BOOK 3
DETAILED SPECIFICATIONS
PART 2 OF 3

STATE / LAKE LOOP ELEVATED STATION

CDOT PROJECT ID: D-1-209
SPECIFICATION NO.: 1269715

CITY OF CHICAGO

BRANDON JOHNSON
MAYOR

Prepared by
Department of Transportation (CDOT)
Contracts Section

THOMAS CARNEY
Acting Commissioner of Department of Transportation
2 N. LaSalle Street, Suite 1110
Chicago, Illinois 60602-2570

DANIEL BURKE, P.E., S.E.
Managing Deputy Commissioner – Division of Engineering

Issued by the
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AILEEN VELAZQUEZ
CHIEF PROCUREMENT OFFICER

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All Signatures To Be Sworn To Before A Notary Public

Any contract entered into as a result of this bid process is governed by the terms and conditions set forth in Book 1 "Terms and Conditions for Construction" for CDOT FTA, as amended and incorporated as if fully set forth here by this reference; and by Book 2, Book 3 (if applicable), plans, drawings, exhibits, and attachments as appropriate.

SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following: Piping materials, equipment, accessories and their installation, commissioning and testing:

1. Water supply piping, drain piping, vent piping.
2. Connections, fittings.
3. Valves, sensors, controls.
4. Sleeves.
5. Escutcheons.
6. Faucets, drains, strainers, traps and accessories.
7. Supports and anchorages.
8. Pumps.
9. Meters.
10. Service connections.
11. Sump pits, manholes, catch basins.
12. Insulation.
13. Heat tracing.
14. Plumbing Fixtures.
15. Hot water heaters.
16. Natural gas piping, connections and valves.

B. Individual plumbing specification sections have specific requirements that are in addition to the requirements of this section.

C. Related Sections:

1. Section 07 84 13, Penetration Firestopping.
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping
3. Section 22 05 18, Escutcheons for Plumbing Piping
4. Section 22 05 19, Meters and Gages for Plumbing Piping
5. Section 22 05 23, General-Duty Valves For Plumbing Piping
6. Section 22 05 29, Hangers and Supports For Plumbing Piping and Equipment
7. Section 22 05 33, Heat Tracing For Plumbing Piping
8. Section 22 07 00, Pipe Insulation
9. Section 22 11 16, Domestic Water Piping
10. Section 22 11 19, Domestic Water Piping Specialties Section 22 11 23, Domestic Water Pumps
11. Section 22 13 14, Plumbing for Underground Drainage
12. Section 22 13 16, Sanitary Waste and Vent Piping
13. Section 22 13 19, Sanitary Waste Piping Specialties
14. Section 22 13 20, Sanitary Drains
15. Section 22 13 29, Sanitary Sewerage Pumps
16. Section 22 14 13, Storm Drainage Piping

17. Section 22 14 23, Storm Drainage Piping Specialties
18. Section 22 14 26, Prefabricated Trench Drain System
19. Section 22 14 29, Sump Pumps
20. Section 22 40 00, Plumbing Fixtures

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

C. Standards: The work shall comply with the following standards:

1. American National Standard Institute (ANSI)

   a. ANSI B1.20.1 -Pipe Threads, General Purpose Revision and Re-designation of ASME/ANSI B2.1.

2. American Society of Sanitary Engineering (ASSE):

   a. ASSE 1001 - Pipe Applied Atmospheric Vacuum Breakers.
   b. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

3. American Society of Mechanical Engineers (ASME):

   a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.
   b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
   c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings.
   d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
   e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
   f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings.
   g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
   h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
   i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
   j. ASME/ANSI B31.9 - Building Service Piping.

4. American Society of Testing and Materials (ASTM):

   a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   b. ASTM A74 - Cast Iron Soil Pipe and Fittings.
   c. ASTM A106 – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

d. ASTM B88 - Seamless Copper Water Tube.
e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

5. American Water Works Association (AWWA):

a. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
b. ANSI/AWWA C510 - Double Check Valve Backflow-Prevention Assembly.

6. Miscellaneous Standards and Regulations:

a. Environmental Protection Agency (EPA)
b. Clean Water Act (CWA)
c. Occupational Safety and Health Act (OSHA)
d. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Unless specified otherwise in the individual plumbing sections, submit product data, catalog cuts, specifications, installation instructions, recommendations, operating instructions, parts list, warranty information and shop drawings for the following plumbing items for review and approval by the Authority:

1. Water supply piping, drain piping, vent piping.
2. Connections, fittings.
3. Valves, sensors, controls.
4. Sleeves.
5. Escutcheons.
6. Faucets, drains, strainers, traps and accessories.
7. Supports and anchorages.
8. Pumps.
9. Meters.
10. Service connections.
11. Sump pits, manholes, catch basins.
12. Insulation.
13. Heat tracing.
14. Plumbing Fixtures.
15. Hot water heaters.
16. Natural gas piping, connections and valves.
17. Penetration Firestopping Materials.

B. Submit welding certificates.

C. Design Drawings: Submit marked up Design Drawings showing proposed locations for piping and equipment for approval.

D. Utility Plans: Submit for Authority's review and approval:

1. Contractor to submit utility plans for all levels of the facility for coordination of all utility runs and chases. The utility plans to show the layout and location horizontally and vertically of all utilities including pipes (water, drains and sewer, vent, gas, fire protection, power, safety, communication); ductwork (supply, return, vent) and equipment.
2. The utility plans to also show all obstructions, structural and building elements, walls and other fixed elements.
3. Purpose of the utility plans are to indicate the relationship and coordination of the utilities to the fixed building elements and to other utilities; indicate clearances; determine location and extent of obstructions and indicate potential interferences. The utility plans to show required clearances and spaces for maintenance of the utilities and access to valves, shutoffs, controls, cleanouts and other equipment. The drawings to show utility chases for pipes and other utilities; their layout and accessibility.
4. It is the Contractor's responsibility to obtain input from all utility and other trades to develop the utility layouts; coordinate their work to avoid conflicts and interferences as well as facilitate an orderly installation of all the work.
5. Upon approval, utility plans to be distributed to all applicable trades.

E. Closeout Submittals: The Contractor shall furnish operating instructions and maintenance specifications and requirements in accordance with the requirements of Division One Section, Closeout Procedures.

1.6 CONTRACT DRAWINGS AND SPECIFICATIONS

A. The Contract Documents are in-part diagrammatic, unless specifically dimensioned, in showing the general arrangement, and approximate sizes of equipment. Certain physical relationships which must be established within the plumbing work, and in its interface with other work is the responsibility of the Contractor. The Contract Documents indicate the best available information on existing conditions, utilities, services, and on new services (if any) to be provided to the project. Accuracy of this information is not assured and must be verified in field by the Contractor.

B. The intent and purpose of Drawings and Specifications are that all necessary labor and materials be provided for completion of all the work specified. The systems installed shall be complete in all details, including all minor items, accessories or devices necessary for a complete operational system ready for service, whether or not they are specifically called for in the Specifications or on the Drawing.

C. Plumbing Contract Drawings are diagrammatic and show requirements by use of graphic symbols. Symbols and Abbreviations drawings are provided. In general, these are recognized symbols of industry and the engineering profession.

1.7 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Each major component of equipment shall have the manufacturer's name, address, model number, and rating on a plate securely affixed in a conspicuous place.

D. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

E. Materials, installation and workmanship shall comply with all applicable codes, local ordinances, regulations, industry standards, utility company regulations and all requirements of local authorities having jurisdiction. Where the Contractor Documents are at variance, the most stringent shall govern. The Contractor shall notify the Authority in writing of discrepancies.

F. Manufacturers shall be firms regularly engaged in manufacturer of equipment and products of types, materials and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

G. The Installer shall be a firm with at least 3 years of successful installation experience on similar projects and all plumbers shall be licensed and experienced.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products properly identified with names, model numbers, types, grades, compliance labels. Adequately package or protected to prevent deterioration during shipment, storage and handling. Store in a dry, well ventilated, indoor space, except where pre-

pared and protected specifically for exterior storage. Coordinate the deliveries of mechanical materials and products with the scheduling and sequencing of the work so that storage requirements at the site are minimized.

B. Follow manufacturer's directions in the delivery, storage, protection and handling of all equipment and materials.

C. Deliver and store equipment and materials to the site in original containers, sheltered from the elements and mechanical injury. Items subject to moisture damage shall be stored in dry, heated spaces.

D. Ascertain whether any temporary access openings in the building will be required for the admission of apparatus and notify the Authority accordingly.

E. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.9 COORDINATION

A. The Contractor is responsible for the coordination of work by the different sub-contractors to avoid interferences and delays. The Authority is not responsible for coordination of construction. In the event that interferences occur between the different trades, the Contractor shall decide as to which trade shall relocate its work at no additional cost to Authority.

B. For locations where several elements of mechanical or electrical work must fit into the available space, prepare coordination shop drawings showing the actual physical dimensions at an accurate scale. Submit prior to fabrication and installation.

C. Install piping and similar services straight and true, aligned with other work, close to walls and overhead structure, concealed in occupied spaces, and out-of-the-way with maximum passageway and headroom remaining in each space.

D. Arrange piping work in a neat, well organized manner running parallel with primary lines of the building construction, and with a minimum of 7'-0" overhead clearance where possible. Give right-of-way to piping which must slope for drainage. Arrange work to facilitate maintenance and repair or replacement of equipment. Locate operating and control equipment and devices for easy access.

E. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

F. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

G. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

1.10 PROTECTION

A. Keep pipe openings closed by means of plugs or caps; cover all fixtures, equipment and apparatus to protect them against damage, both before and after installation.

B. Provide protective guards for devices such as valves which are located in elevator and escalator pits, stairwells and where directed by the Authority.

C. Protect all work against injury by freezing or exposure to the weather while stored or installed in place. All motors shall be wrapped for protection against excessive humidity before the building is enclosed.

1.11 WARRANTY

A. Warranty all materials and workmanship furnished and installed under this Contract for a period of one year form the date of Substantial Completion of these items unless a warranty for a longer period is specified for specific items.

PART 2 PRODUCTS

2.1 GENERAL PLUMBING PRODUCT REQUIREMENTS

A. Provide materials and factory-fabricated products of sizes, types, ratings, and capacities as indicated. Where not indicated, provide proper selection complying with the Specifications and governing regulations. Where more than one type is indicated, selection is the Contractor's option.

B. Quality: Provide no less a quality than manufacturers' standard products, as specified by their published product data while complying with the specified requirements. Do not assume that the available off-the-shelf condition of a product complies with the requirements. Do not purchase specific plumbing materials and equipment for the project until completion of submittals which might affect the purchase.

C. Condition: Except as otherwise indicated, provide new plumbing products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations. To the greatest extent possible and unless otherwise indicated, complete the fabrication, assembly finishing and testing of products prior to delivery to the project.

D. Uniformity: Where multiple units of a generic product are required for a single major system, provide identical products by the same manufacturer, without variations except for size and similar variations as indicated. Product/manufacturer uniformity does not apply to raw materials and bulk materials.

E. Compatibility: Where more than one product selection is specified, either generically or proprietary, selection is the Contractor's option. Provide adaptations as needed for interfacing of selected products in the work.

F. Nameplates: Provide a permanent operational data nameplate on each item of power operated plumbing equipment, indicating the manufacturer, product name, model number, serial number, speed, capacity, power characteristics, labels of tested compliances, and similar essential operating data. Locate nameplates in easily-read locations; except where product is visually exposed in occupied areas of the building, locate nameplate in a concealed position which is accessible for reading by service personnel.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg. F.

1. Manufacturers:

a. Eclipse, Inc.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Central Plastics Company.
b. Epco Sales, Inc.
c. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.

2. Separate companion flanges and steel bolts and nuts shall have 150 psig minimum working pressure where required to suit system pressures.

2.5 PIPE SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.7 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Refer to Specification Section 07 84 13, Penetration Firestopping.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 FIELD VERIFICATION

A. Contractor shall review the Drawings, Specifications and visit the Site before submitting Contractor's bid. Contractor shall examine areas and conditions under which plumbing work is to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 RECORD PLUMBING DRAWINGS

A. Unless specified otherwise in Division 01, maintain a white-print set of the Plumbing Drawings, shop drawings and utility plans in clean, undamaged condition, for mark-up of actual installations which vary substantially from the work as shown. Obtain a set of erasable mylar transparent originals for each drawing and use to record installed conditions. The "Field Record" drawings shall be submitted to the Authority for approval before final payment will be made on the contract. Record every substantive installation of plumbing and mechanical work which previously is either not shown or shown inaccurately, but in any case record the following:

1. Concealed piping drawn to scale and fully dimensioned.
2. Work concealed in a non-accessible arrangement.
3. Valves, sensors, and control devices and items requiring maintenance.

3.3 PRODUCT INSTALLATION GENERAL

A. Except where more stringent requirements are indicated, comply with the product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning, testing, charging, lubrication, start-up, test operation, and shut-down of operating equipment.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements, according to code and as specified in individual Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls or other building systems unless otherwise indicated. Diagonal runs are prohibited unless specifically indicated otherwise. Install piping to allow maximum possible headroom unless specific mounting heights are indicated.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated or required slopes; otherwise install piping level and plumb. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum

interference to other installations. Extend grease fittings to accessible locations. Install equipment to allow right of way for piping installed at required slope.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

M. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

d. Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealers" for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Piping Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Piping Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.5 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

5. All dielectric unions and couplings must be installed in a readily accessible and visual location for ease of maintenance.

3.7 PIPING INSULATION

A. Install insulation materials on clean and dry surfaces, after test acceptance. Do not apply to hot surfaces. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered. Insulate each continuous run with full-length units of insulation, with single cut piece to complete run. Do not cut pieces or scraps abutting each other. Insulation shall have smooth and even outside surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship. Cover insulated surfaces with glass cloth jacketing neatly fitted and firmly secured. Lap seams at least two inches. Apply over vapor barrier where applicable. Extend insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated. On insulated equipment, breeching and stacks, apply using staggered joint method for both single and double-layer construction where feasible. Apply each layer of insulation separately.

3.8 HANGERS AND SUPPORTS

A. All piping and equipment shall be adequately supported, either suspended from the construction above, or by means of struts to the construction below. Comply with MSS SP-69 and SP-89.

1. Cut fit, and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor plumbing materials and equipment.

B. Provide:

1. Approved type inserts for support of work in case of concrete construction.
2. Approved type forged steel beam clamps in the case of steel construction.
3. Supplementary angles, channels, plates, etc., where supports are required between building structural members, spanning the space and attached to building structural members by welding, bolting or with concrete anchors.
4. All rods, angles, rails, struts, brace plates, platforms, etc., required for suspension or support of piping, ducts and equipment.

5. Hangers, rollers, threaded rods, turnbuckles, saddles, insulation protectors, anchors, etc., and all miscellaneous specialties for the attachment of hanger and supports to the structure.
6. Where additional hangers are required, provide ITT Philips "Red Head" self-drilling anchors of the size required by hanger rod size and the imposing loading. Anchors shall not be installed in concrete beams or girders. Anchors shall be installed in accordance with manufacturer's recommendations. Anchor bolts shall be case hardened steel of the type to meet manufacturer's recommended safe working load of anchor.

C. Unless otherwise noted, the piping shall be supported as described under Section 22 40 00 - Plumbing.

D. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

E. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

G. Cut, fit and place metal supports accurately – location, alignment and elevation to support and anchor plumbing materials and equipment.

H. Insulated Piping: Comply with the following installations requirements:

1. Clamps: Attach clamps, including spaces (if any) to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

I. Structural Steel Supports: All structural steel used in the fabrication of pipe and duct supports, including cross members, steel shapes and plates, shall conform to ASTM Specification A-36. Steel shall be well formed to shape and size. Shearing and punching shall leave clean, true lines and surfaces. Carefully match exposed work to produce continuity of line and design. All joints, unless otherwise shown or specified, shall be accurately fitted and rigidly secured with hairline contact. Thickness of metal and details of assembly and support shall give adequate strength and stiffness.

3.9 PIPE SLEEVES

A. Provide pipe sleeves for all pipes which pass through walls, partitions, floors, ceilings, or roofs, in accordance with Section 22 40 00 - Plumbing.

3.10 EQUIPMENT IDENTIFICATION

A. All pumps, fan systems, etc., as well as their motor starters, shall be identified by 1/8 inch thick, white with black core laminated phenolic nameplates. Equipment plates shall be 1½ inch x 4 inch with 3/16 inch lettering, and adhered with adhesive furnished by plate manufacturer.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.

3.11 IDENTIFICATION OF PIPING

A. All service piping which is accessible for maintenance operations (except piping in finished spaces) shall be identified with semi-rigid plastic (not pressure-sensitive) identification markers or equal. Direction of flow arrows shall be included on each marker, unless otherwise specified.

B. In conformance with "Scheme for the Identification of Piping Systems" (ANSI A13.1) and OSHA, each marker shall show (1) approved color--coded background, (2) proper color of legend in relation to background color, (3) approved legend letter size, and (4) approved marker length.

C. For pipes under 3/4 inches O.D. (too small for color bands and legends), brass identification tags 1-1/2 inch in diameter with depressed 1/4 inch high backfilled letters above 1/2 inch back-filled numbers shall be fastened securely at specified locations.

D. Locations for pipe markers shall be as follows:

1. At each branch and riser take-off excluding short take-off for fixtures.
2. At each pipe passage through wall, floor and ceiling construction.
3. At each pipe passage to underground.
4. On all horizontal pipe runs - marked every 25 feet.

E. Pipe markers shall be as manufactured by Seton Name Plate Corp., New Haven, Connecticut, 06505; Badger Tag & Label Company; Bunting Stamp, Inc., or approved equal.

3.12 OPERATING AND MAINTENANCE MANUALS AND PARTS LISTS

A. Comply with the Section 01 70 00: Project Closeout.

B. Each manual shall contain all information pertinent to the equipment and essential for good preventive maintenance practice, and for efficient replacement of all expandable components.

C. The manual shall generally include the items listed below and other features as may be recommended by the manufacturers:

6. Catalog information of the unit installed.
7. Capacity and installation details.
8. Special valves and control devices.
9. Operating pressure and temperatures.
10. Relief devices and setting.
11. Complete list of parts, including a list of spare parts recommended to "keep on hand" for ordinary service requirements, with re-ordering numbers and current pricing.

D. Manuals for instructions shall be complete and explicit.

E. The above information shall be provided for the following and for all other equipment where it is necessary to have the aforementioned data:

1. Plumbing fixtures, faucets, and flush valves.
2. Relief valves.
3. Temperature control systems (as installed).
4. Valves.
5. Vibration isolator units.
6. Specialties, etc.

3.13 FLASHING SLEEVES

A. Wherever pipes pass through the roof, furnish and install Zurn Figure Z-195-10, Josam, Jay R. Smith or approved equal, flashing sleeves, installed in accordance with manufacturer's instructions. See typical detail on drawing.

B. Flashing sleeves shall be provided with 18 ounce copper flashing extending not less than 19 inches beyond the largest diameter of opening.

3.14 NOISE AND VIBRATION CONTROL

A. Make provisions in the installation of work so that noises or vibrations shall not be transmitted through foundations, floors, walls, columns, ducts, piping, etc., so as to be not objectionable in any manner. All equipment provided shall be selected and installed with this in view. If any equipment exceeds reasonable requirements as to quietness of operation and freedom from vibration when operating under continuous maximum demands, it shall be altered or replaced.

B. Furnish and install vibration eliminators and isolation equipment as manufactured by the Vibration Eliminator Co.; Korfund; Mason Industries, or approved equal, for equipment, fans, motors, pumps, etc., as indicated on the drawings, specified or as required.

C. The isolation and vibration eliminator manufacturer and Contractor shall be responsible for the selection of the power units for their loadings, quantities, etc., and he/she shall guarantee that each and every installation and their application shall have a vibration efficiency of 90% or greater. As a minimum, provide types of vibration eliminators as indicated on the drawings.

D. Submit shop drawings to the Authority for approval of all isolation equipment, with dimensions and other data as specified and prepared by the isolation equipment manufacturer.

3.15 PENETRATION FIRESTOPPING INSTALLATION

A. Contractor responsible to firestop all pipe and other penetrations in walls, floors, ceilings and other substrates to prevent infiltration of smoke, fire, air and noise, Firestopping materials and installation to meet applicable codes and required fire ratings.

1. Refer to Specification Section 07 84 13, Penetration Firestopping.

3.16 CUTTING AND PATCHING

A. Cut and patch building materials as required for the installation of work. Do not cut structural framing, walls, floors, decks and other members intended to withstand stress. Holes cut in structural steel must be drilled or punched. Cut openings through concrete (for pipe penetrations and similar services) by core drilling or sawing. Execute patching in the manner recommended by the Installer trade. Restore the cut work in every respect, including the elimination of visual defects in exposed finishes.

3.17 PAINTING

A. All shop fabricated and factory built equipment not primed, galvanized or protected by plating shall be cleaned and given one (1) shop coat of zinc-chromate primer before delivery to the site. Any portions of the shop coat damaged in delivery or during construction shall be re-coated. Piping, ductwork and equipment shall be left cleaned and primed, ready for finish painting. All insulation on piping that does not receive a jacket shall be painted. All finish painting will be done under Section 09 90 00: Painting.

B. Paint nameplates, labels, tags, sprinklers, stainless steel or chromium-plated items such as valve stems, motor shafts, levers, handles, trip strips, etc.

C. Repair marred and damaged factory-painted finished to match existing finishes.

3.18 CLEANING – GENERAL

A. Maintain the premises in an orderly fashion at all times, providing continuous clean-up during the construction period. Remove all cartons, containers, crates, etc., as soon as their contents have been removed and also remove all debris caused by work as soon as possible. Deposit all discarded materials in a suitable refuse container and prevent these materials from being scattered by the elements. All cartons, debris, etc., shall be removed from the premises and site at the sole expense of the Contractor.

B. Contractor shall stack all construction materials associated with this work in areas so as to avoid congestion and interference with other trades.

C. At the completion of the Work, the Contractor shall clean all of his/her work, equipment, etc., free from dust, etc. and shall leave the Work in good housekeeping fashion, in a manner acceptable to the Authority.

3.19 SYSTEM PERFORMANCE TEST RUN

A. With Authority's Representative present, operate each system in a test run to demonstrate compliance with performance requirements. Make final corrections or adjustments of systems to refine and improve performances. Demonstrate that controls and items requiring service or maintenance are accessible.

3.20 CLEANING AND LUBRICATION

A. After final performance test run of each mechanical system, clean system both externally and internally. Flush Domestic water piping systems. Clean strainers and traps. Lubricate equipment and remove excess lubrication. Touch-up minor damage to painted finishes.

