section 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP.

3.04 MANUFACTURER'S SERVICES

Furnish manufacturer's representative for the following services at jobsite or classroom, for minimum person-days listed below, travel time excluded, and in accordance with Section 01 43 3301 43 33, MANUFACTURERS FIELD SERVICES.

1. One (1) person-day for installation assistance, inspection, and certification of installation.

2. Two (2) person-days for functional and performance testing.

-- End of Section --

SECTION 44 42 56.17

FEED PUMPS
09/17

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A single manufacturer shall provide 6 skid mounted end suction horizontal pumps with the specified head and flow conditions with an integral single control panel with Variable Frequency Drives (VFDs) as follows:

1. P-100A/B - Set of primary and secondary feed pumps from EQ Tank to Pressure Filter Unit (PF-200A/B).

2. P-300A/B - Set of primary and secondary feed pumps from Air Stripper (AS-300) to Liquid-Phase Granular Activated Carbon (GAC) Units (LPGAC 1 and LPGAC 2).

3. P-700A - Backwash pump from treated water tank to Liquid-Phase GAC units (LPGAC 1 and LPGAC 2).

4. P-700B - On-demand booster pump from treated water tank for treatment building grey water use.

5. P-800A/B - Sump pump from building sump and backup.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1 (2016; SUPP 2016) Motors and Generators

1.03 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Mechanical And Electrical Drawings; G

Power And Control Wiring Diagrams; G

SD-03 Product Data

Catalog Information; G

Performance Data Curves; G

Motor Nameplate Data; G

SD-05 Design Data

Anchoring And Bracing Calculations; G

SD-06 Test Reports; G

Performance Tests; G

Factory Functional Test Report; G

Filed Functional Test Results; G

SD-07 Certificates

Manufacturer's Certificate Of Proper Installation

SD-08 Manufacturer's Instructions

Manufacturer's Printed Installation Instructions; G

Shipping, Storage And Protection, And Handling Instructions; G

SD-10 Operation and Maintenance Data

Spare Parts List; G

Operation And Maintenance Data; G

PART 2 PRODUCTS

2.01 GENERAL

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

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

Some specific requirements are attached to this section as supplements.

2.03 CONTROL PANEL

A. Provide single control panel for VFDs and pump signals.

B. Control panel fabrication and components, including quality and certification requirements shall be in accordance with Part 1 General and Part 2 Products of Section 25 01 00, MASTER CONTROL SYSTEMS.

C. Provide VFDs for all pumps, including the VFD signal interface and local keypad mounting shall be in accordance with Section 26 29 23, VARIABLE-FREQUENCY FREQUENCY MOTOR CONTROLLERS. The VFDs shall be mounted in the control panel.

D. Control Panel shall include the following switches and indicators:

1. ON/OFF/REMOTE for each pump.
2. Pump Running light for each pump.
3. Fault indicator light for each pump.

2.04 ACCESSORIES

A. Equipment Identification Plate

16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Anchor Bolts

Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS.

2.05 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, PAINTING AND COATING.

B. Manufacturer's standard enamel finish.

2.06 SOURCE QUALITY CONTROL

A. Factory Inspections

Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments

Test all equipment and control panels actually furnished.

C. Factory Test Report

Include curve test results.

D. Functional Test

Perform manufacturer's standard motor test on equipment.

2.07 PRODUCT DATA

Submit the following product data to the Contracting Officer:

A. Complete catalog information, descriptive literature, specifications, and identification of materials of construction. Include Make, model, weight, and horsepower of each equipment assembly.

B. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity.

C. Detailed Mechanical and Electrical Drawings showing the equipment

dimensions, size, and locations of connections and weights of associated equipment.

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

E. Complete motor nameplate data, as defined by NEMA MG 1, motor manufacturer, and including any motor modifications.

F. Factory finish system.

G. Anchoring and bracing calculations as required by Section 01 88 15, SEISMIC ANCHORING AND BRACING.

H. Factory Functional Test Report.

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

J. Manufacturer's printed installation instructions.

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

L. Operation and Maintenance Data: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

M. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, MANUFACTURERS' FIELD SERVICES.

PART 3 EXECUTION

3.01 INSTALLATION

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

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

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

D. After pump and driver have been set in position, aligned, and shimmed to proper elevation, grout space between bottom of skid and concrete foundation with poured, nonshrinking grout of proper category, as specified in Section 03 30 00.00, CAST-IN-PLACE CONCRETE. Remove wedges after grout is set and pack void with grout.

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

F. Anchor Bolts: Accurately place using equipment templates and as

specified in Section 05 50 13, MISCELLANEOUS METAL FABRICATIONS.