3.21 GENERAL OPERATING INSTRUCTIONS

A. Conduct a full-day minimum walk-through explanation and demonstration for orientation and education of Authority's personnel to be involved in continued operation of building and its mechanical plant. Describe each system, its control system, flow adjustments, temperature control and similar operation. Explain identification system. Describe sequencing, interlock provisions, shut-down and season operations. Emphasize emergency procedures and safety provisions during equipment malfunction, disasters, power failures and similar unusual circumstances. Describe system limitations and precautions including weather adjustments. Outline basic maintenance procedures. Explain maintenance manuals, record drawings, spare parts inventory, and storage of extra materials, meter readings and similar service items.

3.22 CONTINUED SYSTEMS OPERATIONS

A. At time of substantial completion of mechanical work, Authority's operating personnel will take over operation of mechanical systems. Respond promptly with consultation and services on whatever operation or maintenance problems may remain or arise in continued operation until expiration of guarantee period.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of COMMON WORK RESULTS FOR PLUMBING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of COMMON WORK RESULTS FOR PLUMBING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: providing and installing for plumbing installations:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

B. Related Sections:

1. Section 07 62 00, Sheet Metal Flashing and Trim.
2. Section 07 84 13, Penetration Firestopping.
3. Section 07 92 00, Joint Sealants.
4. Section 22 11 16 Domestic Water Piping.
5. Section 22 13 16 Sanitary Waste and Vent Piping.
6. Section 22 14 13, Storm Drainage piping.

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

1.4 SUBMITTALS

A. Product Data: For each type of product.

B. Installation Instructions: For each type of product installed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

C. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

1.6 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on exposed installed materials

1.8 WARRANTY

A. All equipment, and accessories to be warranted by the manufacturer and installer for a period of one (1) year after the date of final acceptance unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority for parts or labor, and upon the discretion of the Authority.

PART 2 - PRODUCTS

2.1 PIPE SLEEVES - GENERAL

A. Provide pipe sleeves for all pipes which pass through walls, partitions, floors, ceilings, or roofs.

B. General floor sleeves shall be standard weight galvanized steel pipe with bottom end flush with surface, top end extend 1" above finished floor, caulked.

C. Foundation walls and slabs on grade: Cast iron (per Clow 1430/1435 or Josam, Zurn, J.R. Smith or Wade), sleeves, flush inside and outside, integral waterstop, caulked, or Thunderline linkseal series "LS" sleeve with waterstop, rubber sealing elements, pressure plates and bolts.

D. Concrete walls: Standard weight galvanized steel pipe, flush with wall surface at both ends anchored and caulked.

E. Sleeves through fire/smoke rated walls or floors shall be of standard weight galvanized steel pipe.

F. Interior partitions and ceilings: 20 gauge galvanized steel with lock joints.

G. Sleeves for uninsulated piping shall be two (2) sizes larger than pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the full thickness of the pipe covering with clearance for expansion and contraction.

H. Where pipes pass through floors on fill or concrete exterior walls, caulk sleeves with oakum and lead wool

I. For all fire rated walls, and partitions, annular space between interior surface of all pipes and sleeves shall be packed with fire rated material such as Johns-Manville "Cerafiber", Super 48 Insulating Cement or Thermo-Fiber #CW40 and caulked water-tight with a water-proof mastic such as Ink-Smith B-1 butyl sealant, or approved equal.

J. Pipe sleeves through non-rated wall, floors and partitions shall have the openings packed with glass fiber insulation and both ends of sleeves caulked with waterproof mastic.

2.2 SLEEVES

A. 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. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Approved equal.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, galvanized, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

H. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.3 STACK-SLEEVE FITTINGS

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

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC.
3. Approved equal.

B. Description: Manufactured, galvanized cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.4 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.
6. Approved equal.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber,high-temperature-silicone or Nitrile (Buna N) as shown on the drawings or as selected by the Authority; interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel,,composite plastic, stainless steel or stainless steel, Type 316; as shown on the drawings or as selected by the Authority.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633; stainless steel or stainless steel, Type 316; as shown on the drawings or as selected by the Authority; of length required to secure pressure plates to sealing elements.

2.5 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.
6. Approved equal.

B. Description: Manufactured plastic, sleeve-type, water-stop assembly made for imbedding in concrete slab or wall.

C. Plastic or rubber water-stop collar with center opening to match piping OD.

2.6 GROUT

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

B. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

2.7 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.

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

    a. Dow Corning Corporation.
    b. GE Construction Sealants; Momentive Performance Materials Inc.
    c. Polymeric Systems, Inc.
    d. Schnee-Morehead, Inc., an ITW company.
    e. Sherwin-Williams Company (The).
    f. Approved equal.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

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

    a. May National Associates, Inc.; a subsidiary of Sika Corporation.
    b. Approved equal.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

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

a. Smooth-On.

b. Approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all trim, fittings, and accessories, as shown on the Contract Documents, as required by the referenced standards and codes, as recommended by the manufacturer, according to accepted practice.

B. Installation of trim, fittings and accessory materials shall be coordinated with other work.

3.2 EXAMINATION

A. Verify all dimensions and conditions in the field.

B. Examine walls, floors, roof, and plumbing chases for suitable conditions where specialties are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.3 SLEEVE INSTALLATION

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

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant; as shown on the drawings or as selected by the Authority; seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

3.4 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.5 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.6 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant; as shown on the drawings or as selected by the Authority; to seal the space around outside of sleeve-seal fittings.

3.7 FIELD QUALITY CONTROL

A. Inspections:
   1. Do not enclose or cover, plumbing work until it has been inspected and approved by the Authority.
   2. All plumbing work to be installed as determined by the manufacturer and by code.
   3. Repair or replace all defects using new materials
   4. Prepare reports for all inspections and required corrective action.

B. Sleeves and seals to be sized and selected for the specific piping and substrate involved without excessive gaps. Holes to be round and clearly cut with smooth edges and no damage to adjacent surfaces.

C. Sleeves and seals to be of the proper size, type and material as specified herein.

D. Sleeves and seals of improper size, type or material or installed improperly as determined by the Authority to be adjusted or replaced to the satisfaction of the Authority and at no additional cost.

E. Perform the following tests and inspections:

   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

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

G. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect trim, fittings and accessory materials during remainder of construction period, to avoid dirt and debris, and to prevent damage from traffic and construction work.

3.9 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

   1. Exterior Concrete Walls above Grade:

      a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves, Steel pipe sleeves, or Sleeve-seal fittings; as shown on the drawings or as selected by the Authority.
      b. Piping NPS 6 and Larger: Cast-iron pipe sleeves, Steel pipe sleeves or Sleeve-seal fittings as shown on the drawings or as selected by the Authority.

   2. Exterior Concrete Walls below Grade:

      a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings; as shown on the drawings or as selected by the Authority.

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

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings; as shown on the drawings or as selected by the Authority.

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

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings; as shown on the drawings or as selected by the Authority.

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

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system, Steel pipe sleeves with sleeve-seal system or Sleeve-seal fittings; as shown on the drawings or as selected by the Authority.

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

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves, PVC pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings, Molded-PE or -PP sleeves or Molded-PVC sleeves; as shown on the drawings or as selected by the Authority.
b. Piping NPS 6 and Larger: Steel pipe sleeves, PVC pipe sleeves or Stack-sleeve fittings; as shown on the drawings or as selected by the Authority.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves or PVC pipe sleeves; as shown on the drawings or as selected by the Authority.
b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves; as shown on the drawings or as selected by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Providing and installing the following for plumbing installations:

1. Escutcheons.
2. Floor plates.

B. Related Sections:

1. Section 22 11 16 Domestic Water Piping
2. Section 22 13 16 Sanitary Waste and Vent Piping
3. Section 22 14 13 Storm Drainage Piping

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

1.4 DEFINITIONS

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

1.5 SUBMITTALS

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

B. Installation Instructions: For each type of product indicated.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

C. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

1.7 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on exposed installed materials.

1.9 WARRANTY

A. All plumbing equipment and accessories to be warrantied by the manufacturer and installer for a period of one (1) year after the date of final acceptance unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority for parts or labor, and upon the discretion of the Authority.

PART 2 - PRODUCTS

2.1 ESCUTCHEOUS – GENERAL

A. Provide escutcheons on all exposed piping passing through walls, floors, partitions and ceilings.

B. Escutcheons shall be held in place by internal spring tension or set screws.

2.2 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. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.

3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).
5. Mid-America Fittings, Inc.
6. ProFlo; a Ferguson Enterprises, Inc. brand.
7. Approved Equal

2.3 ESCUTCHEONS

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

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

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

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

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

G. Escutcheons:

1. Provide escutcheons on all exposed piping passing through walls, floors, partitions and ceilings.
2. Escutcheons shall be held in place by internal spring tension or set screws.
3. Application:

Location	Escutcheon Material
Finished Spaces:	Anodized aluminum, chrome plated brass or stainless steel.
Unfinished Spaces: Excluding mechanical equipment rooms.	Plain brass, or aluminum

2.4 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all trim, fittings, and accessories, as shown on the Contract Documents, as required by the referenced standards and codes, as recommended by the manufacturer, according to accepted practice and as specified.

B. Installation of trim, fittings and accessory materials to be coordinated with other work.

3.2 EXAMINATION

A. Verify all dimensions and conditions in the field.

B. Examine walls, floors, roof, and plumbing chases for suitable conditions where specialties are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.3 INSTALLATION

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

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

1. Escutcheons for Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
c. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
d. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
f. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
i. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate,
j. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

a. Chrome-Plated Piping: Split-casting, stamped steel with concealed hinge with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stainless steel with concealed hinge with polished, stainless finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stainless steel with concealed hinge with polished, stainless finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stainless steel with concealed hinge with polished, stainless finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.4 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose or cover plumbing work until it has been inspected and approved by the authority having jurisdiction.
2. All plumbing work to be installed as directed by the manufacturer and by code.
3. Repair all defects using new materials.
4. Prepare reports for all inspections and required corrective action.

B. Using new materials, replace broken and damaged escutcheons and floor plates.

3.5 PROTECTION

A. Protect trim, fittings and accessory materials during remainder of construction period, to avoid dirt and debris, and to prevent damage from traffic and construction work.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of ESCUTCHEONS FOR PLUMBING PIPING shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of ESCUTCHEONS FOR PLUMBING PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.
11. Metering.

B. Related Sections:

1. Section 22 11 16 "Domestic Water Piping" for water meters inside the building.

1.03 SUBMITTALS

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

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Closeout Submittals: Operation and Maintenance Data for meters and gages to include in operation and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Installers performing the work of this section to be experienced plumbers licensed by the City of Chicago.

B. All work performed under this section shall be according to all applicable codes.

PART 2 - PRODUCTS

2.01 BIMETALLIC-ACTUATED THERMOMETERS

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. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.
11. Watts; a Watts Water Technologies company.
12. Weiss Instruments, Inc.
13. Weksler Glass Thermometer Corp.
14. Approved equal.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch or 5-inch nominal diameter, as selected by the Authority.

D. Dial: Non-reflective aluminum with permanently etched scale markings and scales in Degree F and Degree C.

E. Connector Type(s): Union joint, adjustable angle, rigid, back and rigid, bottom, with unified-inch screw threads, as selected by the Authority.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.02 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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

a. Ashcroft Inc.
b. Marsh Bellofram.
c. Miljoco Corporation.
d. Palmer Wahl Instrumentation Group.
e. REOTEMP Instrument Corporation.
f. Trerice, H. O. Co.
g. Weiss Instruments, Inc.
h. Approved equal.

2. Standard: ASME B40.200.

3. Case: Sealed type drawn steel; 4-1/2-inch, 5-inch or 6-inch; as selected by the Authority.
4. Element: Bourdon tube or other type of pressure element, as approved by the Authority.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in Degree F and Degree C.
7. Pointer: Dark-colored metal.
8. Window: Glass
9. Ring: Stainless steel
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads; as selected by the Authority.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation; as selected by the Authority.

    a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

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

    a. AMETEK, Inc.
    b. Ashcroft Inc.
    c. Marsh Bellofram.
    d. Miljoco Corporation.
    e. Palmer Wahl Instrumentation Group.
    f. REOTEMP Instrument Corporation.
    g. Trerice, H. O. Co.
    h. Weiss Instruments, Inc.
    i. WIKA Instrument Corporation.
    j. Approved equal.

2. Standard: ASME B40.200.

3. Case: Sealed type, drawn steel; 4-1/2-inch or 6-inch nominal diameter with back or front flange and holes for panel mounting; as selected by the Authority.
4. Element: Bourdon tube or other type of pressure element, as approved by the Authority.
5. Movement: Mechanical, with link to pressure element and connection to pointer.

6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F
7. Pointer: Dark-colored metal.
8. Window: Glass
9. Ring: Stainless steel
10. Connector Type(s): Union joint, back or bottom; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation; as selected by the Authority.

    a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.03 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

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

    a. Flo Fab Inc.
    b. Miljoco Corporation.
    c. Palmer Wahl Instrumentation Group.
    d. Tel-Tru Manufacturing Company.
    e. Trerice, H. O. Co.
    f. Weiss Instruments, Inc.
    g. Weksler Glass Thermometer Corp.
    h. Winters Instruments - U.S.
    i. Approved equal.

2. Standard: ASME B40.200.

3. Case: Cast aluminum 7-inch or 9-inch nominal size unless otherwise indicated; as selected by the Authority.
4. Case Form: Adjustable angle, Back angle, Straight unless otherwise indicated; as selected by the Authority
5. Tube: Glass with magnifying lens and blue or red organic liquid; as selected by the Authority
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.04 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

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

    a. Flo Fab Inc.
    b. REOTEMP Instrument Corporation.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
    e. Weksler Glass Thermometer Corp.
    f. WIKA Instrument Corporation.
    g. Winters Instruments - U.S.
    h. Approved equal.

2. Case: Metal; 7-inch or 9-inch nominal size unless otherwise indicated; as selected by the Authority.
3. Scale(s): Deg F Deg C.
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
6. Stem: Aluminum Insert material and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus 2 deg F.

B. Remote-Mounted, Light-Activated Thermometers:

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

    a. Miljoco Corporation.
    b. Weiss Instruments, Inc.
    c. Winters Instruments - U.S.
    d. Approved equal.

2. Case: Plastic, for wall mounting.
3. Scale(s): Deg F Deg C.
4. Sensor: Bulb and thermister wire.

    a. Design for Thermowell Installation: Bare stem.

5. Display: Digital.
6. Accuracy: Plus or minus 2 deg F.

2.05 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads, as selected by the Authority.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads, as selected by the Authority.
8. Standard: ASME B40.200.
9. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
10. Material for Use with Copper Tubing: CNR or CUNI.
11. Material for Use with Steel Piping: CRES or CSA.
12. Type: Stepped shank unless straight or tapered shank is indicated.
13. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads, as selected by the Authority.
14. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads, as selected by the Authority.
15. Bore: Diameter required to match thermometer bulb or stem.
16. Insertion Length: Length required to match thermometer bulb or stem.
17. Lagging Extension: Include on thermowells for insulated piping and tubing.
18. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin unless noted otherwise.

2.06 PRESSURE GAGES

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

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

    a. Ametek U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts; a Watts Water Technologies company.
    m. Weiss Instruments, Inc.

2. Standard: ASME B40.100.

3. Case: Liquid-filled Sealed Open-front, pressure relief Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch or 6-inch nominal diameter with flange and holes for panel mounting; as selected by the Authority.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS ¼, NPS 1/4 or NPS 1/2 NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated; as selected by the Authority.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal, Brass or Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of plus or minus 5 percent of whole scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

    a. Ametek U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts; a Watts Water Technologies company.
    m. Weiss Instruments, Inc.
    n. WIKA Instrument Corporation.

2. Standard: ASME B40.100.

3. Case: Liquid-filled Sealed type; cast aluminum or drawn steel metal; 4-1/2-inch or 6-inch nominal diameter with back or front of flange and holes for panel mounting; as selected by the Authority.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS ¼, NPS 1/4 or NPS ½, NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated; as selected by the Authority.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal or Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of plus or minus 5 percent of whole scale range.

2.07 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS ¼, NPS 1/4 or NPS 1/2 NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball or Brass or stainless-steel needle, with NPS ¼, NPS 1/4 or NPS ½, NPS 1/2, ASME B1.20.1 pipe threads.

2.08 TEST PLUGS

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. Flow Design, Inc.
2. Miljoco Corporation.
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company.
8. Weiss Instruments, Inc.
9. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 Degree F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.09 TEST-PLUG KITS

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. Flow Design, Inc.
2. Miljoco Corporation.
3. Nexus Valve, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts; a Watts Water Technologies company.
8. Weiss Instruments, Inc.
9. Approved equal.

B. Furnish one test-plug kit containing one or two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 Degree F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 Degree F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

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. ARCHON Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Rosemount Division.
4. Ernst Flow Industries.
5. John C. Ernst Co., Inc.
6. KOBOLD Instruments, Inc. - USA.
7. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.
8. Pentair Valves & Controls; Penberthy Brand.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends; as selected by the Authority.

D. Minimum Pressure Rating: 125 psig-150 psig as required.

E. Minimum Temperature Rating: 200 Degree F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.11 METERING

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. AMCO Watering Metering Systems.
2. Badger Meter, Inc.
3. Carlon Meter.
4. Hays Fluid Controls.

5. McCrometer, Inc.
6. Mueller Co.
7. Neptune Technology Group Inc.
8. Sensus Metering Systems.
9. Approved Equal.

B. Meters capable of the following:

1. Recording daily water consumption.
2. Communicating data remotely.
3. Electronic data storage for one (1) year.
4. Reports showing daily, monthly, and annual water consumption.
5. Alarming capability in accordance with Water User Efficiency Plan for Operation.

C. Meter potable and reclaimed water sources to the building and onsite non-potable water sources individually.

D. Sub-meter the following:

1. Automatically controlled irrigation systems.
2. Tenant spaces.
3. Makeup-water lines to steam boilers.
4. Makeup-water lines to open-loop chillers.
5. Makeup-water lines to closed-loop systems.
6. Bus and train wash systems

PART 2 - EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending a minimum of two (2) inches into fluid or one-third of pipe diameter to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

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

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.02 CONNECTIONS

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

3.03 ADJUSTING

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

3.04 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Direct or Remote-mounted, metal case, vapor-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:

1. Direct or Remote-mounted, metal case, vapor-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Direct or Remote-mounted, metal -case, vapor-actuated type.

D. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:

1. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.05 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

C. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F.

3.06 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Sealed, direct or remote-mounted, metal case.
2. Sealed, direct or remote-mounted, plastic case.

C. Pressure gages at suction and discharge of each domestic water pump shall be **one of** the following:

1. Liquid-filled or Solid-front, pressure-relief, direct or remote-mounted, metal case.

3.07 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Domestic Water Piping: 0 to 100 psi.

3.08 QUALITY CONTROL

A. All materials and installations performed under this section to be according to the requirements of the section and according to local codes.

B. Meters and gages shall be of proper type, size, pressure rating and other requirements for the specific application and location within the plumbing system.

C. Meters and gages shall be calibrated and adjusted as required after installation. Test the meters and gages for accuracy. Test for leaks. Test for pressure capabilities.

D. Any meters or gages not meeting the requirements of this section or not operating properly need to be repaired, adjusted or replaced as approved by the Authority and at no cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of METERS AND GAGES FOR PLUMBING PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of METERS AND GAGES FOR PLUMBING PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Gate Valves, 2-Inches and Smaller
2. Gate Valves, 2½-Inches and Larger
3. Ball Valves
4. Globe Valves, 2-Inches and Smaller
5. Globe Valves, 2½-Inches and Larger
6. Butterfly Valves
7. Swing Check Valves, 2-Inches and Smaller
8. Swing Check Valves, 2½-Inches and Larger
9. Silent Check Valves, 2-Inches and Smaller
10. Silent Check Valves, 2½-Inches and Larger

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 23 Section “Hydronic Piping”

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

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

B. Operators: Use specified operators and handwheels, except provide the following special operator features:

1. Handwheels: For valves other than quarter turn.

2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with one wrench for every 10-plug valves.

3. Chain-Wheel Operators: For valves 4 inches and larger, installed 96 inches or higher above finished floor elevation.

4. Gear-Drive Operators: For quarter-turn valves 8 inches and larger.

C. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: With extended neck.

D. Valve-End Connections:

1. Solder Joint: With sockets according to ASME B16.18.
2. Threaded: With threads according to ASME B1.20.1.

E. Valve Bypass and Drain Connections: MSS SP-45.

F. Threads: ASME B1.20.1.

G. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

2.02 GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Gate Valves:

a. Crane Company; Valves and Fitting Division
b. Hammond Valve Corporation
c. Milwaukee Valve Company, Inc.
d. Nibco Inc.
e. Approved equal.

B. Gate Valves, 2-Inches and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), or Class 150, 300-psi CWP as required in Application Schedule; ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, dezincification-resistant copper silicon alloy rising stem, union body-bonnet connection, non-asbestos packing, bronze packing nut, malleable-iron handwheel, and threaded or soldered end connections as required in Application Schedule.

C. Gate Valves, 2½-Inches and Larger: MSS SP-70, Class 125, 200-psi CWP or Class 250, 500-psi CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, bolted body-bonnet connection, teflon-impregnated

packing with 2-piece packing gland assembly, flanged end connections; and with cast-iron handwheel.

2.03 BALL VALVES

A. Provide products by one of the following:

1. Ball Valves:

a. Conbraco Industries, Inc.; Apollo Division
b. Hammond Valve Corporation
c. Nibco Inc.
d. Milwaukee Valve Company, Inc.
e. Approved equal.

B. Ball Valves, 2-Inches and Smaller: MSS SP-110, 600-psi CWP, Class 150, ASTM B 584 bronze body and end piece(s), 2-piece or 3-piece construction as required in the Application Schedule; stainless steel ball, full port, blowout proof; stainless steel stem; teflon seats and seals; threaded or soldered end connections as called for in Part 3. Vinyl-covered steel lever handle.

1. Options:

a. Stem Extension: For valves installed in insulated piping (if required in Application Schedule) equip with 2-inch extended handle of non-thermal material. Provide protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
b. Memory Stop: For operator handles (if required in Application Schedule).

C. Hose End Drain Valves: MSS SP-110, 3/4-inch NPS, 400 psi CWP, Class 150, ASTM B 584 bronze body and end piece, two-piece construction, chrome plated ball, full port; brass stem; Teflon seats and seals; threaded or soldered end connections as called for in Part 3. Vinyl covered steel lever handle.

1. Outlet: Short threaded nipple with ASTM B1.20.7 garden-hose thread, cap, and drain.

2.04 GLOBE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Globe Valves:

a. Crane Company; Valves and Fitting Division
b. Hammond Valve Corporation
c. Milwaukee Valve Company, Inc.
d. Nibco Inc.
e. Approved equal.