3.02 FIELD FINISHING

Equipment as specified in Section 09 90 00, PAINTING AND COATING, as required for touchup.

3.03 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Tests

Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

C. Performance Tests

In accordance with Hydraulic Institute Standards. Demonstrate ability of pump, motor, and VFD to perform across entire range of flow and head conditions.

3.04 MANUFACTURER'S SERVICES

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

1. One (1) person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.

B. See Section 01 43 33, MANUFACTURERS' FIELD SERVICES AND SECTION 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP.

3.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. 44 42 56.17 Feed Pump Data Sheet 1.
2. 44 42 56.17 Feed Pump Data Sheet 2.
3. 44 42 56.17 Feed Pump Data Sheet 3.
4. 44 42 56.17 Feed Pump Data Sheet 4.
5. 44 42 56.17 Feed Pump Data Sheet 5.

-- End of Section --

SECTION 44 42 56.17 **FEED PUMP DATA SHEET 1**

Tag Numbers: P-100A, P-100B
Pump Name: EQ EFFLUENT PUMP #1, EQ EFFLUENT PUMP #2
Manufacturer and Model Number: (1) Goulds 3196 1x1.5-6 STi
(2) Or approved equal
(3)

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater
Pumping Temperature (Fahrenheit): Normal: 70 Max 80 Min 40
Specific Gravity @ 60 Degrees F: 1.0 Viscosity Range: 1 cP
pH: 6-9
Abrasive (Y/N): N Possible Scale Buildup (Y/N): N
Inlet Pressure at Pump (psig): 2
Min. Net Positive Inlet Pressure Available (psia):

PERFORMANCE REQUIREMENTS

Rated Capacity: 65 US gpm at 39 ft TDH; secondary point: 35 gpm @ 43 feet TDH
Max. Pump Speed (rpm): 2,019 Constant (Y/N): No Adjustable (Y/N): Yes
Speed Range: 50 % to 100 % of Rated Speed: Constant Torque (Y/N):

DESIGN AND MATERIALS

Pump Body Material: 316 SST Drive Housing Material: 316 SST
Pump Stages: N/A
Connections:
Suction: Flanged:
Discharge: Flanged:
Shaft Sleeve (Y/N): Yes Material: 316 SST
Shaft Seal: Packing (Y/N): No Material:
Lantern Ring (Y/N): No Material:
Mechanical (Y/N): Yes Type: 316 SST
Lubrication:
ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: Oil
Coupling: Falk (Y/N): Fast (Y/N):
Gear Type (Y/N): Manufacturer Standard (Y/N):
Baseplate: Design: Mounted to skid Material: Painted Steel
Drive Type: Direct-Coupled: X Belt: Hydrostatic Adjustable Speed:
Close Coupled Gear Reducer: Other:

DRIVE MOTOR See Section 26 20 00, Low-Voltage AC Induction Motors

Horsepower: 1.2 HP Voltage: 480 V Phase: 3 Base Speed (rpm): 2,019
Service Factor: 1.15 Inverter Duty (Y/N) Yes
Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.
Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____
Drive Arrangement: In-Line: X Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____
Nonreverse Ratchet (Y/N): No

REMARKS _____

SECTION 44 42 56.17 **FEED PUMP DATA SHEET 2**

Tag Numbers: P-300A, P-300B
Pump Name: LPGAC FEED PUMP #1, LPGAC FEED PUMP #2
Manufacturer and Model Number: (1) Goulds 3196 1x1.5-6 STi
(2) Or approved equal
(3)

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater
Pumping Temperature (Fahrenheit): Normal: 70 Max 80 Min 40
Specific Gravity @ 60 Degrees F: 1.0 Viscosity Range: 1 cP
pH: 6-9
Abrasive (Y/N): N Possible Scale Buildup (Y/N): N
Inlet Pressure at Pump (psig): 2
Min. Net Positive Inlet Pressure Available (psia):

PERFORMANCE REQUIREMENTS

Rated Capacity: 65 US gpm at 72 ft TDH; secondary point: 35 gpm @ 77 feet TDH
Max. Pump Speed (rpm): 2,590 Constant (Y/N): No Adjustable (Y/N): Yes
Speed Range: 50 % to 100 % of Rated Speed: Constant Torque (Y/N):

DESIGN AND MATERIALS

Pump Body Material: 316 SST Drive Housing Material: 316 SST
Pump Stages: N/A
Connections:
Suction: Flanged:
Discharge: Flanged:
Shaft Sleeve (Y/N): Yes Material: 316 SST
Shaft Seal: Packing (Y/N): No Material:
Lantern Ring (Y/N): No Material:
Mechanical (Y/N): Yes Type: 316 SST
Lubrication:
ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: Oil
Coupling: Falk (Y/N): Fast (Y/N):
Gear Type (Y/N): Manufacturer Standard (Y/N):
Baseplate: Design: Mounted to skid Material: Painted Steel
Drive Type: Direct-Coupled: X Belt: Hydrostatic Adjustable Speed:
Close Coupled Gear Reducer: Other:

DRIVE MOTOR See Section 26 20 00, Low-Voltage AC Induction Motors

Horsepower: 2.2 HP Voltage: 480 V Phase: 3 Base Speed (rpm): 2,590
Service Factor: 1.15 Inverter Duty (Y/N) Yes
Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.
Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____
Drive Arrangement: In-Line: X Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____
Nonreverse Ratchet (Y/N): No

REMARKS _____

SECTION 44 42 56.17 **FEED PUMP DATA SHEET 3**

Tag Numbers: P-700A

Pump Name: BACKWASH PUMP

Manufacturer and Model Number: (1) Goulds 3196 1.5x3-8 STi
(2) Or approved equal
(3) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater

Pumping Temperature (Fahrenheit): Normal: 70 Max 80 Min 40

Specific Gravity @ 60 Degrees F: 1.0 Viscosity Range: 1 cP

pH: 6-9

Abrasive (Y/N): N Possible Scale Buildup (Y/N): N

Inlet Pressure at Pump (psig): 2

Min. Net Positive Inlet Pressure Available (psia): _____

PERFORMANCE REQUIREMENTS

Rated Capacity: 100 US gpm at 65 ft TDH; secondary point: 35 gpm @ 95 feet TDH

Max. Pump Speed (rpm): 2,761 Constant (Y/N): No Adjustable (Y/N): Yes

Speed Range: 50 % to 100 % of Rated Speed: _____ Constant Torque (Y/N): _____

DESIGN AND MATERIALS

Pump Body Material: 316 SST Drive Housing Material: 316 SST

Pump Stages: N/A

Connections:

Suction: Flanged:

Discharge: Flanged:

Shaft Sleeve (Y/N): Yes Material: 316 SST

Shaft Seal: Packing (Y/N): No Material: _____

Lantern Ring (Y/N): No Material: _____

Mechanical (Y/N): Yes Type: 316 SST

Lubrication: _____

ABMA B-10 Bearing Life (hrs): 100,000 Lubrication: Oil

Coupling: Falk (Y/N): _____ Fast (Y/N): _____

Gear Type (Y/N): _____ Manufacturer Standard (Y/N): _____

Baseplate: Design: Mounted to skid Material: Painted Steel

Drive Type: Direct-Coupled: X Belt: _____ Hydrostatic Adjustable Speed: _____

Close Coupled Gear Reducer: ___ Other: _____

DRIVE MOTOR See Section 26 20 00, Low-Voltage AC Induction Motors

Horsepower: 3.2 HP Voltage: 480 V Phase: 3 Base Speed (rpm): 2,761
Service Factor: 1.15 Inverter Duty (Y/N) Yes
Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.
Enclosure: DIP _____ EXP _____ ODP _____ TEFC X CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____
Drive Arrangement: In-Line: X Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____
Nonreverse Ratchet (Y/N): No

REMARKS _____

SECTION 44 42 56.17 **FEED PUMP DATA SHEET 4**

Tag Numbers: P-700B
Pump Name: TREATED WATER BOOSTER PUMP
Manufacturer and Model Number: (1) Grundfos CMBE 5-31 AQQE
(2) Or approved equal
(3)

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater
Pumping Temperature (Fahrenheit): Normal: 68 Max 140 Min 32
Specific Gravity @ 60 Degrees F: 1.0 Viscosity Range: 1 cP
pH: 6-9
Abrasive (Y/N): N Possible Scale Buildup (Y/N): N
Inlet Pressure at Pump (psig): Integrated Frequency Converter
Min. Net Positive Inlet Pressure Available (psia):

PERFORMANCE REQUIREMENTS

Rated Capacity: 33.6 US gpm at 69 ft TDH; secondary point: 22.7 gpm @ 92 feet TDH
Max. Pump Speed (rpm): 3,780 Constant (Y/N): No Adjustable (Y/N): Yes
Speed Range: 50 % to 100 % of Rated Speed: Constant Torque (Y/N):