B. Globe Valves, 2-Inches and Smaller: MSS SP-80; Class 150, 300-psi CWP or Class 300, 600-psi CWP as required in the Application Schedule; ASTM B 62 cast-bronze body and bonnet bronze or teflon seat disc, dezincification-resistant copper silicon alloy rising

stem, union body-bonnet connection, bronze packing nut, malleable-iron handwheel, threaded end connections.

C. Globe Valves, 2½-Inches and Larger: MSS SP-85, Class 125, 200-psi CWP or Class 250, 500-psi CWP; ASTM A 126 cast-iron body and bonnet with bronze fittings, bolted body-bonnet connection, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.05 BUTTERFLY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Butterfly Valves:

a. Demco
b. Keystone Valve USA, Inc.
c. Dezurik
d. Nibco Inc.
e. Milwaukee Valve Company, Inc.
f. Approved equal.

B. Butterfly Valves: MSS SP-67, 200-psi CWP up to 12-inch and 150-psi for 14-inch and larger, 150-psi maximum pressure differential, ASTM A 536 ductile-iron body, full lug style, extended neck, stainless-steel stem, EPDM liner and stem seals. Suitable for bi-directional dead-end service at valve's rated pressure without need of downstream flange.

1. Disc Type: Aluminum bronze or elastomer-coated ductile iron as indicated in Application Schedule.
2. Operator for Sizes 2-Inches to 6-Inches: Lever handle with latch lock.
3. Operator for Sizes 8-Inches to 24-Inches: Gear operator with position indicator.
4. Operator for Sizes 8-Inches and Larger, 96 Inches or Higher above Floor: Chain-wheel operator.

2.06 CHECK VALVES

A. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP or Class 150, 300-psi CWP as required in the Application Schedule; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with renewable seat and disc, threaded or soldered end connections as required by Application Schedule.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Swing Check Valves:

1) Crane Company; Valves and Fitting Division
2) Hammond Valve Corporation
3) Milwaukee Valve Company, Inc.
4) Nibco Inc.
5) Approved equal.

B. Swing Check Valves, 2½-Inches and Larger: MSS SP-71, Class 125, 200-psi CWP or Class 250, 500-psi CWP as required in the Application Schedule, ASTM A 126 Class B cast-iron body and bolted bonnet, horizontal-swing, bronze disc, flanged connections.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Swing Check Valves:

1) Crane Company; Valves and Fitting Division
2) Hammond Valve Corporation
3) Milwaukee Valve Company, Inc.
4) Nibco Inc.
5) Approved equal.

C. Silent Check Valves, 2-Inches and Smaller: MSS SP-80, Class 125, 250-psig CWP, inline spring actuated lift type, ASTM B 584 bronze body, stainless steel spring, Buna-N seat, threaded connections.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Silent Check Valves:

1) Hammond Valve Corporation
2) Milwaukee Valve Company, Inc.
3) Mueller.
4) Nibco Inc.
5) Approved equal.

D. Silent Check Valves, 2½-Inches and Larger: Class 125, 200-psi CWP, twin disc, spring actuated type, ASTM A 126 Class B case iron body, bronze disc, stainless steel spring, Buna-N seat, wafer, lug or grooved style connections.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Silent Check Valves:

1) Hammond Valve Corporation
2) Milwaukee Valve Company, Inc.
3) Mueller.
4) Nibco Inc.
5) Approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

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

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

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

3.02 VALVE INSTALLATION

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

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

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

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

E. Install all valves with stems in either an upright (preferred) or horizontal position. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Silent Check Valves: In horizontal or vertical position, between flanges.

F. Control valves shall be installed with top works upward unless specifically shown otherwise.

F. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inch and smaller, use gate or ball valves.

G. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inch or smaller, use gate or ball valves.

H. Drain Valves: Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.

3.03 LOCATION OF OPERATION AND MAINTENANCE SYSTEM COMPONENTS

A. System components which require observation, operation or maintenance - such as valves, traps, gauges, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc. - shall be located whenever possible so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access.

B. Instruments (i.e. pressure gauges, thermometers, orifice plates, etc.) are shown on the drawings in their approximate locations. Exact locations shall consider visibility and any special installation requirements.

3.04 SOLDERED CONNECTIONS (FOR DOMESTIC WATER SYSTEMS ONLY)

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.5 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.6 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.8 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.9 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Gate, ball, butterfly valves.
2. Boiler Shutoff Service: OS&Y Gate Valves as shown on drawings
3. Butterfly Valve Dead-End Service: Single-flange lug type.

B. If valves with specified CWP ratings are not available, the same types of valves with higher CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except solder-joint valve-end can be used for domestic water systems and compressed air systems.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 and larger: Flanged ends.

D. Domestic Water Systems: Use the following valve types:

1. Gate Valves, 2-Inches and Smaller: Class 125, bronze body.
2. Gate Valves, 2½-Inches and Larger: Class 125, iron body.
3. Ball Valves: 2-piece with stem extension.
4. Globe Valves, 2-Inches and Smaller: Class 150,bronze body.
5. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
6. Butterfly Valves: Elastomer-coated ductile iron or aluminum bronze disc.
7. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.
8. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
9. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
10. Silent Check Valves, 2½-Inches and Larger: Class125, iron body, use at pump discharge.

E. Heating Water Systems: Use the following valve types:

1. Gate Valves, 2-Inches and Smaller: Class 150, bronze body.
2. Gate Valves, 2½-Inches and Larger: Class 125, iron body.

3. Ball Valves: 2-piece with stem extension and memory stop.
4. Globe Valves, 2-Inches and Smaller: Class 150,bronze body.
5. Globe Valves, 2½-Inches and Larger: Class 125, cast-iron body.
6. Butterfly Valves: Aluminum bronze disc.
7. Swing Check Valves, 2-Inches and Smaller: Class 125, bronze body, use for all applications except at pump discharge.
8. Swing Check Valves, 2½-Inches and Larger: Class 125, iron body, use for all applications except at pump discharge.
9. Silent Check Valves, 2-Inches and Smaller: Class 125, bronze body; use at pump discharge.
10. Silent Check Valves, 2½-Inches and Larger: Class125, iron body, use at pump discharge.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of GENERAL-DUTY VALVES FOR PLUMBING PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of GENERAL-DUTY VALVES FOR PLUMBING PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping, hydronic system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.
9. Fiberglass Strut System.

B. Related Sections include the following:

1. Section 05 50 00, Metal Fabrications.
2. Section 22 05 00, Common Work Results for Plumbing.
3. Section 22 11 16, Domestic Water Piping.
4. Section 22 13 16, Sanitary Waste and Vent Piping.
5. Section 22 14 13, Storm Drainage Piping.

1.3 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

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

C. Perform pipe stress analysis on new boiler heating water system piping per ASME B31.1 Power Piping Code. Design parameters to include 60°F low water temperature, 200°F high water temperature, 150 psig, up to 25% propylene glycol water mix, ASTM A53 Grade B carbon steel schedule 40 piping. Design supports to meet ASME B31.1 criteria and to meet boiler and pump manufacturer's allowable forces and moments for the equipment flange connections regarding the heating water supply and return piping.

D. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

E. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Power-actuated fastener systems.
4. Equipment Supports.
5. Trapeze Hangers.
6. Fiberglass Strut Systems.
7. Pipe Stands.

B. Pipe Stress Analysis report.

C. Shop Drawing: Show Fabrication and Installation Details and Include Calculations for the Following:

1. 3-Dimensional Pipe and Equipment Drawing: Field verified Water pipe distribution and equipment system layout. Include location and type of supports for new piping and equipment. Show clearances between existing building structure and new piping and equipment. Include clearances from existing water piping to remain and show access to valves and equipment. Also include water flow meter (HWFM) location.

2. Pipe supports including trapeze pipe hangers, line stops, anchors and guides.

3. Equipment supports and bracing

4. Plumbing Plan to show routing of all equipment drains and reliefs to floor sinks

5. Professional Licensed Structural Engineer stamped calculations for pipe and equipment support connections and details.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 PIPE HANGERS AND SUPPORTS

A. Provide adjustable hangers, inserts, brackets, rolls, clamps, supplementary steel, and other devices required for proper support of all pipe lines. Hangers shall be designed to allow for expansion and contraction of pipe lines, and shall be of adequate size to permit covering to run continuously through hangers. Piping at pumps, tanks, and other items of equipment shall be supported independently so that no weight shall be supported by the equipment.

B. All non-copper hangers and supports, including rods which are not plated, shall be furnished with shop coat of rust inhibiting primer; copper or copper plated hangers and supports shall be used wherever they touch bare copper tubing.

C. Wire or strap hangers are not permitted.

D. Pipe supports for beam and joist construction shall be beam clamps, B-Line Fig. B3054.

E. For insulated hot pipe and cold pipe in all sizes through 8□, hangers shall be of Clevis type, B-Line Fig. B-3108, for non-insulated piping hangers shall be of Clevis Type B-3100.

F. Piping supported from wall or columns shall utilize a steel bracket, B-Line Fig. 3-3064 with adjustable pipe roll and base, B-Line B-3121 and pipe covering protection saddle B-Line B-3160-3165.

G. Cast iron stacks and galvanized risers shall be supported at each floor with friction clamps bolted together and supported by structural steel or additional channels, B-Line Fig. B-3373.

H. Steel and cast iron pipe support spacing shall not exceed, and sizes of pipe-hanging suspension rods shall not be less than, the spacing and sizes indicated in the following tables.

1. Steel Pipe:

Nominal Pipe Size	Maximum Space Between Hangers	Minimum Rod Diameter
½"	5’	3/8"
¾"	6’	3/8"
1"	7’	3/8"
1¼"	8’	3/8"
1½"	9’	3/8"
2" and 2½"	10’	3/8"
3"	12’	1/2"
4"	12’	5/8"
5"	12’	3/4"
6"	12’	3/4"
8" to 12"	15’	7/8"

2. Copper Pipe:

Nominal Tube Size	Maximum Space Between Hangers	Minimum Rod Diameter
Up to 1”	5’	3/8"
1 ½” to 2”	6’	3/8"
2 1/2"	9’	1/2"
3"	10’	1/2"
4"	12’	5/8"

I. Maximum distance for cast iron piping shall be 10 feet, 0 inches with all hub supported and with a minimum of ½ inch rod diameter.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Globe Pipe Hanger Products, Inc.
3. Grinnell Corp.
4. Carpenter and Paterson, Inc.
5. Tolco Inc.
6. Approved equal.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.04 STRAP-TYPE FIBERGLASS PIPE HANGERS

A. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.

B. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.05 STAINLESS-STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

B. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.06 FIBERGLASS STRUT SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube & Conduit.
2. Champion Fiberglass, Inc.
3. Cooper B-Line, Inc.
4. SEASAFE, INC.; a Gibraltar Industries Company.
5. Approved equal.

B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.

1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.07 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.08 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Power-Strut Div.; Tyco International, Ltd.
3. Unistrut Corp.; Tyco International, Ltd.

4. Tolco Inc.
5. Approved equal.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.09 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. ERICO/Michigan Hanger Co.
2. Pipe Shields, Inc.
3. Rilco Manufacturing Company, Inc.
4. Approved equal.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

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

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

2.10 PIPE STANDS

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

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless Steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.11 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

6. Manufacturers:

a. Hilti, Inc.
b. ITW Ramset/Red Head.
c. Powers Fasteners.
d. Approved equal.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Approved equal.

2.12 EQUIPMENT SUPPORTS

A. Equipment supports require calculation and detail of each unit.

B. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.13 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 6, requiring up to 4 inches of insulation.

3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 6.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 6, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

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

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

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Dissimilar Materials: Install hangers and supports as such to avoid dissimilar materials.

N. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

    c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches) long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS.

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

1.02 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, drains and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1. Plastic insulated, series resistance.
2. Self-regulating, parallel resistance.
3. Constant wattage.

B. The Contractor shall furnish and install complete and functional heat trace systems including wiring; controls; thermostats; all electrical connections and any conduit, cable, boxes, outlets and other equipment and accessories required.

C. Related Requirements:

1. Section 22 07 00 "Mechanical Insulation".

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
3. Thermostat, controls, warning lights, alarms and control panels.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.
3. Layout of wiring, controls and all other equipment.
4. Calculation data showing the electrical load data for each system.
5. Installation instructions for the system.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

E. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall furnish all necessary labor and tools, materials, and equipment and shall properly construct and connect the electric heat trace system in accordance with the manufacturer's directions and recommendations.

B. The electric heat trace cable shall be either be covered with a protective nickel braid or covered with a tinned copper braid and a corrosion protective outer fluoropolymer jacket; unless indicated otherwise.

C. The Contractor shall coordinate the design and installation of the heat trace system with the pipe insulation system.

D. The design, selection and size of the heat trace cable shall be in accordance with correct heat transfer calculations as recommended by the equipment manufactures design guide.

E. The system shall be controlled and monitored from a single control panel. The system shall be controlled from a thermostat with provisions for a manual override from a Hand-Off-Auto switch.

F. Monitoring and alarm circuits shall be provided that monitor each heat trace circuit for current and continuity of the heat trace cable, and the entire system for low temperature failure.

G. The electric heat trace cable, control panel, and accessories shall have UL, FM, or CSA system listing.

2.2 MATERIALS

A. The Contractor shall furnish and install the electric heat trace system which shall include but not be limited to the electric heat trace cable, tape or banding, thermostats, control panel and warning lights and alarm.

B. The electric heat trace system for freeze protection shall be controlled from a common ambient sensing thermostat set to activate the system at 40 degrees, and a parallel backup thermostat set at 40 degrees F. An alarm shall be provided to indicate the failure of either thermostat or lack of power.

C. The control panel shall provide for the necessary controls and contactors plus an additional 25 percent spare space. The contactors shall be electrically operated, electrically

held, 30 ampere, 600 Volt, 3 pole, with a 120 Volt control coil. The contactors shall be as manufactured by Allen Bradley or Square D.

D. LED pilot lights shall be provided to indicate control power available, system on, off, and circuit on and failure alarms for each heat trace circuit.

E. The system and all components shall be approved by the Authority.

F. The cable shall be industrial type, rated 8 watts per foot (W/ft), at 120 volts, at a temperature of 50 degrees F. and a temperature identification number (T-rating) of T6 (185 degrees F. exposure). Values shall be established per Institute of Electrical and Electronics Engineers, Incorporated (IEEE) Standard 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.

G. The heating cable shall be self-regulating. The cable heat output shall decrease with raising ambient temperature without employment of an auxiliary electrical regulatory device.

H. The heating cable shall be composed of two parallel 16 AWG (or larger) stranded, nickel-plated copper bus wires, embedded in a polymeric conductive (heat generative) core (web). The wires and core shall be enclosed within a tinned copper, braided shield, suitable for use as an electrical fault grounding conductor. All cable components shall be jacketed with a tough, abrasion and moisture resistant thermoplastic (e.g. polyolefin), inert with aqueous and cleaning chemicals. The overjacket shall provide corrosion protection for the cable. A polyolefin or fluoropolymer overjacket is an acceptable alternate.

I. The cable shall have, monitor wires and a tinned copper braid, with a fluoropolymer jacket for mechanical and corrosion protection. The cable is suitable for direct placement on metallic and polyvinyl chloride (PVC) piping. The heat trace circuits shall be designed to operate on 20 ampere circuits.

J. The heating cable shall be unaffected by exposure to non-hazardous, unshielded indoor and outdoor environmental conditions. The cable service life shall not be diminished by exposure to ultraviolet radiation and random fluctuating temperatures within the range of -30 degrees to 150 degrees F.

K. The cable shall have a minimum expected service life of 10 years in applications of continuous operation. A minimum of 90% of the nominal rated power shall be exhibited following 1000 hours of continuous operation, in accordance with Underwriters Laboratories, Incorporated (UL) Standard 746B, Polymeric Materials – Long Term Property Evaluations.

L. Heating cable shall be UL approved. Cable shall have original manufacturer's labeling.

M. The heat trace system shall be as manufactured by Delta-Therm, Chemelex, Bylin or approved equal.

2.03 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

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. Delta-Therm Corporation.
2. Easy Heat; a brand of EGS Electrical Group LLC; an division of Emerson Industrial Automation.

3. Nuheat Industries Ltd.
4. Orbit Manufacturing.
5. Pyrotenax; Tyco Thermal Controls.
6. Raychem; Tyco Thermal Controls.
7. WarmlyYours Radiant, Inc.
8. Watts Radiant; a Watts Water Technologies company.
9. Approved equal.

B. Comply with IEEE 515.1.

C. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

D. Electrical Insulating Jacket: Minimum 4.0 mil Kapton with silicone, Tefzel, or polyolefin.

E. Cable Cover: Aluminum braid and silicone or Hylar outer jacket.

F. Maximum Operating Temperature (Power On): 300 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

2.04 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

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. BriskHeat.
2. Chromalox, Inc.
3. Delta-Therm Corporation.
4. Easy Heat; a brand of EGS Electrical Group LLC; an division of Emerson Industrial Automation.
5. Nelson Heat Trace.
6. Pyrotenax; Tyco Thermal Controls.
7. Raychem; Tyco Thermal Controls.
8. Thermon Americas Inc.
9. Trasor Corp.
10. Approved equal.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 (or larger) nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft.

2.05 CONSTANT-WATTAGE HEATING CABLES

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. BriskHeat.
2. Chromalox, Inc.
3. Delta-Therm Corporation.
4. Easy Heat; a brand of EGS Electrical Group LLC; an division of Emerson Industrial Automation.
5. Nelson Heat Trace.
6. Pyrotenax; Tyco Thermal Controls.
7. Raychem; Tyco Thermal Controls.
8. Thermon Americas Inc.
9. Trasor Corp.
10. Approved equal.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 12 or greater AWG, nickel-coated, stranded copper bus wires with single-stranded resistor wire connected between bus wires. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight.

D. Electrical Insulating Jacket: Flame-retardant fluoropolymer.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 392 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft.

2.06 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Microprocessor-based or automatic control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows.

   a. Temperature Span: 34 to 44 deg F.
   b. Adjustable Delay-Off Span: 30 to 90 minutes.
   c. Energize Cables: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
   d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to energize cable or close other contactors.
5. Precipitation sensor shall be freestanding.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

C. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.

2.1 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 22 05 53 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: ¾ inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Heat tracing shall be installed on clean surfaces free of dirt, debris, protrusions, oil, grease and moisture. Remove existing insulation, if any, as required for proper installation of the heat trace cable. Remove existing heat trace system or components as required for installation of the new system or components.

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

C. Locations for installation of the control panel, thermostat and warning light and alarm shall be approved by the Authority.

3.2 INSTALLATION - GENERAL

A. The heat trace cable shall be installed in such a manner as to maintain the best possible contact with the traced pipe, valves, flanges and other in-line equipment. The heat tracing cable shall be secured to the pipe as recommended by the heat trace system manufactures installation instructions.

B. In order to allow for maintenance access to valves, strainers, and other in-line equipment where additional heat tracing is required, a loose loop of heating cable of the length required shall be left at the item to be traced. The loop shall be spiraled around the item and secured as recommended by the heat tracing system manufacture's installation instructions.

C. All junction boxes, splices, and terminations requiring maintenance shall be mounted to be accessible without disturbing the insulation and jacket.

D. The location of the ambient sensing thermostats shall be selected to obtain a representative temperature, be accessible for maintenance, and protected from tampering.

E. The installation and final adjustments to the electrical heat tracing system shall be supervised and field tested by a qualified factory trained equipment manufactures service engineer.

F. After field testing has been completed the installed heat trace system shall be covered with insulation and a jacket as specified in pipe insulation section of this Specification.

G. All pipe electrically heat traced and insulated shall have a plastic label applied to the insulation every 25 feet. The plastic label shall read "Electric Heat Trace Circuit Number, Panel Number.

H. Unless otherwise approved, cable of 1000 feet in length and shorter shall be furnished in one piece. Cable of greater lengths shall be furnished in increments of this length or longer.

3.3 INSTALLATION OF HEATING CABLE

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 22 07 19 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install insulation over piping with electric heating cables according to Section 22 07 19 "Plumbing Piping Insulation."
3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

E. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 ELECTRICAL CONNECTIONS

A. Final electrical connections between the heat trace system and the power source and the energizing of the system will be performed by the Authority’s electrical department unless directed and approved otherwise.

3.6 RE-INSULATION

A. Re-insulate or insulate over the new heat trace cable after installation. See insulation specification. Type of insulation must be approved to be used with the heat trace cable to

avoid fire and other hazards. Insulate according to manufacturer's directions. Take precautions to not damage the heat trace cable.

3.7 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 the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect installed heating cables, including non-heating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

3.9 OPERATION AND MAINTENANCE MANUAL

A. Upon completion, Contractor shall test system for proper operation and set controls.

B. The equipment manufacturer and installer shall provide adequate training for the Authority's Personnel in the proper operation and maintenance of the equipment.

C. The installer shall provide as built drawings indicating the location of heat tracing and location of connections, controls, thermostats and warning lights and alarms. The manufacturer shall provide final and complete operation and maintenance manuals for all components of the heat trace system.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

D. The work of HEAT TRACING FOR PLUMBING PIPING shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of HEAT TRACING FOR PLUMBING PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS.

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4 Stencils.
5. Valve tags.
6. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

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

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.

d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products.
k. Approved equal.

2. Material and Thickness: Brass, 0.032-inch, stainless steel, 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black, Blue, Red, White or Yellow.
4. Background Color: Black, Blue, Red, White or Yellow.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

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

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.
d. Champion America.
e. Craftmark Pipe Markers.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services, Inc.
j. Seton Identification Products.
k. Approved equal.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.

3. Letter Color: Black, Blue, Red, White or Yellow.
4 Background Color: Black, Blue, Red, White or Yellow.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets.

9. Adhesive: Contact-type permanent adhesive, compatible with label and with adhesive.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. 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. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Marking Sevices Inc.
8. National Marker Company.
9. Seton Identification Products.
10. Stranco, Inc.
11. Approved equal.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch or 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black, Blue, Red, White or Yellow.

D. Background Color: Black, Blue, Red, White or Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel [rivets] [or] [self-tapping screws].

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.
12. Approved equal.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially or fully cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 STENCILS

A. Stencils for Piping:

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

a. Brimar Industries, Inc.
b. Carlton Industries, LP.
c. Champion America.
d. Craftmark Pipe Markers.
e. Kolbi Pipe Marker Co.
f. Marking Sevices Inc.

2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiiberboard or metal.
4. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.
12. Approved equal.

B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch; stainless steel, 0.025-inch; aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness; as indicated or as selected by the Authority, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS

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. Brady Corporation.
2. Brimar Industries, Inc.

3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. Kolbi Pipe Marker Co.
8. LEM Products Inc.
9. Marking Sevices Inc.
10. Seton Identification Products.
11. Approved equal.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum or approximately 4 by 7 inches as indicated or as selected by the Authority.
2. Fasteners: Brass reinforced grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulates.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Painting section of these specifications.

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, if approved by the Authority. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

D. Pipe Label Color Schedule:

1. Low-Pressure Compressed Air Piping:

a. Background: Safety blue.
b. Letter Colors: White.

2. High-Pressure Compressed Air Piping:

a. Background: Safety blue.
b. Letter Colors: White.

3. Domestic Water Piping

a. Background: Safety green.
b. Letter Colors: White.

4. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Safety black, Safety purple, Safety white or Safety gray as indicated or selected by the Authority.
b. Letter Color: Black or White as indicated or selected by the Authority.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-

watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches or 2 inches; round or square shape as indicated or as selected by the Authority.
b. Hot Water: 1-1/2 inches or 2 inches; round or square shape as indicated or as selected by the Authority.
c. Low-Pressure Compressed Air: 1-1/2 inches or 2 inches; round or square shape as indicated or as selected by the Authority.
d. High-Pressure Compressed Air: 1-1/2 inches or 2 inches; round or square shape as indicated or as selected by the Authority.

2. Valve-Tag Colors:

a. Cold Water: Natural or safety green as indicated or as selected by the Authority.
b. Hot Water: Natural or safety green as indicated or as selected by the Authority.
c. Low-Pressure Compressed Air: Natural or safety blue as indicated or as selected by the Authority.
d. High-Pressure Compressed Air: Natural or Safety blue as indicated or as selected by the Authority.

3. Letter Colors:

a. Cold Water: White.
b. Hot Water: White.
c. Low-Pressure Compressed Air: White.
d. High-Pressure Compressed Air: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 07 00

PIPE INSULATION

PART 1- GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SCOPE OF WORK:

A. The Contractor shall furnish all labor, material, equipment, and services necessary to furnish and install pipe insulation at the location as directed and required by the Authority.

B. Related Work:

1. Section 23 07 00, Mechanical Insulation.
2. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.

1.3 SUBMITTALS

A. The Contractor shall furnish product data, technical data, samples, installation instructions and shop drawings as required below:

1. Product Data: Provide product description, list of materials, and thicknesses for each type and application of insulation, cement, adhesive, sealant, tape, attachment device, jacket, cover and other accessory.

   a. Provide specifications and test data indicating thermal performance standards of insulating products.
   b. Provide data for each insulating product indicating thickness of material and related R value.

2. Provide product data, specifications, technical data and shop drawings for any equipment insulation indicating thickness, R values, size and profile of equipment to be insulated, location of protrusions, access requirements, method of attachment and seam closure method.
3. Samples: Submit two (2) samples of any representative size illustrating each insulation and accessory type. Provide samples of any jackets or covers in actual color and finish to be supplied.
4. Manufacturer's installation instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.
5. Manufacturer’s certificate of compliance and thermal efficiency.
6. Copy of manufacturer’s warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer of insulation shall have been producing the products successfully for a period of at least five years and be able to provide documentation that the products meet all specified requirements.

B. The material(s) required for the pipe insulation work will be furnished by the Contractor. All material(s) furnished by the Contractor shall be new and shall meet the standards and requirements specified by the applicable institutions and organizations (i.e. ASME,

ASTM, NFPA, and EPA), and local building codes.

C. All installation of insulation shall follow the insulation manufacturer's recommended procedures and meet the standards and requirements specified by the applicable institutions, organizations, Federal, State, and Local building codes.

1.5 REFERENCE STANDARDS

A. American Society for Testing and Materials:

1. ASTM E 84, Surface Burning Characteristics of Building Materials.
2. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
3. ASTM C 195, Specification for Mineral Fiber Thermal Insulating Cement.
4. ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
5. ASTM C 449, Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C 547, Specification for Mineral Fiber Pipe Insulation.
7. ASTM C 585, Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing.
8. ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

B. National Fire Protection Association:

1. NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.
2. NFPA 90A, National Fire Protection Association Standards.

C. Underwriters Laboratories:

1. UL 723 Fire and Smoke Hazard Classification.

1.6 SEQUENCING/SCHEDULING

A. Schedule and perform tasks required for furnishing and installing the thermal insulation and accessories in conformance with the requirements of the accepted project schedule.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver insulation products to the site in unbroken shipping cartons bearing a label indicating the contents and the appropriate ASTM, NFPA and UL flame and smoke hazard ratings as specified herein for the various insulation products.

B. Deliver and store insulation products protected from the weather. Store insulation on the site elevated off wet and otherwise contaminating surfaces.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours

1.9 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.10 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2- PRODUCTS

2.1 PIPE INSULATING MATERIALS, GENERAL:

A. Rigid Insulation on Piping: Use rigid insulation manufactured of molded glass fiber with composite (insulation, jacket or facing, and sealing adhesive) fire and smoke hazard ratings meeting requirements of NFPA 90A Standards, tested per ASTM E 84, NFPA 255 and UL 723, not to exceed a "Flame Spread" rating of 25 and a "Smoke Developed" rating of 50 except as noted herein. Products or their shipping cartons shall bear a label indicating above requirements. Insulation shall have a maximum thermal conductivity of 0.23 BTUH per sq. ft. per degree F. per inch at 70 degrees F. mean temperature. The water vapor transmission rating shall be less than 0.2 perms per inch using a jacket of white kraft bonded to aluminum foil and reinforced with fiberglass yarn.

B. All exterior piping, whether heat traced or not, shall be insulated with cellular glass type insulation having integral self-sealing jacket.

C. Fitting Insulation (Rigid): Insulate fittings and valve bodies with factory-premolded one-piece insulation. Insulation inserts of noncombustible glass fiber shall have a K factor of .27 at 75 degrees F. mean temperature.

D. Acceptable Manufacturers of Insulating Materials:

1. Johns-Manville, J-M Flame-Safe AP.
2. Owens-Corning Fiberglass.
3. Certain-Teed.
4. Pittsburgh Corning.

E. Acceptable Manufacturers of Aluminum Jacketing:

1. Childers.
2. Johns Manville.
3. Owens Corning.

2.2 INSULATING CEMENTS

A. Mineral Fiber certified to meet the requirements specified in the current edition of ASTM C 195.

1. Thermal Conductivity: Average max. 1.0 BTU·in./h·ft^{2}·^{o}F at 500 ^{o}F mean temperature.
2. Minimum compressive strength: 10 p.s.i. at 5 percent deformation.

B. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement certified to meet the requirements specified in the current edition of ASTM C 449.

1. Apparent Thermal Conductivity: Average max. 1.2 BTU·in./h·ft^{2}· ^{o}F at 400 ^{o}F mean temperature.
2. Minimum compressive strength: 100 p.s.i. at 5 percent deformation.

2.3 PREFORMED GLASS FIBER

A. Molded and jacketed inorganic glass fibers, bonded with a thermosetting resin, into products preformed via a molding process to yield rigid full-round cylindrical pipe insulation sections, certified to meet the requirements specified in the current edition of ASTM C 547, for Type I insulation.

1. Apparent Thermal Conductivity: Average max. 0.26 BTU·in./h·ft^{2}· ^{o}F at 75 ^{o}F mean temperature.
2. Density: Average max. 10 lb/ft^{3}

B. Surface Burning Characteristics: All preformed glass fiber insulation shall have composite (insulation, jacket, tape seal, and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested in accordance with the current editions of ASTM E 84, NFPA 255 and UL 723, not exceeding

1. Flame Spread 25
2. Smoke Developed 50

C. Hot-Surface Performance: All preformed glass fiber insulation shall not flame, glow, smolder, crack, delaminate or warp after 96 hours exposure to the heated surface of a heating pipe when tested in accordance with the current edition of ASTM C 411.

D. Jacketing: The preformed glass fiber insulation shall be furnished with either a foil and paper jacket with end joint butt strips or an aluminum jacket. All jacketing shall conform to the requirements specified herein under Article 3.1.5-Jackets.

2.4 JACKETS

A. Foil and Paper Jacket- Laminated glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil having self-sealing lap conforming to the current edition of ASTM C 1136, Type I, and ASTM C 921, Type I or Type II.

1. Water Vapor Permeance: 0.02 perms maximum, when tested in accordance with the current edition of ASTM E 96.
2. Puncture Resistance: 50 beach units minimum, when tested in accordance with ASTM tests.

B. Aluminum Jacket - Aluminum jacketing material shall be Alloy 3003, H14 temper roll stock, ready for shop or field fabrication to required sizes, in compliance with the current edition of ASTM B 209.

1. Finish and Thickness: Smooth finish, 0.010 inch to 0.016 inch thick.
2. Moisture Barrier: Factory applied 1-mil, heat bonded polyethylene and Kraft paper.
3. Moisture Barrier: Factory applied 3-mil Dupont Surlyn, or approved equal.

C. Aluminum fitting jackets shall be factory preformed from the same material having the same finish, moisture barrier, and thickness as that specified for jackets.

D. All straight runs of pipe insulation are to be protected with Childers Corrolon or approved equal aluminum jacketing. The jacketing is to be manufactured from .016" type 3003 or 5005 aluminum. All jacketing shall have an integrally bonded polykraft moisture barrier over the entire surface in contact with the insulation. All jacketing shall be installed in accordance with manufacturer's latest published recommendations.

E. All 90 degree F and 45 degree F insulated elbows having a nominal iron pipe size of ¼" to 12", inclusive, shall be protected with Childers Aluminum Ell-Jacs or approved equal manufactured from 1100 Aluminum alloy in .024" thickness. The Ell-Jacs shall be installed in accordance with manufacturer's latest published recommendations.

2.5 STANDARD PVC FITTING COVERS

A. Factory-fabricated fitting cover consisting of one-piece, pre-molded, PVC covers manufactured from 20-mil thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, reducers, end caps, soil-pipe hubs, traps, mechanical joints, roof drains, and P-trap, in compliance with the current edition of ASTM C 585.

2. Smooth high gloss surface that does not promote bacteria or fungi growth.

2.6 ATTACHMENTS, ADHESIVES AND SEALANT MATERIAL

A. Metal bands shall be 3/4 inch wide x 0.20 inch thick Type 304 stainless steel.

B. Wire tie material shall be one of the following: 14 gage nickel-copper alloy, 16 gage soft-annealed stainless steel, or 16 gage soft-annealed galvanized steel as indicated in the contract document.

C. Adhesives for the flexible elastomeric cellular insulation shall be solvent based, and suitable for the insulation furnished as recommended by the insulation manufacturer.

D. Adhesives for rigid preformed glass fiber insulation shall be non-flammable, solvent based and have a service temperature range of minus 20 °F to plus 180 °F.

E. Vapor Barrier Compound shall be a water-based fire-resistive composition exhibiting the following characteristics.

1. Water Vapor Permeance: 0.08 perm maximum.
2. Temperature Range: Minus 20 °F to plus 180 °F.

F. Weatherproof Sealant: Flexible-elastomer-based, vapor barrier sealant designed to seal metal joints.

1. Water Vapor Permeance: 0.02 perm maximum.
2. Temperature Range: Minus 50 °F to plus 250 °F.
Color: Aluminum.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

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

C. Carefully inspect installed work of other Trades in connection with insulating work and verify such work shall be complete, including system or equipment testing, to such point where insulating work may begin.

D. Verify that systems to be insulated are free of defects. Verify that piping has been tested and approved before applying insulation materials.

E. Verify that surfaces to be insulated are clean and dry.

3.2 PREPARATION

A. Apply insulation on clean, dry surfaces only and without foreign materials. Perform cleaning required for removal of construction debris, spills, etc. prior to installation.

3.3 INSTALLATION

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

B. Install insulation continuous through structure penetration of surfaces being insulated. All pipe insulation shall be continuous through walls, ceilings, floor openings or sleeves except where firestop or firesafing materials are required.

C. Insulation installed on piping operating below ambient temperatures shall have a continuous vapor barrier. Adequately seal hanger, support, and anchor penetrations of insulation. All joints, seams and fittings shall be sealed with approved materials.

D. Apply specified insulation adhesive, sealers and coatings at the manufacturer's specified minimum coverage per gallon.

3.4 PIPING INSULATION:

A. Apply insulation materials on piped services listed below and in accordance with thicknesses listed below. Insulate fittings and valve bodies and in-line control devices, except gage and thermometer faces, setting or measuring scales integral with in-line devices and control handles. Do not insulate unions or flanges.

B. Rigid Insulation Installation: Install on piping according to manufacturer's instructions, using specified adhesive to seal both longitudinal jacket laps and butt strips. Insulate in-line appurtenances with factory-premolded one-piece insulated covers as previously specified. Secure fitting cover by stapling first followed by a tape sealing using tape specified by the fitting cover manufacturer. Install insulation in thickness as follows:

1. Domestic hot & cold water in heated spaces - 1 inch thick; in unheated spaces - 2 inches thick.
2. Soil, waste and vent piping in heated spaces - 1 inch thick; in unheated spaces - 2 inches thick.

3. Horizontal downspouts - 1 inch thick.
4. All heat traced piping - 2 inches thick minimum.
5. Refrigeration piping - 1 inch thick minimum
6. Drain line from fan coil drip pan - 1 inch thick minimum

C. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement applied in two inch thick coats. Install the glass reinforcing mesh in the first coat while tacky and allow to dry before applying the second coat. Cover with aluminum jacket with seams located on bottom side of horizontal piping and facing building wall on vertical pipe. Secure cover with 3/4 inch wide and 0.20 inch wide stainless steeldraw brands on maximum 2 foot centers, or edges with aluminum sheet metal screws on maximum 4 inch centers. Caulk seams with flexible latex caulking.

D. For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

E. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

F. Insulate piping and equipment less than 8 feet above finished floors in locations accessible to personnel contact so that temperatures of exposed surfaces do not exceed 180 degrees F.

G. Carry vapor barriers down and seal to the cold surface at not more than 50 foot intervals on horizontal runs and at not more than 10 foot intervals on vertical runs.

H. Seal hanger rods on pipes carrying fluids of less than 70 degrees F to a point of 2 inches minimum above the top of the insulation where the insulation is penetrated.

I. Vapor barrier jackets may be all purpose jackets, foil-scrim-kraft jacket, minimum 3 mil plastic sheeting, or spray on plastic coatings.

J. Provide a factory or field applied fiberglass cloth jacket over all vapor barriers, except all-purpose jackets, on all piping exposed to view or specified to be painted.

K. Provide a factory or field applied fiberglass cloth jacket over all thermal insulation exposed to view or specified to be painted, except all-purpose jackets. Size all insulation exposed to view in accordance with section painting.

L. Adhesives and fasteners used to secure jackets and covers on insulation shall be vermin, rodent and mildew resistant and have a smoke and flame spread rating equal to or greater than the insulation on which applied.

M. Apply insulation so that it does not interfere with the operation of control valves or servicing of equipment, valves or controls. Apply insulation so that access doors, covers, panels and access plates on equipment and piping can be removed, opened or operated without damage to the insulation. Insulation shall not cover nameplates, inspection stamps, rating plates, code stamps, and similar information attachments.

N. On high-temperature piping, provide double layering of insulation. Stagger insulation joints when more than one layer of insulation is applied.

O. All ends of insulation materials shall be firmly butted and secured with appropriate butt strip materials.

P. When installing insulation cover seams, locate in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

3.5 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

F. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

G. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies according to code.

3.6 CLEANUP

A. Ensure a general clean-up is conducted at all work sites at the close of each workday. All waste material or rubbish (e.g. old insulation) must be disposed of in accordance with

all applicable City and State regulations in effect for the work area, including disposal of waste in a licensed yard and/or refuse land fill.

B. Do not dispose of waste material or rubbish into the Authority's refuse containers or anywhere else on or about the Authority's property.

C. Keep premises free from accumulation of waste material or rubbish as the work progresses. At completion of work, the Contractor shall remove all rubbish from the worksite and shall remove all tools, scaffolding and surplus materials, leaving the work area "broom clean". In case of dispute, the Authority may remove rubbish and charge such costs to the Contractor. Any damages caused by the Contractor, either directly or indirectly, shall be the sole responsibility of the Contractor.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each location of piping insulation work.

2. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DEFECTIVE MATERIALS OR WORKMANSHIP

A. All material and workmanship covered by this specification shall be subject to the inspection and approval of the Authority and shall be in conformance with this specification, all relevant codes and requirements and good practice. All materials used for this work shall be new, in original packaging and undamaged prior to installation.

B. Any defective material shall be immediately removed from the premises by the Contractor and replaced at no cost to the Authority. Any defective workmanship shall be promptly corrected to the satisfaction of the Authority and at no cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of PIPE INSULATION shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of PIPE INSULATION shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
2. Encasement for piping.

B. Related Requirements:

1. Section 22 05 00, Common Work Results for Plumbing
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping
3. Section 22 05 18, Escutcheons for Plumbing Piping
4. Section 22 05 19, Meters and Gages for Plumbing Piping
5. Section 22 05 23, General-Duty Valves for Plumbing Piping
6. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment
7. Section 22 05 33, Heat Tracing for Plumbing Piping
8. Section 22 05 53, Identification for Plumbing Piping and Equipment
9. Section 22 07 00, Pipe Insulation
10. Section 22 11 19, Domestic Water Piping Specialties
11. Section 22 11 23, Domestic Water Pumps
12. Section 22 13 16, Sanitary Waste and Vent Piping
13. Section 22 13 19, Sanitary Waste Piping Specialties
14. Section 22 13 20, Sanitary Drains
15. Section 22 40 00, Plumbing Fixtures

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

C. Standards: The work shall comply with the following standards:

1. American National Standard Institute (ANSI)

a. ANSI B1.20.1 -Pipe Threads, General Purpose Revision and Redesignation of ASME/ANSI B2.1.

2. American Society of Sanitary Engineering (ASSE):

    a. ASSE 1001 - Pipe Applied Atmospheric Vacuum Breakers.
    b. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

3. American Society of Mechanical Engineers (ASME):

    a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.
    b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
    c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings.
    d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
    e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
    f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings.
    g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
    h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
    i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
    j. ASME/ANSI B31.9 - Building Service Piping.

4. American Society of Testing and Materials (ASTM):

    a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
    b. ASTM A74 - Cast Iron Soil Pipe and Fittings.
    c. ASTM A106 - StandardSpecification for Seamless Carbon Steel Pipe for High-Temperature Service.
    d. ASTM B88 - Seamless Copper Water Tube.
    e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

5. American Water Works Association (AWWA):

    a. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
    b. ANSI/AWWA C510 - Double Check Valve Backflow-Prevention Assembly.

6. Miscellaneous Standards and Regulations:

    a. Environmental Protection Agency (EPA)
    b. Clean Water Act (CWA)
    c. Occupational Safety and Health Act (OSHA)
    d. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.4 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of the Division One Section, “Submittals” and as required below:

B. Shop Drawings:

1. Shop Drawings of piping floor layouts in plan drawn to a minimum scale of 1/8″ = 1′ -0″.
2. Supply, Drainage, and Vent Plumbing Diagrams showing pipe sizes, shut off valves, provision for expansion, cleanouts, etc.
3. Contractor to submit utility plans for all levels of the facility for coordination of all utility runs and chases. The utility plans to show the layout and location horizontally and vertically of all utilities including water pipes, other pipes, ductwork and equipment.

    a. The utility plans to also show all obstructions, structural and building elements, walls and other fixed elements.
    b. Purpose of the utility plans are to indicate the relationship and coordination of the utilities to the fixed building elements and to other utilities; indicate clearances; determine location and extent of obstructions and indicate potential interferences. The utility plans to show required clearances and spaces for maintenance of the utilities and access to valves, shutoffs, controls, cleanouts and other equipment. The drawings to show utility chases for pipes and other utilities; their layout and accessibility.
    c. Utility plans to indicate for the hot and cold water piping pipe sizes, type of pipe, valves, connections, provision for expansion and other related items.
    d. It is the Contractor’s responsibility to obtain input from other trades to develop the utility layouts; coordinate their work to avoid conflicts and interferences as well as facilitate an orderly installation of all the work.

C. Product Data: Submit for Authority's review, manufacturer’s literature indicating installation instructions and dimensions, materials, accessories, performance information, certified performance curves, rated capacities, electrical requirements and wiring diagrams, standards listing, certification and guarantees for the following:

1. Piping, tubing, fittings and couplings
2. Joints and materials.

D. Product data submitted shall include specifications section and paragraph reference with intended use clearly indicated. A submittal shall be made for review and approval for all items; even if already identified herein by manufacturer’s model number.

E. System purging and disinfecting activities report.

F. Field quality-control reports.

G. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Pressure Testing of Piping.

1.5 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings and other submittals for that portion of the work has been completed and returned to the Contractor marked “Approved”. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

E. Regulatory Requirements: City of Chicago Plumbing Code.

F. Welding: Qualifying welding procedures, welders and operators in accordance with ASME B31.9, as applicable, for shop and project site welding of pipe work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

G. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

1.6 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

C. Schedule fixture and piping rough-in with installation of other building components.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 WARRANTY

A. All plumbing equipment and accessories including piping and valves shall be warranted by the manufacturer and installer for a period of one (1) year after the date of final acceptance unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority for parts or labor, and upon the discretion of the Authority.

1.9 FIELD CONDITIONS

A. Notify the Authority no fewer than fourteen (14) days in advance of proposed interruption of water service.

1. Do not interrupt water service without the Authority's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

F. Copper-Tube, Extruded-Tee Connections:

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

a. T-DRILL Industries Inc.

b. Approved equal.

2. Description: Tee formed in copper tube according to ASTM F 2014.

G. Appurtenances for Grooved-End Copper Tubing:

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

a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products.
d. Victaulic Company.
e. Approved equal.

2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.

3. Mechanical Couplings for Grooved-End Copper Tubing:

a. Copper-tube dimensions and design similar to AWWA C606.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51.
2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

H. Appurtenances for Grooved-End, Ductile-Iron Pipe:

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

   a. Shurjoint Piping Products.
   b. Smith-Cooper International.
   c. Star Pipe Products.
   d. Victaulic Company.
   e. Approved equal.

2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

   a. AWWA C606 for ductile-iron-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating:

      1) NPS 14 to NPS 18 (DN 350 to DN 450): 250 psig (1725 kPa).
      2) NPS 20 to NPS 46 (DN 500 to DN 900): 150 psig (1035 kPa).

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53, Type E, Grade B, Standard Weight.
2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.

4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:

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

   a. Anvil International.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.
   e. Approved equal.

2. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47, malleable-iron casting; ASTM A 106, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
3. Fittings for Grooved-End, Galvanized-Steel Pipe:

   a. AWWA C606 for steel-pipe dimensions.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating:

      1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa).
      2) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).