DESIGN AND MATERIALS

Pump Body Material: Stainless Steel Drive Housing Material: Stainless Steel
Pump Stages: N/A
Connections:
Suction: Flanged:
Discharge: Flanged:
Shaft Sleeve (Y/N): N Material: N/A
Shaft Seal: Packing (Y/N): Yes Material: AQQE
Lantern Ring (Y/N): No Material:
Mechanical (Y/N): No Type: N/A
Lubrication:
ABMA B-10 Bearing Life (hrs): N/A Lubrication: N/A
Coupling: Falk (Y/N): Fast (Y/N):
Gear Type (Y/N): Manufacturer Standard (Y/N):
Baseplate: Design: Mounted to skid Material: Painted Steel
Drive Type: Direct-Coupled: Belt: Hydrostatic Adjustable Speed:
Close Coupled Gear Reducer: Other:

DRIVE MOTOR See Section 26 20 00, Low-Voltage AC Induction Motors

Horsepower: 1.5 HP Voltage: 200-240 V Phase: 3 No Base Speed (rpm): 360-4,000 rpm

Service Factor:_____ Inverter Duty (Y/N) Yes

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC __ CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

Drive Arrangement: In-Line:_____ Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____

Nonreverse Ratchet (Y/N): No

REMARKS _____

SECTION 44 42 56.17 **FEED PUMP DATA SHEET 5**

Tag Numbers: P-800A/ P-800B (Spare)
Pump Name: BUILDING SUMP PUMP
Manufacturer and Model Number: (1) Grundfos Unilift KP 350
(2) Or approved equal
(3) _____

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Groundwater
Pumping Temperature (Fahrenheit): Normal: 70 Max 80 Min 40
Specific Gravity @ 60 Degrees F: 1.0 Viscosity Range: 1 cP
pH: 6-9
Abrasive (Y/N): N Possible Scale Buildup (Y/N): N
Inlet Pressure at Pump (psig): 2
Min. Net Positive Inlet Pressure Available (psia): _____

PERFORMANCE REQUIREMENTS

Rated Capacity: 65 US gpm at 3 ft TDH; secondary point: 35 gpm @ 22 feet TDH
Max. Pump Speed (rpm): N/A Constant (Y/N): Y Adjustable (Y/N): N
Speed Range: 100 % to 100 % of Rated Speed: ____ Constant Torque (Y/N): _____

DESIGN AND MATERIALS

Pump Body Material: 304 SST Drive Housing Material: 304 SST
Pump Stages: N/A
Connections:
Suction: Flanged:
Discharge: Flanged:
Shaft Sleeve (Y/N): Yes Material: 316 SST
Shaft Seal: Packing (Y/N): N/A Material: _____
Lantern Ring (Y/N): Y Material: NBR
Mechanical (Y/N): Yes Type: 304 SST
Lubrication: _____
ABMA B-10 Bearing Life (hrs): N/A Lubrication: Water
Coupling: Falk (Y/N): _____ Fast (Y/N): _____
Gear Type (Y/N): _____ Manufacturer Standard (Y/N): _____
Baseplate: Design: _____ Material: _____
Drive Type: Direct-Coupled: _____ Belt: ____ Hydrostatic Adjustable Speed: _____
Close Coupled Gear Reducer: ___ Other: _____

DRIVE MOTOR See Section 26 20 00, Low-Voltage AC Induction Motors

Horsepower: 0.5 HP Voltage: 115 V Phase: 1 Base Speed (rpm): _____
Service Factor: _____ Inverter Duty (Y/N) _____
Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.
Enclosure: DIP _____ EXP _____ ODP _____ TEFC __ CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____
Drive Arrangement: In-Line: _____ Vertical "Z": _____ Piggy Back: _____
Horizontal Offset: _____ C-Face Mounted: _____
Nonreverse Ratchet (Y/N): No

REMARKS _____

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

SECTION 46 61 00

FILTRATION EQUIPMENT
02/11

PART 1 GENERAL

1.01 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN LADDER INSTITUTE (ALI)

ALI A14.3	(2008) Standard for Fixed Ladders and Safety Requirements

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A1264.1	(2017) Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrail/Handrail Systems

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2011) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2013) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2014) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A193/A193M	(2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194/A194M	(2017) Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A216/A216M	(2016) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A312/A312M	(2017) Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A420/A420M	(2016) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A707/A707M	(2014) Standard Specification for Forged Carbon and Alloy Steel Flanges for Low-Temperature Service
ASTM C1147	(2014) Standard Practice for Determining the Short Term Tensile Weld Strength of Chemical-Resistant Thermoplastics
ASTM D1330	(2004; R 2010) Rubber Sheet Gaskets
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2015) Standard Specification for

	Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2564	(2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3308	(2012) PTFE Resin Skived Tape
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ANSI/ISA 5.1	(2009) Instrumentation Symbols and Identification