2.5 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61 Annex G.

B. Stainless-Steel Pipe: ASTM A 312, Schedule 10 and Schedule 40.

C. Stainless-Steel Pipe Fittings: ASTM A 815.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:

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

   a. Anvil International.
   b. Grinnell Mechanical Products.
   c. Shurjoint Piping Products.
   d. Victaulic Company.
   e. Approved equal.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

a. AWWA C606 for stainless-steel-pipe dimensions.
b. Stainless-steel housing sections.
c. Stainless-steel bolts and nuts.
d. EPDM-rubber gaskets suitable for hot and cold water.
e. Minimum Pressure Rating:

1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa).
2) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).

2.6 CPVC PIPING

A. CPVC Pipe: ASTM F 441, Schedule 40 and Schedule 80.

1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846, SDR 11, tube and socket fittings.

2.7 PEX TUBE AND FITTINGS

A. PEX Distribution System: ASTM F 877, SDR 9 tubing.

B. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

C. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

2.8 PEX-AL-PEX TUBE AND FITTINGS

A. PEX-AL-PEX Distribution System: ASTM F 1281 tubing.

B. Fittings for PEX-AL-PEX Tube: ASTM F 1281, metal-insert type with copper or stainless-steel crimp rings and matching PEX-AL-PEX tube dimensions.

2.9 PEX-AL-HDPE TUBE AND FITTINGS

A. PEX-AL-HPDE Distribution System: ASTM F 1986 tubing.

B. Fittings for PEX-AL-HDPE Tube: ASTM F 1986, metal-insert type with copper or stainless-steel crimp ring and matching PEX-AL-HDPE tube dimensions

2.10 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80..

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.11 PP PIPE AND FITTINGS

A. PP Pipe: ASTM F 2389, SDR 7.4 and SDR 11.

B. PVC Socket Fittings: ASTM F 2389.

2.12 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.13 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: As selected by the Authority.

2.14 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

a. Cascade Waterworks Mfg. Co.
b. Dresser, Inc.
c. Ford Meter Box Company, Inc. (The).
d. Jay R. Smith Mfg. Co.
e. JCM Industries, Inc.
f. Romac Industries, Inc.
g. Smith-Blair, Inc.
h. Viking Johnson.
i. Approved equal.

D. Plastic-to-Metal Transition Fittings:

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

a. Charlotte Pipe and Foundry Company.
b. Harvel Plastics, Inc.
c. Spears Manufacturing Company.
d. Uponor.
e. Approved equal.

2. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:

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

a. Colonial Engineering, Inc.
b. NIBCO INC.
c. Spears Manufacturing Company.
d. Approved equal.

F. Description:

1. CPVC or PVC four-part union.
2. Brass or stainless-steel threaded end.
3. Solvent-cement-joint or threaded plastic end.
4. Rubber O-ring.

5. Union nut.

2.15 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. 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. A.Y. McDonald Mfg. Co.
   b. Capitol Manufacturing Company.
   c. Central Plastics Company.
   d. HART Industrial Unions, LLC.
   e. Jomar Valve.
   f. Matco-Norca.
   g. Watts; a Watts Water Technologies company.
   h. Wilkins.
   i. Zurn Industries, LLC.
   j. Approved equal.

2. Standard: ASSE 1079.
3. Pressure Rating: 250 psig (1725 kPa) unless indicated otherwise.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Matco-Norca.
   d. Watts; a Watts Water Technologies company.
   e. Wilkins.
   f. Zurn Industries, LLC.
   g. Approved equal.

2. Standard: ASSE 1079.

3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 300 psig (2070 kPa) minimum at 180 deg F unless indicated otherwise.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.
    e. Approved equal.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig (1035 kPa) unless indicated otherwise.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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

    a. Elster Perfection Corporation.
    b. Grinnell Mechanical Products.
    c. Matco-Norca.
    d. Precision Plumbing Products.
    e. Victaulic Company.
    f. Approved equal.

2. Standard: IAPMO PS 66.

3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

2.16 VALVES

A. General: Valves shall comply with ASME B31.9 for building service piping. Provide valves specified and indicated on the Drawings. Water working pressure rating for valves shall be less than hydrostatic test pressures for the system in which they are installed. In addition comply with manufacturer's Standardization Society of the Valves and Fittings Industry standards as follows.

1. Cast Iron Gate Valves, SP-70
2. Cast Iron Check Valves, SP-71
3. Bronze Valves, SP-80

B. End Connections:

1. Threads: Comply with ANSI B2.1, steel pipe connection 2 inch and smaller.
2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves, steel pipe connection 2 1/2 inch and larger.
3. Solder Joint: Comply with ANSI B16.22, copper tube connection.

a. Caution: Where soldered end connections are used, use solder having a melting point below 840 degrees F for gate, globe and check valves; below 421 degrees F for ball valves.
b. The use of filler material with lead content is prohibited.

C. Gate Valves:

1. Gate Valves - 2 inches and smaller: MSS SP-80; Class 125, body and bonnet of ASTM B 62 cast bronze, rising stem threaded ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

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

a. Stockham, B-109 or B-100
b. Nibco, S-111 or T-111
c. Milwaukee, 1149 or 148
d. Approved Equal.

3. Gate Valves - 2½ inch and larger: MSS SP-70; OS&Y, Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

a. Stockham, B-24 or B-22
b. Nibco, S-235 or T-235
c. Milwaukee, 1590T or 590T
d. Approved Equal.

D. Check Valves:

1. Swing Check Valves - 2 inch and smaller: MSS SP-80; Class 125, cast bronze body and cap conforming in ASTM B62, horizontal swing, Y-pattern, with bronze disc, and having threaded ends. Valve shall be capable of being reground while the valve remains in the line. Class 150 valves meeting the above specification may be used where pressure requires or Class 125 are not available.

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

a. Stockham, B-309 or B-319
b. Nibco, S-413-B or T-413-B
c. Milwaukee, 1509T or 509T
d. Approved Equal.

E. Ball Valves:

1. Size 2½ inch and smaller: 400 lb. WOG, two piece cast bronze body, screwed ends, chrome plated brass ball, teflon ball and flange seals, rod silicon brass stem, teflon and Viton "O" ring stem seals, zinc plated carbon steel handle with vinyl grip and brass handle nut.

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

   a. Apollo, 70-100/200
   b. Stockham, S-216
   c. Nibco, 580
   d. Approved Equal.

F. Drain Valves: 3/4 inch brass, 150-lb. WSP, angle valves, fitted with 3/4" brass hose nipple.

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

   a. Stockham B-229
   b. Milwaukee
   c. Nibco
   d. Approved Equal.

G. Mixing Valves (MV):

1. Thermostat mixing valve to comply with ASSE 1017. Manually adjustable. Bronze body. Union angle strainer check stops on inlets. Adjustable temperature setting locking regulator. Integral wall support. Cast lever handle, bronze finish. Minimum flow 1 GPM.

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

   a. Leonard Valve Co. Model TM-28.
   b. Lawler Manufacturer Co.
   c. Symmons Industries.
   d. Approved Equal.

H. Solenoid Valves (SV):

1. 2-way brass diaphragm valves:
   Size: 1 ¾ inch to 1 inch.
   Pressure range: 145 psi.
   Temperature range: 14 degrees Fahrenheit to 140 degrees Fahrenheit.
   Power: 6.5 watts at 24 VDC.
   Body: Brass.
   Seal: buna.
   Other parts: stainless steel.
   Coil: class F, molded, continuous duty and UL recognized.

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

   a. Kip Norgen Co. , Model 8241.
   b. Dwyer.
   c. Neptronic.

d. Approved Equal.

I. Freeze Protection Drain Valves (FPV):

1. Stainless steel body, fittings, spring and plug. Maximum operating pressure: 300 psig.
Maximum operating temperature: 200 degrees F.
Full open temperature: 35 degrees F.
Full close temperature: 48 degrees F.
Brass Thermal Actuator

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

a. Therm-Omega-Tech, Inc., Model HAT/FP.
b. Danfoss.
c. Dwyer.
d. Approved Equal.

J. General Duty Valves:

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

a. Stockham
b. Nibco
c. Milwaukee
d. Crane
e. Approved Equal.

K. Relief Valves:

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

a. Conbraco Industries, Inc.
b. Watts Regulator Co.
c. Zurn Industries, Inc.; Wilkins-Regulator Div.
d. Approved Equal.

L. Two stage Electronic Thermostat (TF) for Freeze Protection:

1. On/Off control of valves:
Set point range: -30 degrees Fahrenheit to 220 degrees Fahrenheit.
Remote temperature sensing: up to 400 feet.
Input voltage: 120 VAC.
Switch action SPDT sensor 2 inches long x ¼ inch diameter with 8 feet cable.

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

a. Ranco Instrumentation, Model ETC.
b. Dayton.
c. Granger.
d. Approved Equal.

M. General Application: Use gate and ball for shut-off duty; ball valve for throttling duty.

2.17 HOSE BIBB WALL HYDRANT

A. Non-Freeze Wall Hydrant (WH): Anti siphon automatic draining, non-freeze type wall hydrant incorporating integral backflow preventer approved by American Society of Sanitary Engineers (ASSE) and accepted by US Department of Health and listed by International Association of Plumbing and Mechanical Officials (IAPMO), with rough brass finish on brass casting, 3/4 inch hose thread nozzle. Operating stem to be hardened stainless steel. For concealed installations against vandalism, provide polished bronze box and hinged cover with loose "Tee" key to be furnished with each hydrant. Packing nut to be secured with locknut. Large hemispherical (compression type) permanent valve seat.

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

a. Zurn Z-1320-6.
b. Josam Series 71000.
c. Smith 5509QT.
d. Approved Equal.

2.18 FLOOR HYDRANT

A. Provide hydrant with box for standard 3/4 inch hose end outlets. Hydrant of cast bronze box, hinged latching cover mechanism, adjustable locknut, removable nylon seat.

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

a. Josam Manufacturing Co., No. 7160.
b. Zurn Industries, Inc.
c. Wade.
d. Jay R. Smith Manufacturing Company No. 5611.
e. Approved equal.

2.19 WATER PIPING ACCESSORIES

A. Air Cushions: Fixtures and Tops of Risers: Each supply riser and fixture supply, including hot and cold water, shall have a separate air cushion chamber. At fixtures provide job-fabricated air cushions, consisting of a section of pipe not less than 12 inches long, and the same size to fixture, but not less than ¾ inches.

B. Backflow Preventers: Reduced Pressure Backflow Preventer (RPZ) shall comply with ASSE 1013 and AWWA C511 and consist of stainless steel internal parts and flange bolts and tight-sealing rubber check valve assemblies, suitable for 175 psi and 140 degree Fahrenheit temperature. Complete assembly includes supply strainer, ball valves before and after device and device composed of a pressure differential relief valve be-

tween two positive seating check valves and an intermediate atmospheric vent. Relief valve discharge piped to drain. Permission to use this is required by the City of Chicago.

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

    a. Watt, Model 909s-QT.
    b. Hersey Products.
    c. Febco.
    d. ITT.
    e. Approved Equal.

C. Thermometers: Thermometers shall be of the adjustable socket, mercury-in-glass, red-reading type with 9″ Fahrenheit scale of proper range for the service, enclosed in metal, glass-covered case, with magnified mercury columns, separable wells, straight or angle mounted as required, and installed where indicated in piping systems in such a manner as to be easily read. Provide extension necks where required to clear insulation. Thermometers shall be provided where indicated.

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

    a. Ashcroft
    b. Trerice
    c. Weksler
    d. Approved Equal.

D. Pressure Gauges: Pressure gauges shall be Grade A, accurate within 1%, of the Bourdon tube, spring type, with 4½″ dials (unless otherwise indicated) and with recalibrating screws. Gauges shall have plain cases with screwed rings and be finished in black enamel. Each gauge shall be installed with necessary piping, including a shut-off cock. Provide pressure snubber on each gauge. Gauges shall not be installed until systems are cleaned.

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

    a. Ashcroft "Quality"
    b. Trerice No. 600
    c. Weksler "Regal"
    d. Approved Equal.

2. Pressure gauge ranges shall be such that the portion of the pointer during normal operation will be 50% of dial range.
3. Pressure gauge shall be provided where indicated and as follows:

    a. On each incoming cold water service main.
    b. On discharge side of each pump.

2.20 PIPE HANGERS AND SUPPORTS

A. Provide adjustable hangers, inserts, brackets, rolls, clamps, supplementary steel, and other devices required for proper support of all pipe lines. Hangers shall be designed to

allow for expansion and contraction of pipe lines, and shall be of adequate size to permit covering to run continuously through hangers. Piping at pumps, tanks, and other items of equipment shall be supported independently so that no weight shall be supported by the equipment.

B. All non-copper hangers and supports, including rods which are not plated, shall be furnished with shop coat of rust inhibiting primer; copper or copper plated hangers and supports shall be used wherever they touch bare copper tubing.

C. Wire or strap hangers are not permitted.

D. Pipe supports for beam and joist construction shall be beam clamps, B-Line Fig. B3054.

E. For insulated hot pipe and cold pipe in all sizes through 8″, hangers shall be of Clevis type, B-Line Fig. B-3108, for non-insulated piping hangers shall be of Clevis Type B-3100.

F. Piping supported from wall or columns shall utilize a steel bracket, B-Line Fig. 3-3064 with adjustable pipe roll and base, B-Line B-3121 and pipe covering protection saddle B-Line B-3160-3165.

G. Cast iron stacks and galvanized risers shall be supported at each floor with friction clamps bolted together and supported by structural steel or additional channels, B-Line Fig. B-3373.

H. Steel and cast iron pipe support spacing shall not exceed, and sizes of pipe-hanging suspension rods shall not be less than, the spacing and sizes indicated in the following tables.

1. Steel Pipe:

Nominal Pipe Size	Maximum Span	Minimum Rod Diameter
½"	5′	3/8"
¾"	6′	3/8"
1"	7′	3/8"
1¼"	8′	3/8"
1½"	9′	3/8"
2" and 2½"	10′	3/8"
3"	12′	1/2"
4"	12′	5/8"
5"	12′	3/4"
6"	12′	3/4"
8" to 12"	15′	7/8"

2. Copper Pipe:

Nominal Tube Size	Maximum Space Between Hangers	Minimum Rod Diameter
Up to 1”	5′	3/8"
1 ½” to 2”	6′	3/8"
2 1/2"	9′	1/2"
3"	10′	1/2"
4"	12′	5/8"

2.21 PIPE SLEEVES AND ESCUTCHEONS

A. Provide pipe sleeves for all pipes which pass through walls, partitions, floors, ceilings, or roofs.

B. General floor sleeves shall be standard weight galvanized steel pipe with bottom end flush with surface, top end extend 1" above finished floor, caulked.

C. Foundation walls and slabs on grade: Cast iron (per Clow 1430/1435 or Josam, Zurn, J.R. Smith or Wade), sleeves, flush inside and outside, integral waterstop, caulked, or Thunderline linkseal series "LS" sleeve with waterstop, rubber sealing elements, pressure plates and bolts.

D. Concrete walls: Standard weight galvanized steel pipe, flush with wall surface at both ends anchored and caulked.

E. Sleeves through fire/smoke rated walls or floors shall be of standard weight galvanized steel pipe.

F. Interior partitions and ceilings: 20 gauge galvanized steel with lock joints.

G. Sleeves for uninsulated piping shall be two (2) sizes larger than pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the full thickness of the pipe covering with clearance for expansion and contraction.

H. Where pipes pass through floors on fill or concrete exterior walls, caulk sleeves with oakum and lead wool.

I. For all fire rated walls, and partitions, annular space between interior surface of all pipes and sleeves shall be packed with fire rated material such as Johns-Manville "Cerafiber", Super 48 Insulating Cement or Thermo-Fiber #CW40 and caulked water-tight with a water-proof mastic such as Ink-Smith B-1 butyl sealant, or approved equal.

J. Pipe sleeves through non-rated wall, floors and partitions shall have the openings packed with glass fiber insulation and both ends of sleeves caulked with waterproof mastic.

K. Escutcheons:

1. Provide escutcheons on all exposed piping passing through walls, floors, partitions and ceilings.
2. Escutcheons shall be held in place by internal spring tension or set screws.
3. Application:

Location	Escutcheon Material
Finished Spaces:	Anodized aluminum, chrome plated brass or stainless steel.
Unfinished Spaces: Excluding mechanical equipment rooms.	Plain brass, or aluminum

2.22 REDUCED PRESSURE BACKFLOW PREVENTER

A. Threaded type bronze construction, stainless steel internal parts and flange bolts, and tight-sealing rubber check valve assemblies. Suitable for supply to 175 psi and 140 degrees F. temperature. Complete assembly includes supply strainer, ball valves before and after the device and the device composed of a pressure differential relief valve between two positive seating check valves and an intermediate atmospheric vent. Relief valve discharge piped to drain. Backflow preventer approved under ASSE Standard 1013. Permission to use this is required by the City.

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

   a. Watts Regulator Company, No. 909S-QT.
   b. Hersey Products, Inc.
   c. ITT Lawler.
   d. Approved equal.

2.23 WATER METERS

A. Coordinate supplying and installing water meters with "Water Systems" section of these specifications. Provide water meter assemblies with remote reading system as indicated and as required by the City of Chicago. Meters of nominal size 1-inch shall be of the rotating disc type which includes integral strainer housing. Assemblies shall include two isolating valves and union and nipples for meters with screwed end fittings.

1. Pressure Drop: Pressure drop across assembly shall not exceed ½ atmosphere, with the following rates of flow.
2. Register: Totalizing registers shall be of the following range: 1-1/2 to 3 inch size and 10 gallon total capacity with 100 gallons per sweep hand revolution.

3. Manufacturers (Size 3 inches and smaller): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Badger Meter, Inc.
   b. Hersey, model HD Series.
   c. Hedland flow meter.
   d. Approved Equal.

PART 3 – EXECUTION

3.1 GENERAL

A. Provide and install all piping, fittings, equipment, fixtures, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for hot and cold water supply systems.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced with risers and drops running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment have water connections to verify actual locations of piping connections prior to installation.

C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.3 GENERAL PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated layout and locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install piping according to applicable plumbing code.

K. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

M. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

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

1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping.

P. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted.

Q. All pipe shall be cut to exact measurement to be installed without forcing. After cutting, ends shall be reamed and cleaned to eliminate foreign matter and burrs.

R. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

S. All pipe and fittings shall be marked by the manufacturer in accordance with the marking sections of the standards to which reference is made or in accordance with the requirements of MSS-S-5: Standard Marking System for Valves, fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fittings Industry.

T. Make all changes in size and direction of piping with manufactured fittings. Field fabricated fittings will not be allowed.

U. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and/or servicing.

V. In no case shall any pipe be installed where it is supported on, or suspended from, another pipe or the piping of other trades.

W. All piping subject to expansion and contraction, at the time of installation, shall be cold sprung to allow in part for expansion.

X. In all cases where pipe connections are made to piping or any item of equipment of dissimilar metal, provide the proper type of dielectric fitting; EPCO or Center Plastics insulated unions.

Y. Layout of piping shall follow drawings, utility plans and if applicable, approved shop drawings.

3.4 EXCAVATION AND BACKFILL

A. Excavation:

1. Pipe trench excavation: The width of the trench at and below the top of the pipe shall be the outside diameter of the pipe plus 18 inches, unless otherwise indicated. The width above the level may be as wide as necessary for proper performance of the work. The bottom of the trenches shall be accurately graded to provide continuous uniform bearing and support. Bell holes and depressions for joints shall be carefully dug to be no larger than necessary. Over-excavation of the trench bottom shall be brought back to grade with pit run gravel or clean concrete sand compacted with 4 inch layers, or with concrete.

2. Under-slab work shall not be covered until it has been inspected, tested and approved.

B. Bedding and Backfill:

1. All trenches shall be backfilled, from the trench bottom to a point at least 12 inches above the top of the pipe, with fine aggregate trench bedding gradation as follows:

100% passing the 1" sieve
65-100% passing the No. 4 sieve
40-90% passing the No. 10 sieve
30-80% passing the No. 16 sieve
10-50% passing the No. 50 sieve
0-30% passing the No. 100 sieve
0-10% passing the No. 200 sieve

2. Depth of pipe bedding shall be a minimum of 6 inches below pipe.
3. The remainder of the trench shall be filled with limestone screenings or clean sand, placed in 6 inch lifts and compacted by mechanical tampers or vibratory compactors, completely filling the trenches to the bottom of the slab grade or sub-grade.
4. Backfilling around appurtenances shall be as specified for backfilling of pipe trenches above the pipe.
5. If the material found at the elevations specified are unstable and not suitable or in case it is found desirable or necessary to go an additional depth, the Contractor shall provide 6" deep stabilization stone below pipe bedding. The stabilization stone shall be crushed stone and have CA-1 gradation conforming to the Illinois Department of Transportation Standard Specifications.
6. All material and backfill operations shall be subjected to testing.

C. Removal of Water:

1. The elevation of the groundwater shall be maintained to a minimum depth of 12 inches below the bottom of the excavation until the trench is backfilled to finished grade.
2. At all times during the excavation period and until its completion and acceptance at final inspection, ample means and equipment shall be provided with which to remove promptly and dispose of properly all waste entering any excavation or other parts of work. The excavation shall be kept dry.
3. Water pumped or drained from the work hereunder shall be disposed of in a suitable manner without damage to adjacent areas, to other work under construction or to pavements. Water shall not be discharged without adequate protection of the surface at the point of discharge.
4. Any and all damages caused by dewatering the work shall be promptly repaired by the Contractor.

3.5 UNDERGROUND PIPE INSTALLATION

A. Hot and cold water piping and forced drainage mains shall be double electrically isolated at the point where the piping leaves or enters the structure. Electrical continuity shall be established along all metallic piping buried in the soil.

B. Buried hot and cold water piping and forced drainage mains shall be installed with dielectric coating rate at a minimum insulation resistance of 1,076,391 ohms per square meter

as measured by ASTM D-257-78. The coating shall consist of a hot-applied coal tar and asphalt enamel in compliance with the National Association of Pipe Coating Applications (NAPCA) Bulletin 3-67-83. Manufacturer's recommendations shall be adhered to for piping preparation, priming, and coating application.

3.6 SUSPENDED PIPING INSTALLATION - WATER DISTRIBUTION

A. General: All piping shall include the following:

1. Isolation valves and unions or flanges at each branch, and in supply and return to each item of equipment such as pumps, tanks, automatic valves etcetera. Valves and unions or flanges shall be located to isolate each unit, branch, or section of piping to facilitate maintenance and/or removal of all equipment.
2. Gate valves on capped services for extension to equipment furnished under other sections.
3. Drain valves at all low points of each system to enable complete drainage.
4. Drain piping from pump glands, relief and safety valves, etc., to spill over open sight drains, floor drains, or other acceptable discharge points, terminating drain line with plain end (unthreaded) pipe.
5. Horizontal water supply and return piping, with straight side of eccentric fittings at top of pipe, and pitch upward 1" in 40′ in direction of flow.

3. 7 LOCATION OF OPERATION AND MAINTENANCE SYSTEM COMPONENTS

A. System components which require observation, operation or maintenance - such as valves, traps, gauges, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc. - shall be located whenever possible so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access.

B. Install all valves with stems in either an upright (preferred) or horizontal position. Control valves shall be installed with top works upward unless specifically shown otherwise.

C. Instruments (i.e. pressure gauges, thermometers, orifice plates, etc.) are shown on the drawings in their approximate locations. Exact locations shall consider visibility and any special installation requirements.

3.8 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inch and smaller, use gate or ball valves.

B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inch or smaller, use gate or ball valves.

C. Drain Valves: Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system.

3.9 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

H. Install domestic water piping level plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install PEX piping with loop at each change of direction of more than 90 degrees.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping.

U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section, "Domestic Water Pumps."

V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section, "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section, "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section, "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section, "Escutcheons for Plumbing Piping."

3.10 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Square cut or roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

N. Joints for PEX Piping: Join according to ASTM F 1807.

O. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.11 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.12 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings, nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits or nipples.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.13 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet with 1/2-inch rod.
6. NPS 6 (DN 150): 10 feet with 5/8-inch rod.
7. NPS 8 (DN 200): 10 feet with 3/4-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.

7. NPS 6 (DN 150): 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet with 7/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

H. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.
7. NPS 6 (DN 150): 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet with 7/8-inch rod.

I. Install supports for vertical stainless-steel piping every 15 feet.

J. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
5. NPS 6 (DN 150): 48 inches with 3/4-inch rod.
6. NPS 8 (DN 200): 48 inches with 7/8-inch rod.

K. Install supports for vertical CPVC piping every 60 inches for NPS 1 (DN 25) and smaller, and every 72 inches for NPS 1-1/4 (DN 32) and larger.

L. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 32 inches with 3/8-inch rod.

M. Install hangers for vertical PEX piping every 48 inches.

N. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
4. NPS 6 (DN 150): 48 inches with 3/4-inch rod.
5. NPS 8 (DN 200): 48 inches with 7/8-inch rod.

O. Install supports for vertical PVC piping every 48 inches.

P. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 (DN 25) and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches with 3/8-inch rod.

3. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
5. NPS 6 (DN 150): 48 inches with 3/4-inch rod.
6. NPS 8 (DN 200): 48 inches with 7/8-inch rod.

Q. Install supports for vertical PP piping every 60 inches for NPS 1 (DN 25) and smaller, and every 72 inches for NPS 1-1/4 (DN 32) and larger.

R. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.14 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.15 ESCUTCHEON INSTALLATION

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

B. Escutcheons for New Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
5. Bare Piping in Equipment Rooms: One piece, cast brass.
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.16 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

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

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. Seal space outside of sleeves in concrete slabs and walls with grout.

H. Install sleeves that are large enough to provide ¼-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

I. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.

2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe.

    a. Extend sleeves 2 inches above finished floor level.

    b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

4. Sleeves for Piping Passing through Concrete Slabs: Steel pipe.

5. Sleeves for Piping Passing through Interior Concrete Walls:

    a. Steel pipe sleeves for pipes smaller than NPS 6.

J. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.17 SLEEVE SEAL INSTALLATION

A. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.18 WALL PENETRATION SYSTEM INSTALLATION

A. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.19 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 Section, "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.20 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.21 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain p lugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.22 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and (if applicable) parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C601 or AWWA C651 or follow procedures described below:

   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.23 HEAT TRACING

A. All water, waste and vent piping exposed to the cold weather shall be heat-traced as indicated on the Drawings.

B. All heat traced piping shall be insulated and provided with a weatherproof jacket to protect the insulation.

3.24 CORROSION CONTROL

A. All metallic piping passing from within the structure into the ground shall be fitted with two stage dielectric isolation couplings to prevent possible stray currents.

3.25 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed copper pressure-seal fittings; and pressure-sealed joints.
2. PVC, Schedule 40 Schedule 80; socket fittings; and solvent-cemented joints.
3. PP, SDR 7.4; SDR 11 socket fittings; and fusion-welded joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K; ASTM B 88, Type L Type B); wrought-copper, solder-joint fittings; and brazed joints.
2. Mechanical-joint, ductile-iron pipe; standard or compact pattern, mechanical-joint fittings; and mechanical joints.
3. Push-on-joint, ductile-iron pipe; standard or compact pattern, push-on-joint fittings; and gasketed joints.
4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
5. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
6. PP, SDR 7.4, SDR 11 socket fittings; and fusion-welded joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard or compact pattern, mechanical-joint fittings; and mechanical joints.
2. Push-on-joint, ductile-iron pipe; standard or compact pattern, push-on-joint fittings; and gasketed joints.
3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Hard or soft copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed copper pressure-seal-joint fittings; and pressure-sealed] joints.
2. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
3. PP, SDR 7.4, SDR 11 socket fittings; and fusion-welded joints.

H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; cast or wrought copper, solder-joint fittings; and brazed or soldered joints.
3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
4. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on-joint fittings; and push-on joints.
5. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.

8. PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.
9. PE-AL-PE tube, NPS 1 (DN 25) and smaller; fittings for PE-AL-PE tube; and crimped joints
10. PEX-AL-PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
11. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
12. PP, SDR 7.4, SDR 11 socket fittings; and fusion-welded joints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; cast or wrought copper, solder-joint fittings; and brazed or soldered joints.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint, copper-tube appurtenances; and grooved joints.
4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
6. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
9. PP, SDR 7.4; SDR 11 socket fittings; and fusion-welded joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; cast or wrought-copper, solder-joint fittings; and brazed or soldered joints.
2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
5. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.
6. CPVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.
7. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
8. PVC, Schedule 40 or Schedule 80; socket fittings; and solvent-cemented joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to (DN 300), shall be one of the following:

1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
2. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Stainless-steel Schedule 10 or Schedule 40 pipe, grooved-joint fittings, and grooved joints.

3.26 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: [Calibrated] [Memory-stop] balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DOMESTIC WATER PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DOMESTIC WATER PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum Breakers.
2. Backflow Preventers.
3. Water Pressure Reducing Valves.
4. Automatic Water Shutoff Valves.
5. Balancing Valves.
6. Water Mixing Valves.
7. Hose Stations.
8. Hose Bibbs.
9. Wall Hydrants.
10. Floor Hydrants.
11. Drain Valves.
12. Water Meters.

B. Related Sections include the following:

1. Section 22 05 00, “Common Work Results for Plumbing”.
2. Section 22 05 19, "Meters and Gages for Plumbing Piping
3. Section 22 05 53, ” Identification for Plumbing Piping and Equipment”.
4. Section 22 11 16, "Domestic Water Piping"
5. Division 26 Sections, Electrical Sections

1.3 PERFORMANCE REQUIREMENTS

A. Potable water piping and components to comply with NSF 61.

B. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, provide product data including specifications, installation instructions, parts list, operation and maintenance instructions, warranty information.

B. Shop Drawings:

1. Diagrams for power, signal, and control wiring.

2. Proposed layout of piping and specialties indicating locations, vertical distances, interferences and enclosures.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

E. Qualification Data: Provide information, copies of licenses, experience and other data to substantiate that the manufacturer(s), installer(s) and testing agency meet the qualification requirements stated in the Quality Assurance section of this specification section.

F. Warranty or warranties for review and approval.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

C. Manufacturer's Qualifications: Manufacturer(s) to be experienced and certified to manufacture products of this section. Manufacturer(s) to have successfully produced products of this section for a minimum of five (5) years.

D. Installer's Qualifications: Installer to be licensed in the City of Chicago and experienced in installing products of this section. Plumber to have been licensed and experienced in installing the products of this section for a minimum of five (5) years.

E. Testing Agency's Qualifications: Testing agency for domestic water piping specialties to be paid for by the Contractor and be approved by the Authority as a licensed and experienced agency performing tests for plumbing systems and equipment for a minimum period of five (5) years.

1.06 WARRANTY

A. The materials and installation of Domestic Water Piping Specialties to be warrantied for a period of minimum one year after the date of substantial completion. The warranty to include defects in material and workmanship. Defects include the equipment not functioning as specified and leaks. The work shall be repaired and/or materials shall be replaced as approved by the Authority and at no cost to the Authority.

B. Extended warranties may be offered for specific specialty items in which case, those warranties will be in addition to the standard one year warranty.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. 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. FEBCO; SPX Valves & Controls.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.
   d. Approved equal.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 2 as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

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

   a. Watts Industries, Inc.; Water Products Div.
   b. Woodford Manufacturing Company.
   c. Zurn Plumbing Products Group; Light Commercial Operation.
   d. Approved equal.

7. Standard: ASSE 1011.
8. Body: Bronze, non-removable, with manual drain.
9. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
10. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

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

   a. Ames Fire & Waterworks; A WATTS Brand.
   b. Apollo Flow Controls; Conbraco Industries, Inc.
   c. FEBCO; A WATTS Brand.
   d. Flomatic Corporation.
   e. Toro Company (The).
   f. WATTS.
   g. Zurn Industries, LLC.
   h. Approved equal.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: **5** psig maximum, through middle third of flow range.

5. Size: As shown on the drawings, NPS.
6. Design Flow Rate: As shown on the drawings, gpm.
7. Selected Unit Flow Range Limits: As shown on the drawings, gpm.
8. Pressure Loss at Design Flow Rate: As shown on the drawings, psig.
9. Accessories:

    a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

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

    a. FEBCO; SPX Valves & Controls.
    b. Watts Industries, Inc.; Water Products Div.
    c. Zurn Plumbing Products Group; Wilkins Div.
    d. Approved equal.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Pressure Loss at Design Flow Rate: 10 gpm for sizes NPS 2 and smaller.
6. Body: Bronze for NPS 2 and smaller; steel with interior lining complying with AWWA C550 or that is FDA approved
7. End Connections: Threaded for NPS 2 and smaller.
8. Configuration: Designed for horizontal, straight through flow, with shut-off valves.
9. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Hose-Connection Backflow Preventers:

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

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. WATTS.
    c. Woodford Manufacturing Company.
    d. Approved equal.

2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

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

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. Cash Acme, A Division of Reliance Worldwide Corporation.
    c. Honeywell Water Controls.
    d. WATTS.
    e. Zurn Industries, LLC.
    f. Approved equal.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: As shown on drawings, NPS.
5. Design Flow Rate: As shown on the drawings, gpm.
6. Design Inlet Pressure: As shown on the drawings, psig.
7. Design Outlet Pressure Setting: As shown on the drawings, psig.
8. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water-Control Valves:

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

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. CLA-VAL Automatic Control Valves.
    c. Flomatic Corporation.
    d. OCV Control Valves.
    e. WATTS.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.

3. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

    a. Size: As shown on the drawings, NPS.
    b. Pattern: Angle or Globe-valve design, as selected by the Authority.
    c. Trim: Stainless steel.

4. Design Flow: As shown on the drawings, gpm.

5. Design Inlet Pressure: As shown on the drawings, psig.

6. Design Outlet Pressure Setting: As shown on the drawings, psig.

7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.4 AUTOMATIC WATER SHUTOFF VALVES

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. DynaQuip Controls.
2. FloLogic, Inc.
3. OnSite PRO Inc.
4. QMI Manufacturing Inc.
5. Reliance Detection Technologies.

B. Standards: NSF 61 and NSF 372.

C. Shutoff Control Ball Valve:

1. Size: NPS ½, NPS ¾, NPS 1, NPS 1-1/4, NPS 1-1/2, NPS 2 as shown on the drawings or as otherwise required.
2. Design Flow Rate: As shown on the drawings, gpm.
3. Design Inlet Pressure: As shown on the drawings, psig.
4. Control Valve: Two-piece, full-port brass ball valve, MSS SP-110.

    a. End Connections: Threaded, female.
    b. Seats: PTFE.
    c. O-Rings: FKM.
    d. Stem: Low lead brass. Blowout proof.
    e. CWP Rating: 600 or as shown on the drawings, psig.

5. Manual override control turn-knob for emergency operation of the valve.

D. Shutoff Control Butterfly Valve:

1. Size: NPS 2-1/2, NPS 3, NPS 4 as shown on the drawings or as otherwise required.
2. Compliance: MSS SP-67.
3. Full-port, epoxy-coated, ductile-iron lug body.
4. Seat: EPDM, minus 30 deg F to plus 250 deg F.
5. Face-to-Face Flange: ASME B16.5 flanges.
6. Disc Design: Floating stainless-steel dual shaft.
7. Disc Material: Stainless steel.
8. Locating Pin: Carbon steel.
9. Bushings: PTFE.
10. O-Rings: EPDM.
11. Ten position stop.
12. Manual override control turn-knob for emergency operation of the valve.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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

    a. Armstrong International, Inc.
    b. Flo Fab Inc.
    c. ITT Corporation.
    d. NIBCO INC.
    e. Schneider Electric USA, Inc.
    f. TACO Comfort Solutions, Inc.
    g. WATTS.
    h. Approved equal.

2. Type: Ball or Y-pattern globe, as selected by the Authority, valve with two readout ports and memory-setting indicator.
3. Body: Brass or bronze, as selected by the Authority.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

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

    a. Armstrong International, Inc.
    b. Flo Fab Inc.
    c. ITT Corporation.
    d. NIBCO INC.
    e. Schneider Electric USA, Inc.
    f. WATTS.
    g. Approved equal.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.

3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Armstrong International, Inc.
c. Cash Acme, A Division of Reliance Worldwide Corporation.
d. Honeywell Water Controls.
e. Legend Valve & Fitting, Inc.
f. Leonard Valve Company.
g. POWERS; A WATTS Brand.
h. Symmons Industries, Inc.
i. TACO Comfort Solutions, Inc.
j. WATTS.
k. Zurn Industries, LLC.
l. Approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: As shown on the drawings, deg F.
9. Tempered-Water Design Flow Rate: As shown on the drawings, gpm.
10. Valve Finish: Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves <Insert drawing designation if any>:

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

a. Acorn Engineering Company.
b. Apollo Flow Controls; Conbraco Industries, Inc.
c. Armstrong International, Inc.
d. Lawler Manufacturing Company, Inc.
e. Leonard Valve Company.
f. POWERS; A WATTS Brand.
g. Symmons Industries, Inc.
h. Zurn Industries, LLC.
i. Approved equal.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted or Cabinet-type as shown on the drawings or as selected by the Authority, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: As shown on the drawings, deg F (deg C).
9. Tempered-Water Design Flow Rate: As shown on the drawings, gpm (L/s).
10. Selected Valve Flow Rate at 45-psig Pressure Drop: As shown on the drawings, gpm .
11. Pressure Drop at Design Flow Rate: As shown on the drawings, psig.

12. Valve Finish: Polished, chrome plated unless shown otherwise.
13. Piping Finish: Chrome plated unless shown otherwise.
14. Cabinet: Factory fabricated, stainless steel, for recessed or surface mounting, as shown on the drawings, and with hinged, stainless-steel door.

2.7 HOSE STATIONS

A. Single-Temperature-Water Hose Stations:

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

    a. ARCHON Industries, Inc.

    b. Armstrong International, Inc.
    c. Cooney Brothers, Inc.
    d. DynaFluid Ltd.
    e. Leonard Valve Company.
    f. Strahman Valves, Inc.
    g. T&S Brass and Bronze Works, Inc.
    h. Approved equal.

2. Standard: ASME A112.18.1.
3. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze.
7. Mounting: Wall, with reinforcement; Floor, with stainless-steel pedestal.
8. Supply Fittings: NPS ½ or NPS 3/4 gate, globe, or ball valve and check valve and NPS ½ or NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 or 50 feet long; selections as shown on the drawings.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker:

    a. Integral or factory-installed, non-removable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.08 HOSE BIBBS

A. Hose Bibbs:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.

c. MIFAB, Inc.
d. Prier Products, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. WATTS.
g. Woodford Manufacturing Company.
h. Zurn Industries, LLC.
i. Approved equal.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig.
8. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Operation for Equipment Rooms: Wheel handle or operating key.
11. Include operating key with each operating-key hose bibb.
12. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Non-freeze Wall Hydrants:

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. Josam Company, Series 71000.
b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc., 5509QT.
c. Zurn Plumbing Products Group; Light Commercial Operation, Z-1320-6.
d. Approved equal.

2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.
13. Anti-siphon automatic draining, non-freeze type wall hydrant incorporating integral backflow preventer approved by American Society of Sanitary Engineers (ASSE) and accepted by US Department of Health and listed by International Association of Plumbing and Mechanical Officials (IAPMO), with rough brass finish on brass casting, 3/4 inch hose thread nozzle. Operating stem to be hardened stainless steel. For concealed installations against vandalism, provide polished bronze box and hinged cover with loose “Tee” key to be furnished with

each hydrant. Packing nut to be secured with locknut. Large hemispherical (compression type) permanent valve seat.

B. Vacuum Breaker Wall Hydrants:

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

a. A.Y. McDonald Mfg. Co.
b. Arrowhead Brass Products.
c. Jay R. Smith Mfg. Co.
d. Mansfield Plumbing Products LLC.
e. Prier Products, Inc.
f. WATTS.
g. Woodford Manufacturing Company.
h. Zurn Industries, LLC.
i. Approved equal.

2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed, as selected by the Authority.
5. Pressure Rating: 125 psig.
6. Operation: Wheel handle.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.10 FLOOR HYDRANT

A. Provide hydrant with box for standard 3/4 inch hose end outlets. Hydrant of cast bronze box, hinged latching cover mechanism, adjustable locknut, removable nylon seat.

1. Josam Manufacturing Co., No. 7160.
2. Zurn Industries, Inc.
3. Wade.
4. Jay R. Smith Manufacturing Company No. 5611.

2.11 WATER METERS

A. Displacement-Type Water Meters:

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

a. AALIANT.
b. ABB.
c. Carlon Meter.
d. Mueller Co.
e. Schlumberger Limited.

f. Sensus.
g. Approved equal.

2. Standard: AWWA C700.
3. Pressure Rating: 150-psig (1035-kPa) working pressure.
4. Body Design: Nutating disc; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.
6. Case: Bronze.
7. End Connections: Threaded.

B. Turbine-Type Water Meters:

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

a. AALIANT.
b. ABB.
c. Badger Industries, Inc.
d. Hays Fluid Controls.
e. Master Meter, Inc.
f. McCrometer, Inc.
g. Mueller Co.
h. Schlumberger Limited.
i. SeaMetrics, Inc.
j. Sensus.
k. Approved equal.

2. Standard: AWWA C701.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: Turbine; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.
6. Case: Bronze.
7. End Connections for Meters NPS 2 and Smaller: Threaded.
8. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:

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

a. ABB.
b. Badger Industries, Inc.
c. Master Meter, Inc.
d. Mueller Co.
e. Schlumberger Limited.
f. Sensus.
g. Approved equal.

2. Standard: AWWA C702.

3. Pressure Rating: 150-psig (1035-kPa) working pressure.
4. Body Design: With integral mainline and bypass meters; totalization meter.

5. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
6. Case: Bronze.
7. Pipe Connections: Flanged.

D. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Backflow Preventers: Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Water Control Valves: Install with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

E. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve and downstream from fire sprinkler system supply. Install valve controller is an accessible location with sensors in areas where water is likely to accumulate.

F. Balancing Valves: Install in locations where they can easily be adjusted.

G. Hose Stations: Install with check stops or shutoff valves on inlets and with thermometer on outlet.

H. Nonfreeze, Draining-Type Post Hydrants: Install with one (1) cu. Yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in one (1) cu. Ft. of concrete block at grade.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings and approved shop drawings indicate general arrangement of piping and specialties.

B. Electrical ground equipment according to Division 26.

C. Connect electrical wiring according to Division 26.

D. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each water piping specialty, including, but not exclusive of the following:

1. Pressure vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Automatic water shutoff valves.
5. Calibrated balancing valves.
6. Primary water tempering valves.
7. Outlet boxes.
8. Hose stations.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each vacuum breaker**,** reduced-pressure-principle backflow preventer and double-check according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

C. Test for leaks at connections with piping and at the specialty equipment itself.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DOMESTIC WATER PIPING SPECIALTIES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the

Work of DOMESTIC WATER PIPING SPECIALTIES shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Sections include the following:

1. Section 22 05 00, Common Work Results for Plumbing.
2. Section 22 05 19, Meters and Gages for Plumbing Piping.
3. Section 22 05 23, General-Duty Valves for Plumbing Piping.
4. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
5. Section 22 05 53, Identification for Plumbing Piping and Equipment.
6. Section 22 11 16, Domestic Water Piping.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

C. All materials and installations performed under this section to be according to all applicable local codes.

D. Installation of pumps to be performed by experienced plumbers licensed by the City of Chicago.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

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. Grundfos Pumps Corp.
2. TACO Comfort Solutions, Inc.
3. WILO USA LLC - WILO Canada Inc.
4. Approved equal.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Casing: Bronze, with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

D. Capacities and Characteristics:

1. Capacity: As indicated on drawings.
2. Total Dynamic Head: As indicated on drawings.
3. Minimum Working Pressure: 125 psig.
4. Maximum Continuous Operating Temperature: 220 deg F.
5. Inlet and Outlet Size: As indicated on drawings.
6. Pump Speed: As indicated on drawings.
7. Pump Control: Pressure switch, Thermostat or Timer, as indicated or selected by the Authority.
8. Motor Horsepower: As indicated on drawings.
9. Electrical Characteristics:

    a. Volts: 120.
    b. Phases: Single.
    c. Hertz: 60.
    d. Full-Load Amperes: As indicated on drawings.
    e. Minimum Circuit Ampacity: As indicated on drawings.
    f. Maximum Overcurrent Protection: As indicated on drawings.

2.2 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

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. Bell & Gossett; a Xylem brand.
2. Marshall Engineered Products Co.
3. TACO Comfort Solutions, Inc.
4. Thrush Co. Inc.
5. Approved equal.

B. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Coupling: Flexible.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing, as indicated.

E. Capacities and Characteristics:

1. Capacity: As indicated on drawings.
2. Total Dynamic Head: As indicated on drawings.
3. Casing Material: Bronze or Cast iron, as indicated.
4. Impeller Material: ASTM B 584, cast bronze; ASTM B 584, cast bronze or stainless steel; Stainless steel; as indicated on the drawings.
5. Minimum Working Pressure: 125 psig or 175 psig; as indicated on the drawings.
6. Maximum Continuous Operating Temperature: 225 deg F.
7. Inlet and Outlet Size: As indicated on drawings.
8. Pump Speed: As indicated on drawings.
9. Pump Control: Pressure switch, Thermostat or Timer as indicated or selected by the Authority.
10. Motor Horsepower: As indicated on drawings.
11. Electrical Characteristics:

    a. Volts: 120 or 240; as indicated.
    b. Phases: Single or Three; as indicated.
    c. Hertz: 60.
    d. Full-Load Amperes: As indicated on drawings.
    e. Minimum Circuit Ampacity: As indicated on drawings.
    f. Maximum Overcurrent Protection: As indicated on drawings.