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993; Reaffirmed 2010) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2017) Butterfly Valves
MSS SP-70	(2011) Gray Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2011; Errata 2013) Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-78	(2011) Cast Iron Plug Valves, Flanged and Threaded Ends
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

1.02 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications Of The Installer, And The Manufacturer's And Media Supplier's Representatives; G

SD-02 Shop Drawings

Wiring And Schematic Diagrams; G

Dimensions, Weight, Layout, And Anchoring Locations; G

Process Flow Diagram And Piping Diagram For Pipe/Valve Manifold System; G

SD-03 Product Data

Posting Framed Instructions; G

Catalog Cut Sheets And Technical Descriptions; G

SD-06 Test Reports

Acceptance Testing; G

SD-10 Operation and Maintenance Data

Field Training; G

Operating And Maintenance Instructions; G

Spare Parts Data For Each Different Item; G

SD-11 Closeout Submittals

Special Tools, Calibration Devices, And Instruments; G

Wiring And Control Diagrams Under Glass Or In Laminated Plastic ; G

1.03 QUALIFICATIONS

Submit qualifications of the installer, and the manufacturer's and media supplier's representatives.

A. Installer

The installer shall have experience in the installation of similar filtration systems and shall show evidence of satisfactory operation for each installation.

B. Manufacturer's Representative

A representative of the filtration system manufacturer, who is familiar with the design and experienced in the installation, adjustment, and operation of the equipment specified shall be present at the jobsite during installation of the filtration system.

C. Media Supplier Representative

A representative of the media supplier who is experienced in the installation of the specified filtration media shall be present at the jobsite during media installation.

1.04 DELIVERY, STORAGE, AND HANDLING

Protect from the weather, excessive humidity, excessive temperature variation, and dirt, dust, or other contaminants equipment delivered and placed in storage.

1.05 EXTRA MATERIALS

Standard spare parts shall be provided as recommended in the manufacturer's instruction manuals for each component of the equipment. Submit spare parts data for each different item of material and equipment specified. Include in the data a complete list of parts and supplies, with current unit prices and source of supply.

PART 2 PRODUCTS

2.01 GENERAL

Submit complete wiring and schematic diagrams; equipment layout and anchorage; and any other details required to demonstrate that the filtration system has been coordinated and will properly function as a unit.

2.02 SYSTEM DESCRIPTION

Provide two bag filtration systems, each with two bag housing units. First bag filtration system shall be used for the pre-treatment of the influent groundwater prior to treatment via air stripper unit, and the second bag filtration system shall be used for the pre-treatment of the backwash water prior to discharge into floor sump. The filtration systems shall be designed, constructed, and installed to comply with the following design conditions.

Supply auxiliary systems and equipment required to maintain complete and workable filter systems including, but not limited to, required piping between units, auxiliary equipment for plumbing and power, and controls and interfaces between auxiliary equipment and the filter. Chemical additives will not be allowed to enhance the filtration system. The installation shall be constructed indoors.

A. Influent Flow Characteristics (First System; Second System)

Average Design Flow	35 gpm; 70 gpm
Maximum Flow Rate	65 gpm; 100 gpm
Minimum Available Head	44 feet; 73 feet
Design Influent Temperature	58 degrees F; 58 degrees F
Maximum Influent Temperature	75 degrees F; 75 degrees F
Minimum Influent Temperature	40 degrees F; 40 degrees F
Flow Conditions	Continuous; Continuous

Design Influent, Suspended Solids	0 mg/L; 50 mg/L
Design Influent, Particle Size	10 micron; 10 micron
Maximum pH	7.3; 7.3
Minimum pH	6; 6
Source of Process Water	Groundwater; Backwash Water
Chemical Pretreatment	None; None
Alkalinity, Bicarbonate	179 mg CaCO3/L; 179 mg
Alkalinity, Carbonate	0 mg CaCO3/L; 0 mg CaCO3/L
Calcium Concentration	73.9 mg/L; 73.9 mg/L

B. Design Criteria (Each System)

Number of Filters	2
Maximum Effluent, Suspended Solids	0 mg/L
Maximum Effluent, Particle Size	10 micron
Backwash Type	none
Maximum Filtration Rate	0.22 gal/second/sq ft
Maximum Influent, Pipe Velocity	3 ft/s
Maximum Effluent, Pipe Velocity	3 ft/s
Clean Bed Maximum Headloss (at design flow and temperature)	5 feet