2.3 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

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. Alyan Pump Company.
2. Bell & Gossett; a Xylem brand.
3. Marshall Engineered Products Co.
4. Pentair Pump Group.
5. TACO Comfort Solutions, Inc.
6. Thrush Co. Inc.
7. Approved equal.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Pump Construction:
1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics:
1. Capacity: As indicated on drawings.
2. Total Dynamic Head: As indicated on drawings.
3. Casing Material: Bronze or Cast iron; as indicated.
4. Impeller Material: ASTM B 584, cast bronze, ASTM B 584, cast bronze or stainless steel, Stainless steel; as indicated.
5. Minimum Working Pressure: 175 psig.
6. Maximum Continuous Operating Temperature: 225 deg F.
7. Inlet and Outlet Size: As indicated on drawings.
8. Pump Control: Pressure switch, Thermostat or Timer as indicated or selected by the Authority.
9. Electrical Characteristics:

a. Volts: 120 or 240; as indicated.
b. Phases: Single or Three; as indicated.
c. Hertz: 60.
d. Full-Load Amperes: As indicated on drawings.
e. Minimum Circuit Ampacity: As indicated on drawings.
f. Maximum Overcurrent Protection: As indicated on drawings.

2.4 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

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. Alyan Pump Company.
2. Armstrong Pumps, Inc.
3. Bell & Gossett; a Xylem brand.
4. Flo Fab Inc.
5. Grundfos Pumps Corp.
6. Marshall Engineered Products Co.
7. PACO Pumps; Grundfos Pumps Corporation, USA.
8. Pentair Pump Group.
9. TACO Comfort Solutions, Inc.
10. Thrush Co. Inc.
11. Weinman Division.
12. Approved equal.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.

C. Pump Construction:

1. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 closed, and keyed to shaft.
2. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.

3. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
4. Bearings: Oil-lubricated; bronze-journal or ball type.
5. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.

D. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

E. Capacities and Characteristics:

1. Capacity: As indicated on drawings.
2. Total Dynamic Head: As indicated on drawings.
3. Casing Material: Bronze or Cast iron; as indicated.
4. Impeller Material: ASTM B 584, cast bronze; ASTM B 584, cast bronze or stainless steel or Stainless steel; as indicated.
5. Minimum Operating Pressure: 175 psig.
6. Maximum Continuous Operating Temperature: 225 deg F.
7. Inlet and Outlet Size: As indicated on drawings.
8. Pump Control: Pressure switch, Thermostat or Timer as indicated or selected by the Authority.
9. Pump Speed: As indicated on drawings.
10. Motor Horsepower: As indicated on drawings.
11. Electrical Characteristics:

a. Volts: 120 or 240; as indicated.
b. Phases: Single or Three; as indicated.
c. Hertz: 60.
d. Full-Load Amperes: As indicated on drawings.
e. Minimum Circuit Ampacity: As indicated on drawings.
f. Maximum Overcurrent Protection: As indicated on drawings.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors as specified herein, indicated on the drawings, selected and approved by the Authority or as otherwise required for the manufacturer of the pumps.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.6 CONTROLS

A. Pressure Switches: Electric, adjustable for control of [water-supply] <Insert application> pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, Type 4X or as indicated.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 24 V, ac or 120 V, ac as required.

6. Settings: Start pump and stop pump at pressure levels indicated on the drawings.

B. Thermostats: Electric; adjustable for control of hot-water circulation or other pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 50 to 125 deg F, 65 to 200 deg F, 100 to 240 deg F, as indicated on drawings.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac; as indicated on drawings.
7. Settings: Start pump at 105 deg F, 110 deg F, or 115 deg F as selected by the Authority and stop pump at 120 deg F or 125 deg F; as selected by the Authority.

C. Timers: Electric, for control of hot-water circulation pump.
1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 24-V ac or 120-V ac; as required.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, Type 4X.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: 24-V ac or 120-V ac; as required.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with manufacturer’s instructions and recommendations.

B. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

C. Install horizontally mounted, in-line, separately coupled and close-coupled centrifugal pumps with shaft(s) horizontal.

D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.

E. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using elastomeric pads, elastomeric mounts or restrained spring isolators; as indicated or selected by the Authority. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."

1. Minimum Deflection: 1/4 inch or 1 inch; as indicated or selected by the Authority.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

F. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.

2. Comply with requirements for hangers and supports specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

G. Install pressure switches in water supply piping.

H. Install thermostats in hot-water return piping.

I. Install timers at location shown or selected by the Authority.

J. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
b. Horizontally mounted, in-line, close-coupled centrifugal pumps.

c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Section 22 11 16 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 “General-Duty Valves in Plumbing Piping” and comply with requirements for strainers specified in Section 22 11 16 "Domestic Water Piping."

1. Install pressure gage at suction of each pump and pressure gage at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

E. Connect pressure switches, thermostats, time-delay relays, and timers to pumps that they control.

F. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

A. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Set pressure switches, thermostats, timers and time-delay relays for automatic starting and stopping operation of pumps.

5. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

7. Start motor.

8. Open discharge valve slowly.

9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.6 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 QUALITY CONTROL

A. All pumps and their installation to be according to the requirements of this section and according to local governing codes. The type of pump and capacity to be as recommended for the specific application.

B. The pumps shall be calibrated for proper operation. The pumps shall be tested by the Contractor for proper installation and operation. Check the installation for leaks and code compliance wiring. Pump shall be secure to avoid vibration during operation. Test the pump for proper cycling, pressure capacity and other requirements.

C. Any pumps found to be improperly installed shall be adjusted as required. Any pumps found to be malfunctioning to be replaced with a new pump at no cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DOMESTIC WATER PIPING PUMPS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DOMESTIC WATER PIPING PUMPS shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 13 14

PLUMBING FOR UNDERGROUND DRAINAGE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Contractor shall furnish all labor, material, equipment, and services necessary to furnish and install Plumbing at the locations shown on the Drawings, as specified herein, or as otherwise required.

B. The plumbing work includes but is not limited to the following:

1. Underground sewer pipe and pipe fittings.
2. Floor drains and cleanouts.
3. Connections to manholes, drains, sewers.
4. Adapters, gaskets and other accessories.
5. Excavation and backfilling.
6. Plumbing permits.
7. Testing.
8. All other required accessories and necessary work.

C. Related Sections:

1. Section 22 05 00, Common Work Results For Plumbing
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping
3. Section 22 05 18, Escutcheons for Plumbing Piping
4. Section 22 13 16, Sanitary Waste and Vent Piping
5. Section 22 13 19, Sanitary Waste Piping Specialties
6. Section 22 13 20, Sanitary Drains
7. Section 22 13 29, Sanitary Sewerage Pumps
8. Section 22 14 26, Prefabricated Trench Drain System
9. Section 22 14 29, Sump Pumps
10. Section 31 20 00, Earth Moving
11. Section 31 20 10, Excavation, Trenching and Backfilling (Utilities).
12 Section 33 31 13 , Sewer Main Pipe and Fiittings

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for his/her written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Plumbing Code
2. State of Illinois Plumbing Code

C. Standards: The work shall comply with the following standards.

1. American Society of Mechanical Engineers (ASME)

    a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications
    b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
    c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings
    d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250
    e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings
    f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings
    g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
    h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes
    i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions
    j. ASME/ANSI B31.9 - Building Service Piping

2. American Society of Testing and Materials (ASTM)

    a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
    b. ASTM A74 - Cast Iron Soil Pipe and Fittings
    c. ASTM B88 - Seamless Copper Water Tube
    d. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for his/her written approval before proceeding with the work in question.

1.4 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of Division One Section, Submittals, and as required below:

1. Shop Drawings of Piping layouts in plan drawn to a minimum scale of 1/8” = 1’-0”.

B. Product Data: Submit for Authority's review, manufacturer’s literature indicating product data, specifications, catalog cuts, installation instructions and dimensions, materials, accessories, performance information, electrical requirements and wiring diagrams, standards listing, certification and guarantees for the following:

1. Piping and fittings.
2. Joints, gaskets and other materials.
3. Cleanouts.
4. Drains.

C. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Pressure Testing of Piping

D. The Contractor shall furnish operating instructions and maintenance recommendations/requirements for the sump pump in accordance with the requirements of Division One Section, Project Closeout.

E. If required by the Authority, the Contractor shall submit on letterhead that all the floor drains and cleanouts, including those for stations, bus turnaround bathrooms, etc. meet HS – 20 top loading.

1.5 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings or submittals for that portion of work has been completed and returned to the Contractor. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials and equipment manufactured by a company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with minimum five (5) years documented experience.

E. Regulator Requirements: City of Chicago Plumbing Code.

F. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 PROJECT/SITE CONDITIONS

A. Verify that field measurements and elevations are as indicated.

B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities to the Authority.

C. Verify locations of all existing utilities, manholes, and other site conditions. Coordinate connections to and interruptions of existing utilities with the Authority and the respective utility company.

1.8 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the size and location of concrete and other walls and other construction.

C. Coordinate the installation of pipe sleeves for foundation wall penetrations.

D. Coordinate the installation of plumbing in poured-in-place concrete slabs, provide for proper drain elevations, and slope of slab to drains.

E. Coordinate the installation of sewer systems as necessary to interface floor drains and other elements with drainage piping systems.

F. Coordinate the size, location and other requirements of the drains and other elements that is to be connected to the building waste line.

G. Coordinate the requirements for the new sump pump including size and location of sump pump pit and size and location of plumbing drain connection. Coordinate location of electrical outlet, electrical requirements, grounding, ground fault, etc. as required.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering plumbing, piping, equipment and fixtures which may be incorporated in the work included, but are not limited to, those listed herein:

2.2 PIPING SYSTEM MATERIALS

A. Pipe: ductile iron pipe shall conform to AWWA C151. Pipe shall be supplied in standard lengths as much as possible. Provide minimum Class 350 for piping 12-inches and smaller in diameter. All gaskets shall be Viton, and conform to AWWA C111 and Table 5-1 of AWWA M-41. Acceptable ductile iron pipe manufactures include:

1. American Cast Iron Pipe Company
2. US Pipe and Foundry Company
3. Griffin Pip Products Company

B. Pipe Joints: restraint for push on joint pipe shall be positive locking ring “locked-type” joints manufactured by the pipe and fitting manufacturer that utilize restrain independent of the joint gasket. All restrained joint shall be fabricated of heavy section ductile iron castings. Bolts and nuts shall be low carbon steel conforming to ASTM A193, Grade B7. Restraint for mechanical joint fittings shall use retainer glands for restraining joint. Restraint push on joints shall be by one of the following or an approved equal:

1. “Flex Ring (positive locking style)” by the American Cast Iron Pipe Company.
2. “TR Flex” by US Pipe and Foundry Company
3. “Snap Lok” by Griffin Pipe Products Company

C. All pipe and fittings shall be restrained.

D. Where mechanical joint fittings are used, Contractor shall use a retainer gland. The retainer gland shall be EBAA Iron Megalug Series 1100, or approved equal.

E. Interior lining: all ductile iron pipe and fittings shall have ceramic epoxy interior lining. Acceptable products and manufacturers include PROTECTO 401 Lining by Induron Coatings, Inc. or NOVACOAT SP-200W by Superior Environmental Products, Inc.

F. Exterior coating: All buried ductile iron pipe shall be installed with bituminous coating in accordance with AWWA C151 and C110 respectively. All buried pipe shall be installed in polyethylene encasement. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standard established by AWWA C105, current edition. Acceptable manufacturers include North Town Company, AA thread and Seal Tape, Inc., Sigma Corp, or approved equal. Polyethylene encasement shall meet the minimum size requirements per TABLE 3 of Section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe. Polyethylene seams, cuts, or tears shall be joined using 2-inch wide plastic adhesive tape such as Calpico Vinyl, Polyken, U.P.C Tape, or approved equal. Duct tape will not be allowed.

G. Drainage piping specialties, cleanouts and drains:

Josam Mfg. Co.
Knight Division, Koch Engineering Co.
Smith (Jay R) Mfg. Co.
Wade, Div. of Tyler Corp.
Zurn Industries Inc., Hydromechanics Div.

H. Cast-Iron Waste Underground Pipe: ASTM A74, service weight, hub-and-spigot coated waste pipe and fittings. Pipe shall be encased with 8 mil polyethylene sheeting installed in accordance with ANSI/AWWA C105/A21.5.

1. Lead and Oakum Joints

2.3 DRAINAGE FITTINGS

A. General: Provide drainage fittings as indicated on the drawings and as hereinafter specified. Connection sizes of drainage fittings shall be as indicated in the drawings.

B. Floor Drains: Floor drains are to be ASTM A112.21.1 M, round, cast iron body, and round secured, cast-iron or ductile iron grate with vandal proof screws and integral cleanout. Drains shall be top loaded, heavy duty rated HS-20. Include bottom outlet with no-hub connection of sizes indicated on Drawings. Contractor shall connect the bottom outlet to the riser pipe in accordance with the manufacturer's recommendations. Acceptable manufacturers and models are as follows:

Jay R.Smith, Model 2510-B-U
Josam, Model 38040-VP-81-84
Zurn, Model Z730-VP-Y
Approved equal

C. Cleanouts: Provide cast bronze, taper threads, counter sunk type cleanout plugs where shown on drawings and as required by Local Codes. Furnish access body assemblies for all cleanouts located in floors. Cleanouts shall be top loaded, heavy duty rated for HS-20.

1. Cleanout Plugs: Cleanout Plugs shall be cast bronze taper thread countersunk type, complying with ANSI B2.1.
2. Cleanouts - Threaded Seal - Unfinished Floors: Cleanouts with cast iron body and frame, round adjustable scoriated cast iron or ductile iron top with non-tilt tractor cover and vandal proof screws. Include bottom outlet with no-hub connections of sizes indicated on Drawings. Contractor shall connect the bottom outlet to the riser pipe in accordance with the manufacturer's recommendations. Acceptable manufacturers and models are as follows:

Jay R. Smith, Model 4223S-M-U
Josam, Model 55004-22-Y-5-VP

Zurn, Model Z1400-BP-VP
Approved equal.

PART 3 EXECUTION

3.1 GENERAL

A. Provide and install all piping, fittings, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes and as specified for waste system.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced and running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for plumbing fixtures and other equipment have drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls, floors and pit for suitable conditions where piping and specialties are to be installed.

E. Verify that trench cut is ready to receive the work and excavations, dimensions and elevations are as indicated on Drawings. Trench to allow for minimum required cover for all piping.

F. Do not proceed until unsatisfactory conditions have been corrected.

3.3 GENERAL PIPING INSTALLATION

A. All ductile iron pipes, fittings and appurtenances shall be installed in accordance with the requirements of AWWA C600 except as modified herein.

B. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted.

C. All pipe shall be cut to exact measurement to be installed without forcing. After cutting, ends shall be reamed and cleaned to eliminate foreign matter and burrs.

D. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

E. All pipe and fittings shall be marked by the manufacturer in accordance with the marking sections of the standards to which reference is made or in accordance with the requirements of MSS-S-5: Standard Marking System for Fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fittings Industry.

F. Make all changes in size and direction of piping with manufactured fittings. Field fabricated fittings will not be allowed.

G. Restrained joints shall be installed in accordance according to the pipe manufacturer's instructions.

H. Joints in threaded pipe installations shall be made tight without caulking or the use of lead or paint, and no lubricant shall be used except flake graphite and cylinder oil paste; Dixon's Compound or Key Paste, and the lubricant shall be applied to make threads only.

I. In screwed pipe installations, the use of short lengths of pipe and couplings shall not be permitted. Piping between fittings shall be continuous wherever possible. If, however, the distance between fittings exceeds the normal random length of pipe, and couplings shall be used, they shall be heavy recessed couplings of the same material as the pipe to which they are attached.

J. In screwed pipe installations, provide a union at each screwed valve, strainer, etc., and elsewhere as indicated on the drawings or wherever required for proper servicing of equipment, accessibility, etc.

K. The use of close or short screwed pipe nipples shall be avoided wherever possible; however, if roughing-in dictates the use of close or short nipples, they shall be of pipe the same material as adjoining pipe.

L. All piping subject to expansion and contraction, at the time of installation, shall be cold sprung to allow in part for expansion.

M. In all cases where pipe connections are made to piping or any item of equipment of dissimilar metal, provide the proper type of dielectric fitting; EPCO or Center Plastics insulated unions.

N. Polyethylene encasement shall be installed per ANSI/AWWA C105/A21.5, Method 'A' in accordance with Section 2.15 of DIPRA's installation Guide for Ductile Iron Pipe. All seams in the polyethylene encasement shall be sealed completely with approved 2-inch wide plastic adhesive tape. Extreme care shall be taken to ensure that all reps or tears in the polyethylene encasement are properly repaired with additional tape and film as described in ANSI/AWWA C105/A21.5.

3.4 CONNECTIONS TO STRUCTURES

A. Whenever a pipe 3-inches in diameter or larger passes from concrete to earth horizontally, two flexible joints spaced from 2 to 4-inches apart (depending on pipe size) shall be installed, within 2-feet of the exterior face of the wall, whether or not shown on the Drawings.

B. Piping underneath structures or aprons located inside the canopy of the Bus Fueling Facility shall be concrete encased.

3.5 EXCAVATION AND BACKFILL

A. Excavation:

1. Pipe trench excavation: The width of the trench at and below the top of the pipe shall be the outside diameter of the pipe plus 18 inches, unless otherwise indicated. The width above the level may be as wide as necessary for proper performance of the work. The bottom of the trenches shall be accurately graded to provide continuous uniform bearing and support. Bell holes and depressions for joints shall be carefully dug to be no larger than necessary. Over-excavation of the trench bottom shall be

brought back to grade with pit run gravel or clean concrete sand compacted with 4 inch layers, or with concrete.

2. Underground work shall not be covered until it has been inspected, tested and approved.

B. Bedding and Backfill:

1. All trenches shall be backfilled, from the trench bottom to a point at least 12 inches above the top of the pipe, with fine aggregate trench bedding gradation as follows:

   100% passing the 1" sieve
   65-100% passing the No. 4 sieve
   40-90% passing the No. 10 sieve
   30-80% passing the No. 16 sieve
   10-50% passing the No. 50 sieve
   0-30% passing the No. 100 sieve
   0-10% passing the No. 200 sieve

   Depth of pipe bedding shall be a minimum of 6 inches below pipe.

2. The remainder of the trench shall be filled with limestone screenings or clean sand, placed in 6 inch lifts and compacted by mechanical tampers or vibratory compactors, completely filling the trenches to the bottom of the slab grade or sub-grade.
3. Backfilling around appurtenances shall be as specified for backfilling of pipe trenches above the pipe.
4. If the material found at the elevations specified are unstable and not suitable or in case it is found desirable or necessary to go an additional depth, the Contractor shall provide 6" deep stabilization stone below pipe bedding. The stabilization stone shall be crushed stone and have CA-1 gradation conforming to ARTICLE 704 of the Illinois Department of Transportation Standard Specifications.
5. All material and backfill operations shall be subjected to testing.

C. Removal of Water:

1. The elevation of the groundwater shall be maintained to a minimum depth of 12 inches below the bottom of the excavation until the trench is backfilled to finished grade.
2. At all times during the excavation period and until its completion and acceptance at final inspection, ample means and equipment shall be provided with which to remove promptly and dispose of properly all waste entering any excavation or other parts of work. The excavation shall be kept dry.
3. Water pumped or drained from the work hereunder shall be disposed of in a suitable manner without damage to adjacent areas, to other work under construction or to pavements. Water shall not be discharged without adequate protection of the surface at the point of discharge.
4. Any and all damages caused by dewatering the work shall be promptly repaired by the Contractor.

D. Contaminated water shall be disposed of properly by the Contractor and according to all applicable regulations. Submit procedures to the Authority for approval.

3.6 UNDERGROUND PIPE INSTALLATION

A. General: Underground sanitary, storm and vent piping within the structure line and to a line 5 feet outside the structure line for connection to the underground exterior sewer system, shall be laid at a pitch not less than 1/4" per foot. All changes in direction of piping shall proceed up-grade with the spigot ends of bell-and-spigot pipe pointing in the direction of flow. Each pipe

shall be laid true to line and grade an in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.

B. Bell-and-Spigot Lead Joints: Bell-and-spigot joints shall be made by ramming rings of rope oakum into the bell to fill same within 1" of the top of bell. The bell shall then be poured full with molten lead and the lead caulked watertight and airtight flush with top of the bells.

3.7 SEWER CONNECTIONS

A. Where a storm sewer connection is to be made to the proposed underground exterior sewer system, a Y branch fitting shall be installed at the junction.

B. Where a connection is to be made to an existing sewer manhole structure, at a location where no factory-made junction exists, a circular opening shall be made in the existing manhole structure as close as possible to the outside diameter of the proposed sewer, and a concrete collar shall be constructed around the sewer pipe connection placed in the opening.

C. Sewer connections shall be performed as shown on the Drawings. New sewer main shall not protrude inside the manholes more than 2”. Any deficiencies found during this inspection process shall be corrected at the Contractor’s expense.

3.8 LOCATION OF OPERATION AND MAINTENANCE SYSTEM COMPONENTS

A. System components which require observation, operation or maintenance - such as cleanouts, etc. - to be located whenever possible so as to be readily accessible.

3.9 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation drainage piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection shall be made. Perform tests specified by the City of Chicago Building Code in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Reinspection: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Test drainage system as follows:

1. Test for leaks and defects all drainage and vent piping systems. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders, test the piping of

plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
6. Prepare reports for all tests and required corrective action.

3.10 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.11 CLEANING

A. At the conclusion of the Work, thoroughly clean all of the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be slushed last to assure debris removal.

B. After the pipe has been cleaned and if the groundwater level is above the pipe or water in the pipe trench is above the pipe following a heavy rain, the Authority will examine the pipe for leaks. If defective pipes, fittings or joints are discovered at this time, they shall be repaired or replaced by the Contractor.

3.12 CORROSION CONTROL

A. All metallic piping passing from within the structure into the ground shall be fitted with two stage dielectric isolation couplings to prevent possible stray currents.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PLUMBING FOR UNDERGROUND DRAINAGE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of PLUMBING FOR UNDERGROUND DRAINAGE shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Stainless-steel drainage pipe and fittings.
5. Ductile-iron pipe and fittings.
6. Copper tube and fittings.
7. Specialty pipe fittings.
8. Encasement for underground metal piping.