C. Cartridge and Bag Operating Parameters (First System; Second System)

Design Flow	35 gpm; 75 gpm
Maximum Flow Rate	65 gpm; 100 gpm
Design Inlet Pressure	10 psi; 22 psi
Maximum Pressure	20 psig; 32 psig
Filter Area	5.0 square feet; 5.0 sq ft
Fluid Viscosity	1488.16 lb/ft-s; 1488.16 lb/ft-s
Flow Conditions	Continuous; Continuous

D. Cartridge and Bag Design Criteria

Total Number Operating Units	2
Number of On-line Units	2
Number of Stand-by Units	0
Number of Elements per Unit	2
Design Effluent, Suspended Solids	0 mg/L

Design Effluent, Particle Size	10 micron
Maximum Differential Pressure	10 psi at design temperature
	10 psi at maximum temperature

2.03 MATERIALS AND EQUIPMENT

A. Product Data

Contractor shall provide the following information:

1. Catalog cut sheets and technical descriptions on vessel construction including materials of construction, coatings and liners, and performance.

2. Shop drawings including dimensions, weight, layout, and anchoring locations.

3. Process flow diagram and piping diagram for pipe/valve manifold system for connection to Air Stripper

B. Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

C. Nameplates

Provide each major item of equipment with the manufacturer's name, address, type of style, model or serial number, and catalog number on a plate secured to the item of equipment.

D. Protection of Moving Parts

Completely enclose by guards belts, chains, couplings, and other moving parts to prevent accidental personal injury. Guards shall be removable or arranged to allow access to the equipment for maintenance. If equipment is housed in a lockable housing, this shall be sufficient protection and no additional guards are necessary.

E. Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

F. Steel Plates, Shapes and Bars

Comply with ASTM A36/A36M.

G. Pipe and Fittings

Pipe and fittings shall conform to the standards specified below.

1. Steel Pipe

Comply with ASTM A53/A53M.

a. Flanged Joints: ASTM A707/A707M.
b. Welded Joints: AWS D1.1/D1.1M.
c. Bolts: ASTM A307, Grade B.
d. Fittings: ASTM A420/A420M.

2. Ductile Iron Pipe

Comply with AWWA C115/A21.15.

a. Flanged Pipe: AWWA C115/A21.15 with ASME B16.1, Class 125 flanges.
b. Rubber-Gasket Joints: AWWA C111/A21.11.
c. Fittings: AWWA C110/A21.10.
d. Push-on Joints: AWWA C151/A21.51.
e. Bolts and Nuts: ASTM A307, Grade B.

3. Stainless Steel Pipe

Comply with ASTM A312/A312M, Schedule 40, Type 316 or Type 304.

a. Flanged Pipe: ASME B16.5, Class 150.
b. Rubber-Gasket Joints: ASTM D1330.
c. Fittings: ASME B16.3.
d. Bolts: ASTM A193/A193M, Class 1, Grade B8.
e. Nuts: ASTM A194/A194M, Grade 8.

4. Polyvinyl Chloride (PVC) Pipe

PVC pipe and fittings less the 4 inch diameter shall be in accordance with ASTM D1785 or ASTM D2241. PVC pipe and fittings 4 inch in diameter or larger shall be in accordance with ASTM D2241 and shall have push-on joints.

a. Push-on Joints: ASTM D3139 or ASTM F477.
b. Solvent Cement: ASTM D2564.

H. Pipe Hangers and Supports

Comply with MSS SP-58.

I. Valves

1. Steel Valves

Comply with ASTM A216/A216M, Grade WCB.

2. Cast Iron Valves

Comply with ASTM A126, Class B.

a. Globe and Angle Valves: MSS SP-85.
b. Gate Valves: MSS SP-70.
c. Plug Valves: MSS SP-78.
d. Butterfly Valves: MSS SP-67.
e. Ball Valves: MSS SP-72.
f. Check Valves: MSS SP-71.

3. PVC Valves

Comply with ASTM D1784, Class 12454-B (formerly designated Type I, Grade 1).

J. Other Materials

1. Polypropylene Support Material
Comply with ASTM C1147.

2. Joint Compound

Joint compound for threaded joints shall be a stiff mixture of graphite and oil, inert filler and oil, or a graphite compound.

3. Joint Tape

Joint tape for threaded joints shall comply with ASTM D3308.

2.04 BAG FILTER

A. Equipment Capacity

Supply 2 filtration units for each of the 2 bag filtration systems. 1 unit shall be on-line, 1 shall be standby during operation for each system, respectively. Each on-line and standby unit shall have the capacity to treat the entire waste stream as specified in Paragraph Cartridge and Bag Design Criteria.

B. Filter Material

The filter material shall be of polyester, PTFE, or approved equal.

C. Gasket Material

A single gasket cover seal for each bag element shall be provided. The material of construction shall be silicone, buna-N, or approved equal.

D. Pore Size/Rating

The bag pore size shall be 10 microns.

E. Bag Surface Area

The bag surface area shall be 5 square feet.

F. Bag Support

Support material shall be 304 stainless steel.

G. Filter Housing

1. Material of Construction

The filter housing head, shell, and associated internal and external connections and internal and external hardware shall be constructed of 304 stainless steel. The housing shall be prefabricated and delivered to the site in such a condition that the unit can be fastened in the location designated on the design drawings. The following are typical filter housing dimensions and inlet, outlet, and system control connections:

Diameter	7.7 in
Overall Height	57 in
Inlet/Outlet	3 in, Flange, ANSI 150 lb, raised face
Gauge	0 to 60 psig

2. Shell O-Ring Material

The filter housing shell O-ring material shall be buna-N, silicon, or approved equal.

2.05 SAMPLE PORTS

Two sample ports, at a minimum, shall be located on each unit; one to sample the influent and one to sample the effluent. The sample ports shall be readily accessible and shall be of the manufacturer's standard design and placement.

2.06 TURBIDIMETER

A turbidimeter for automatically testing the turbidity of the water shall be installed in the influent line and effluent line for each filter unit. The influent and effluent sample shall be obtained directly from the piping. The turbidimeter shall be housed in a NEMA 4x enclosure and located within 5 feet from the sensor. It shall be programmable to read in NTU units.

2.07 ACCESS WALKWAYS, PLATFORMS, LADDERS AND HANDRAILS

Walkways, platforms and ladders shall be provided for access to equipment for operation and maintenance in accordance with Section 05 50 13 MISCELLANEOUS METAL FABRICATIONS. Walkways and platforms shall be nonslip open grating fabricated from galvanized steel, aluminum, or approved equal. Rigid handrails and kick-plates shall be provided along the sides of walkways and platforms. Handrails shall be fabricated from galvanized steel, aluminum, or approved equal, shall be 4 feet high, and shall have two horizontal rails. Gates shall be provided as required for access to equipment. The last rung

of the ladder on top shall be at the same level as the top of the tank. Construction shall conform to ASSE/SAFE A1264.1 and ALI A14.3.

PART 3 EXECUTION

3.01 EXAMINATION

Verify all dimensions in the field and advise the Contracting Officer of any discrepancy before performing the work.

3.02 PREPARATION

A. Fabrication

Work not required to be performed in the field shall be performed in a factory under controlled conditions.

B. System Installation

The system shall be installed such that proper flow through the unit and required effluent conditions as specified in Paragraphs Design Criteria or Cartridge and Bag Design Criteria (as applicable) will be achieved and maintained. Electrical work shall be in accordance with the applicable requirements of DIVISION 26, ELECTRICAL.

3.03 PAINTING

Painting shall be performed in accordance with applicable requirements provided in Section 09 90 00 PAINTING AND COATING, and additional requirements provided herein.

A. Metal surfaces

Metal surface, except aluminum, bronze, brass, galvanized steel, and stainless steel shall be painted. Surface preparation and painting shall be performed in the shop or in the field as indicated. Manufactured items, such as motors and switchboards, shall be finished with the manufacturer's standard finish.

B. Preparation and Application

Ferrous metal surfaces shall be prepared in accordance with SSPC SP 6/NACE No.3 and painted with two or three coats of MIL-DTL-24441 epoxy paint to achieve a total dry film thickness of 150 microns (6 mils). Master Painter's Institute (MPI) #120 Epoxy, High Build, Self Priming, Low Gloss, is an acceptable replacement to MIL-DTL-24441.

C. Coating Testing

Coating shall be examined for flaws and tested for thickness. Thickness of coatings shall be measured wet and dry using a commercial film thickness gauge. The Contracting Officer shall be notified in advance of any painting. Additional coats shall not be applied until the previous coat has been approved. Repair or additional coats shall be accomplished at no additional cost to the government.

D. Coating Repair

If welding is required after application of the coating or if the coating is damaged in any way, repair shall consist of preparing the affected area in compliance with SSPC SP 6/NACE No.3 and reapplying the coating to that area. If holidays are detected or film thickness is insufficient, the surface shall be prepared and additional coats applied in the affected area in compliance with the manufacturer's instructions.

3.04 VALVE AND PIPE INSTALLATION

A. Valves

Valves shall be installed as close as possible to the position shown on the Contract Drawings. Valves shall be erected and supported in their respective position free from distortion and strain on appurtenances during handling and installation. Material shall be inspected for defects in workmanship and material. Debris and foreign material shall be cleaned out of valve openings and seats; operating mechanisms shall be operated to check their proper functioning, and nuts and bolts checked for tightness. Valves and other equipment which do not operate easily or are otherwise defective shall be repaired or replaced.

B. Piping

Piping shall be installed to accurate lines and grades. Where temporary supports are used they shall be sufficiently rigid to prevent shifting or distortion of the pipe. Provision shall be made for expansion where necessary. Piping shall pitch toward low points, and provision shall be made for draining these low points. A sufficient number of unions or flanges shall be used to allow for the dismantling of all water pipe, valves, and equipments. Installation of piping including cleaning, cutting, threading and jointing, shall be in accordance with DIVISION 22 - PLUMBING.

3.05 UNDERDRAIN

The underdrain shall be installed in accordance with approved shop drawings and requirements of the manufacturer, including instructions of the manufacturer's representative.

3.06 IDENTIFICATION SYSTEMS

A. Identification Tags

Identification tags made of brass, engraved laminated plastic, or engraved anodized aluminum, indicating service and valve number shall be installed on valves, except those valves installed on supplies at plumbing fixtures. Tags shall be 1-3/8 inch minimum diameter, and marking shall be stamped or engraved. Indentations shall be black, for reading clarity. Tags shall be attached to valves with No. 12 AWG, copper wire, chrome-plated beaded chain, or plastic straps designed for that purpose.

B. Color Coding

Color coding for piping identification shall be as specified in Section 09 90 00 PAINTING AND COATING.

3.07 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. Submit proposed diagrams and instruction prior to posting. Post the framed instructions before acceptance testing of the system.

3.08 FIELD TESTS AND INSPECTIONS

Perform field tests in the presence of the Contracting Officer and provide labor, equipment, and incidentals required for the tests. Provide for disposal of all waste residuals resulting from the tests. Notify the Contracting Officer 5 days prior to the date and time for the acceptance tests. Any deficiencies found shall be rectified and work affected by such deficiencies shall be retested.

A. Initial Operation

Following completion of installation of the treatment systems and after the Contractor and manufacturer's representative agree the system is ready for operation, the system shall be operated as specified in Section 01 91 14, EQUIPMENT TESTING AND FACILITY STARTUP. Demonstrate proper operation of the equipment, including, but not limited to, the ability of the system to produce the minimum specified effluent requirements detailed in Paragraphs Design Criteria or Cartridge and Bag Design Criteria (as applicable), proper operation of the media cleaning equipment, and the control system ability to provide the correct operational logic to optimize the filtration process.

B. Acceptance Testing

Acceptance testing shall commence following approval of the initial operation and as per the schedule approved by the Contracting Officer. The acceptance tests shall demonstrate the ability of the filtration system to meet the effluent specified requirements when operating at the design flow rate and to demonstrate the control system ability to provide the correct operational logic to optimize the filtration process. In the event that the specified filtered water quality requirements are not met during the period that acceptance testing is conducted, the defective equipment or operation shall be modified or replaced and the testing repeated. The schedule for retesting is subject to approval by the Contracting Officer.

Submit test reports in booklet form showing field tests performed to adjust each component and to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

3.09 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided after the system is functionally complete but prior to final acceptance test. Field training shall cover all of the items contained in the Operating and Maintenance Instructions. The instructions shall include, but shall not be limited to the following:

a. System layout showing piping, valves and controls and installation requirements.

b. Approved wiring, logic, and control diagrams prepared in accordance with ANSI/ISA 5.1 including a drawing index, legend and symbols list, and abbreviations and identifiers.

c. A control sequence describing startup, operation, and shutdown; including the functional and operational description of the control system covering the procedures for programming, operation, startup, shut-down, and calibration.

d. Operating and maintenance instructions for each piece of equipment, including checkout, troubleshooting, and servicing.

e. Manufacturer's bulletins, cut sheets and descriptive data, parts list, and recommended spare parts.

3.10 OPERATING AND MAINTENANCE INSTRUCTIONS

Provide operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown in accordance with this paragraph and Section 01 78 23, OPERATION AND MAINTENANCE DATA. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of equipment and their basic operating features. Also, provide maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble shooting guides. The instructions shall include simplified diagrams for the system as installed. The manual shall require valves be numbered and tagged and shall provide a schematic indicating the number of each valve. Each set shall be permanently bound and shall have a hard cover. The following identification shall be inscribed on the covers: the words "OPERATING AND MAINTENANCE INSTRUCTIONS," name and location of the facility, name of the Contractor, and contract number.

-- End of Section --