B. Related Requirements:

1. Section 22 05 00, Common Work Results for Plumbing
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping
3. Section 22 05 18, Escutcheons for Plumbing Piping
4. Section 22 05 19, Meters and Gages for Plumbing Piping
5. Section 22 05 23, General-Duty Valves for Plumbing Piping
6. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment
7. Section 22 05 33, Heat Tracing for Plumbing Piping
8. Section 22 05 53, Identification for Plumbing Piping and Equipment
9. Section 22 07 00, Pipe Insulation
10. Section 22 11 16, Domestic Water Piping
11. Section 22 13 19, Sanitary Waste Piping Specialties
12. Section 22 13 20, Sanitary Drains
13. Section 22 13 29, Sanitary Sewerage Pumps
14. Section 22 40 00, Plumbing Fixtures

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, elevations, sections, and details for drainage and vent piping system.

1. Show layout and locations of sanitary waste and vent system. Indicate locations and access to cleanouts. Indicate hangers for securing and supporting piping.

2. Shop Drawings of piping floor layouts in plan drawn to a minimum scale of 1/8″ = 1′ -0″.
3. Drainage Plumbing Diagrams showing pipe sizes, provision for expansion, cleanouts, etc.
4. Contractor to submit utility plans for all levels of the facility for coordination of all utility runs and chases. The utility plans to show the layout and location horizontally and vertically of all utilities including sanitary waste and vent piping, water pipes, other pipes, ductwork and equipment.

    a. The utility plans to also show all obstructions, structural and building elements, walls and other fixed elements.
    b. Purpose of the utility plans are to indicate the relationship and coordination of the utilities to the fixed building elements and to other utilities; indicate clearances; determine location and extent of obstructions and indicate potential interferences. The utility plans to show required clearances and spaces for maintenance of the utilities and access to valves, shutoffs, controls, cleanouts and other equipment. The drawings to show utility chases for pipes and other utilities; their layout and accessibility.
    c. Utility plans to indicate for the sanitary waste and vent piping: pipe sizes, type of pipe, cleanouts, connections, provision for expansion and other related items.
    d. It is the Contractor's responsibility to obtain input from other trades to develop the utility layouts; coordinate their work to avoid conflicts and interferences as well as facilitate an orderly installation of all the work.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to Authority's facilities or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the Authority no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Authority's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Waste, Force-Main Piping: 100 psig, unless a higher pressure is indicated .

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Extra Heavy class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

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

    a. Conine Manufacturing Co., Inc.
    b. SE Sovent.
    c. Approved equal.

C. CISPI, Hubless-Piping Couplings:

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

    a. ANACO-Husky.
    b. Charlotte Pipe and Foundry Company.
    c. Dallas Specialty & Mfg. Co.
    d. Fernco Inc.
    e. Josam Company.
    f. Matco-Norca.
    g. MIFAB, Inc.
    h. Mission Rubber Company, LLC; a division of MCP Industries.
    i. NewAge Casting.
    j. Stant.
    k. Tyler Pipe; a subsidiary of McWane Inc.
    l. Approved equal.

2. Standards: ASTM C 1277 and CISPI 310.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

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

   a. ANACO-Husky.
   b. Charlotte Pipe and Foundry Company.
   c. Clamp-All Corp.
   d. Dallas Specialty & Mfg. Co.
   e. MIFAB, Inc.
   f. Mission Rubber Company, LLC; a division of MCP Industries.
   g. NewAge Casting.
   h. Stant.
   i. Tyler Pipe; a subsidiary of McWane Inc.
   j. Approved equal.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

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

   a. Charlotte Pipe and Foundry Company.
   b. MG Piping Products Company.
   c. Approved equal.

2. Standard: ASTM C 1277.

3. Description: Two-piece ASTM A 48, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

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

a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products USA Inc.
d. Smith-Cooper International.
e. Victaulic Company.
f. Approved equal.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47 malleable-iron castings, ASTM A 234 forged steel fittings, or ASTM A 106 steel pipes with dimensions matching ASTM A 53 steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.6 STAINLESS-STEEL DRAINAGE PIPE AND FITTINGS

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

1. BLÜCHER; A Watts brand.
2. Josam Company.
3. Approved equal.

B. Description: Comply with requirements of ASME A112.3.1, drainage pattern.

C. Material: Type 316L stainless steel.

D. Pipe Construction: Seamless.

E. Internal Sealing Rings: EPDM, marked or color coded for the application.

F. Joints: Single or double, socket and spigot ends.

2.7 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.

D. Ductile-Iron, Grooved-End Pipe Appurtenances:

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

   a. Anvil International.
   b. Shurjoint Piping Products USA Inc.
   c. Smith-Cooper International.
   d. Star Pipe Products.
   e. Victaulic Company.
   f. Approved equal.

2. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings, with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.8 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Nonpressure Transition Couplings:

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) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Froet Industries LLC.
4) Mission Rubber Company, LLC; a division of MCP Industries.
5) Plastic Oddities.
6) Approved equal.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Nonpressure Transition Couplings:

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) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

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) Apollo Flow Controls; Conbraco Industries, Inc.
2) Cascade Waterworks Mfg. Co.
3) Dresser, Inc.
4) EBAA Iron, Inc.
5) Ford Meter Box Company, Inc. (The).
6) Jay R. Smith Mfg. Co.
7) JCM Industries, Inc.
8) Romac Industries, Inc.
9) Viking Johnson.
10) Approved equal.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Stainless steel.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. Dielectric Unions:

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) A.Y. McDonald Mfg. Co.
2) Capitol Manufacturing Company.
3) Central Plastics Company.
4) HART Industrial Unions, LLC.
5) Jomar Valve.
6) Matco-Norca.
7) WATTS.
8) Wilkins.
9) Zurn Industries, LLC.
10) Approved equal.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig, or as indicated otherwise.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

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) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Matco-Norca.
4) WATTS.
5) Wilkins.
6) Zurn Industries, LLC.
7) Approved equal.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 150 psig, or as indicated otherwise.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.
5) Approved equal.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig, or as indicated otherwise.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

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) Elster Perfection Corporation.
2) Grinnell Mechanical Products.
3) Josam Company.
4) Matco-Norca.

5) Precision Plumbing Products.
6) Victaulic Company.
7) Approved equal.

b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F or as otherwise indicated.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural, as selected by the Authority.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all piping, fittings, equipment, fixtures, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for hot and cold water supply systems.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced with risers and drops running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in ac-accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine rough-in requirements for plumbing fixtures and other equipment have water connections to verify actual locations of piping connections prior to installation.

C. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

D. Do not proceed until unsatisfactory conditions have been corrected.

3.3 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.4 GENERAL PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Layout of piping shall follow drawings, utility plans and if applicable, approved shop drawings.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

K. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Revise three subparagraphs below as required by authorities having jurisdiction.
2. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
3. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
4. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

R. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
4. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
5. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

S. Install force mains at elevations indicated.

T. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

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

1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping.

Y. Make all changes in size and direction of piping with manufactured fittings. Field fabricated fittings will not be allowed.

Z. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and/or servicing.

AA. In no case shall any pipe be installed where it is supported on, or suspended from, another pipe or the piping of other trades.

BB. All piping subject to expansion and contraction, at the time of installation, shall be cold sprung to allow in part for expansion.

CC. In all cases where pipe connections are made to piping or any item of equipment of dissimilar metal, provide the proper type of dielectric fitting; EPCO or Center Plastics insulated unions.

3.3 UNDERGROUND PIPE INSTALLATION

A. General: Underground sanitary, waste and vent piping within the structure line and to a line 5 feet outside the structure line for connection to the underground exterior sewer

system, shall be laid at a pitch not less than 1/8" per foot. All changes in direction of piping shall proceed up-grade with the spigot ends of bell-and-spigot pipe pointing in the direction of flow. Each pipe shall be laid true to line and grade an in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.

B. Bell-and-Spigot Lead Joints: Bell-and-spigot joints shall be made by ramming rings of rope oakum into the bell to fill same within 1" of the top of bell. The bell shall then be poured full with molten lead and the lead caulked watertight and airtight flush with top of the bells.

3.4 INTERIOR SUSPENDED PIPE INSTALLATION

A. Horizontal drain runs shall be installed at a pitch not less than 1/8" to the foot, shall be suspended with hangers. All changes in direction of suspended soil and waste piping shall be made with long-sweep drainage fittings. All offsets shall be made with 45° fittings, except as otherwise noted. Due allowance for expansion shall be made in all lines.

B. Traps shall be furnished and installed to connect each fixture or piece of equipment not having a trap or seal as an integral part of same into sewer system. They shall conform to the following patterns and materials:

1. Recessed threaded cast iron drainage traps, where shown or required, shall be installed when connections are made in steel pipe.

2. Bell-and-spigot cast iron drainage traps shall be installed when connection are made in bell-and-spigot pipe.

3. All exposed traps for fixtures shall be cast-brass, chrome-plated.

4. All traps installed in accessible positions shall be fitted with cleanout plugs or with other acceptable means of cleaning.

C. Vent piping shall run parallel to the drainage systems, venting all traps on fixtures, and connecting to the main stacks, which shall be extended through the roofs. Extra-heavy cast iron increasers shall be installed on the top of each soil and vent stack before the same passes through the roof. These increasers shall be one pipe size larger than the soil and vent stacks, with no roof increaser smaller than 4". Soil and vent stacks shall extend at least 12" square, extended up and 3" down into tops of increasers. All horizontal vent pipes shall be grade up to meet the requirements of local and State codes.

D. Provide cleanouts at each 90° change of direction in suspended horizontal soil or waste pipe, 50' intervals in straight runs, at the base of each downspout and stack, in all P-traps not installed in ground, and at such other points as may be necessary for proper cleaning. Provide flashing flange with each cleanout and a clamping device where cleanouts pass through a waterproof membrane.

3.5 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.6 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Unshielded or Shielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 VALVE INSTALLATION

A. Comply with requirements in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," Section 22 05 23.14 "Check Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves, closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves with cleanout cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.10 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.11 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

   a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

   a. Isolate test source and allow to stand for four hours.
   b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.12 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.13 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller to be any of the following, as selected by the Authority:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.
6. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger pipe size range to be any of the following, as selected by the Authority:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.

4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
5. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller to be any of the following, as selected by the Authority:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Stainless-steel pipe and fittings gaskets, and gasketed joints.
5. Copper Type DWV tube, copper drainage fittings, and soldered joints.

    a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

6. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger to be any of the following, as selected by the Authority:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller to be any of the following, as selected by the Authority:

1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed calking materials; and calked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; and coupled joints.
3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
4. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings..

G. Underground, soil and waste piping NPS 5 and larger to be any of the following, as selected by the Authority:
1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed calking materials; and calked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty cast-iron hubless-piping couplings; coupled joints.
3. Dissimilar Pipe-Material Couplings: Unshielded or Shielded, nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 to be any of the following, as selected by the Authority:
1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 to be any of the following, as selected by the Authority:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Galvanized-steel pipe, pressure fittings, and threaded joints.
   3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

J. Underground sanitary-sewage force mains NPS 4 and smaller to be any of the following, as selected by the Authority:
   1. Hard or Soft copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
   2. Ductile-iron, mechanical-joint piping and mechanical joints.
   3. Ductile-iron, push-on-joint piping and push-on joints.
   4. Ductile-iron, grooved-joint piping and grooved joints.
   5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

K. Underground sanitary-sewage force mains NPS 5 and larger to be any of the following, as selected by the Authority:
   1. Hard copper tube, Type L; wrought-copper pressure fittings; and soldered joints.
   2. Ductile-iron, mechanical-joint piping and mechanical joints.
   3. Ductile-iron, push-on-joint piping and push-on joints.
   4. Ductile-iron, grooved-joint piping and grooved joints.
   5. Pressure transition couplings if dissimilar pipe materials.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SANITARY WASTE AND VENT PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SANITARY WASTE AND VENT PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 07 62 00, Sheet Metal Flashing and Trim.
2. Section 07 84 13, Penetration Firestopping.
3. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
4. Section 22 05 53, Identification for Plumbing Piping and Equipment.
5. Section 22 13 16, Sanitary Waste and Vent Piping.
6. Section 22 14 23, Storm Drainage Piping Specialties
7. Section 33 31 13, Sewer Main Pipe and Fittings

1.3 REFERENCES

A. American Society of Materials Engineers (ASME):

1. ASME A 112.1.2 Air gaps in plumbing system
2. ASME A 112.3.1 Stainless Steel Draining Systems.
3. ASME A 112.36.2M Cleanouts
4. ASME A 112.6.4 Roof, Deck and Balcony Drains

B. American Society of Safety Engineers (ASSE):

1. ASSE 1051 Perform more requirements for individual and branch type air admittance value for sanitary draining system

C. American Society for Testing and Materials (ASTM):

1. ASTM A48 Standard specification for Gray Iron coating
2. ASTM A74 Standard specification for cast iron sail pipe and fittings
3. ASTM C564 Standard specification for rubber gaskets for cast iron sail pipe and fittings

D. National Fire Protection Association (NFPA):

1. NFPA 70 National Electrical Code

E. Underwriters Laboratories (UL):

1. UL 1479 Fire tests through protection fire stops

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. PVC: Polyvinyl chloride.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:

1. Piping and Fittings.
2. Cleanouts.
3. Valves.

B. Shop Drawings:

1. Shop Drawings of piping floor layouts in plan drawn to a minimum scale of 1/8″ = 1′ -0″.

2. Drainage Plumbing Diagrams showing pipe sizes, provision for expansion, cleanouts, etc.

3. Show fabrication and installation details for frost-resistant vent terminals.

4. Wiring Diagrams: Power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. WATTS.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.

4. Body: Cast iron.

5. Cover: Cast iron with bolted or threaded access check valve.

6. End Connections: Hub and spigot, Hub and spigot or hubless, or Hubless; as shown on the drawings or as selected by the Authority.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed or open for airflow unless subject to backflow condition.

8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. WATTS.
    d. Zurn Industries, LLC.
    e. Approved equal.

2. Size: Same as floor drain outlet.

3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

4. Check Valve: Removable ball float.

5. Inlet: Threaded.

6. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

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

    a. Canplas LLC.
    b. IPS Corporation.
    c. NDS Inc.
    d. Oatey.
    e. Plastic Oddities.
    f. Sioux Chief Manufacturing Company, Inc.
    g. Zurn Industries, LLC.
    h. Approved equal.

2. Size: Same as connected piping.

3. Body: ABS or PVC, as shown or required.

4. Cover: Same material as body with threaded access to check valve.

5. Check Valve: Removable swing check.

6. End Connections: Socket type.

2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. WATTS.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Standard: ASME A112.36.2M.

3. Size: Same as connected drainage piping

4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as shown on the drawings or as selected by the Authority and as required to match connected piping.

5. Closure: Countersunk, Countersunk or raised-head; Raised-head brass or cast-iron plug as shown on the drawings or as selected by the Authority.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Stainless-Steel Exposed Cleanouts:

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

    a. BLÜCHER; A Watts brand.
    b. Josam Company.
    c. WATTS.
    d. Approved equal.

2. Standard: ASME A112.3.1.

3. Size: Same as connected drainage piping

4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.

5. Closure: Stainless-steel plug with seal.

C. Cast-Iron Exposed Floor Cleanouts:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Oatey.
    d. Sioux Chief Manufacturing Company, Inc.
    e. Tyler Pipe; a subsidiary of McWane Inc.
    f. WATTS.
    g. Zurn Industries, LLC.
    h. Approved equal.

2. Standard: ASME A112.36.2M for adjustable housing; cast-iron soil pipe with cast-iron ferrule; heavy-duty, adjustable housing; threaded, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Type: Adjustable housing; Cast-iron soil pipe with cast-iron ferrule; Heavy-duty, adjustable housing; Threaded, adjustable housing.

5. Body or Ferrule: Cast iron.

6. Clamping Device: Required unless indicated otherwise.

7. Outlet Connection: Inside calk, Spigot or Threaded.

8. Closure: Brass plug with straight threads and gasket; Brass plug with tapered threads; Cast-iron plug.

9. Adjustable Housing Material: Cast iron with threads, setscrews or other device.

10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy, Painted cast iron, Polished bronze or Rough bronze as shown on the drawings or as selected by the Authority.

11. Frame and Cover Shape: Round or Square as shown on the drawings or as selected by the Authority.

12. Top Loading Classification: Extra Heavy, Heavy, Light or Medium Duty as shown on the drawings or as required by the Authority.

13. Riser: ASTM A 74, Extra-Heavy or Service class, as shown on the drawings or as required by the Authority cast-iron drainage pipe fitting and riser to cleanout.

D. Stainless-Steel Exposed Floor Cleanouts:

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

   a. BLÜCHER; A Watts brand.
   b. Josam Company.
   c. Kusel Equipment Co.
   d. WATTS.
   e. Zurn Industries, LLC.
   f. Approved equal.

2. Standard: ASME A112.3.1.

3. Size: Same as connected branch.

4. Housing: Stainless steel.

5. Closure: Stainless steel with seal.

6. Riser: ASTM A 74, Extra-Heavy or Service class; stainless-steel or cast-iron drainage pipe fitting and riser to cleanout; as shown on the drawings or as required by the Authority.

7. Body or Ferrule: Stainless steel.

8. Clamping Device: Required unless indicated otherwise.

9. Outlet Connection: Inside calk, Spigot or threaded as shown on the drawings or as selected by the Authority.

10. Closure: Brass plug with straight threads and gasket or Brass plug with tapered threads; Cast-iron plug.

11. Adjustable Housing Material: Cast iron with threads, setscrews or other device.

12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy; Painted cast iron; Polished bronze; Rough bronze or Stainless steel as shown on the drawings or as selected by the Authority.

13. Frame and Cover Shape: Round or Square as shown on the drawings or as selected by the Authority.

14. Top Loading Classification: Extra Heavy, Heavy, Light or Medium Duty; as shown on the drawings or as selected by the Authority.

E. Cast-Iron Wall Cleanouts:

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

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.
   e. WATTS.
   f. Zurn Industries, LLC.
   g. Approved equal.

2. Standard: ASME A112.36.2M. Include wall access.

3. Size: Same as connected drainage piping.

4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.

5. Closure Plug:

   a. Brass or Cast iron as shown on the drawings or as selected by the Authority.

   b. Countersunk or raised head; as shown on the drawings or as selected by the Authority.

   c. Drilled and threaded for cover attachment screw.

   a. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access: Round; deep, chrome-plated bronze; flat, chrome-plated brass or stainless-steel cover plate with screw as shown on the drawings or as selected by the Authority.

7. Wall Access: Round or Square; nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover as shown on the drawings or as selected by the Authority..

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

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

   a. Ayrlett, LLC.
   b. Durgo, Inc.
   c. Oatey.
   d. ProSet Systems Inc.
   e. RectorSeal.
   f. Studor, Inc.
   g. Approved equal.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

3. Operation: Mechanical sealing diaphragm.

4. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

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

a. Durgo, Inc.
b. Oatey.
c. Studor, Inc.
d. Approved equal.

2. Standard: ASSE 1050 for vent stacks.

3. Operation: Mechanical sealing diaphragm.

4. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:

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

a. Durgo, Inc.
b. Oatey.
c. RectorSeal.
d. Studor, Inc.
e. Zurn Industries, LLC.
f. Approved equal.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.

3. Size: About 9 inches wide by 8 inches high by 4 inches deep.

2.5 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

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

a. Acorn Engineering Company.
b. Thaler Metal Industries Ltd.
c. Zurn Industries, LLC.
d. Approved equal.

2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch or 6.0-lb/sq. ft. , 0.0938-inch- thick (as shown on the drawings or as selected by the Authority) lead flashing collar and skirt extending at least 6 inches, 8 inches or 10 inches (as shown on

the drawings or as selected by the Authority) from the pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Open-Top Vent Cap: Without cap.

b. Low-Silhouette Vent Cap: With vandal-proof vent cap.

c. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

a. ProSet Systems Inc.
b. Approved equal.

2. Standard: UL 1479 assembly of sleeve-and-stack fitting with fire-stopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

5. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.

2. Size: Same as connected waste piping with increaser fitting of size indicated on the drawings.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2. Size: Same as connected waste piping.

a. NPS 2: 4-inch- minimum water seal.

b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch or 2 inches (as shown on the drawings or as selected by the Authority) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install air-admittance-valve wall boxes recessed in wall.

H. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."

I. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."

J. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

K. Assemble open drain fittings and install with top of hub 1 inch or 2 inches above the floor, as shown on the drawings or as selected by the Authority.

L. Install deep-seal traps on floor drains and other waste outlets, if indicated.

M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

O. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

P. Install vent caps on each vent pipe passing through roof.

Q. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

R. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

T. Install wood-blocking reinforcement for wall-mounting-type specialties.

U. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Comply with requirements in Section 07 62 00 "Sheet Metal Flashing and Trim."

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SANITARY WASTE PIPING SPECIALTIES shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SANITARY WASTE PIPING SPECIALTIES shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 13 20

SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The contractor shall furnish all labor, material, equipment and services necessary to furnish and install sanitary drain systems at the locations shown on the drawings or as otherwise required, including the following::

1. Floor drains.
2. Trench drains.
3. Channel drainage systems.

B. The work also includes the following:

1. Connections to sewer.
2. Plumbing permits.
3. Testing.
4. All other required accessories and necessary work.

C. Related sections:

1. Section 22 05 53, Identification for Plumbing piping and equipment.
2. Section 22 13 16, Sanitary waste and vent piping.
3. Section 22 13 19, Sanitary work piping specifications.
4. Section 22 13 29, Sanitary sewerage pumps.
5. Section 22 14 23, Storm Drainage Piping Specialties

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which can not meet the referenced standards and codes shall be brought to the attention of the Authority for his/her written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Plumbing Code
2. State of Illinois Plumbing Code

C. Standards: The work shall comply with the following standards

1. American Society of Mechanical Engineers (ASME)

a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications

b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings
d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250
e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings
f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings
g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes
i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions
j. ASME/ANSI B31.9 - Building Service Piping
k. ASME A 112.1.2, Air gaps in plumbing systems.
l. ASME A 112.3.1, Stainless Steel Draining Systems.
m. ASME A 112.36.2, Cleanouts

2. American Society of Testing and Materials (ASTM)

a. ASTM A48 – Gray Iron Coating.
b. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
c. ASTM A74 - Cast Iron Soil Pipe and Fittings
d. ASTM B88 - Seamless Copper Water Tube
e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for his/her written approval before proceeding with the work in question.

1.4 SUBMITTALS

A. The Contractor shall furnish for the Authority's review and approval shop drawings in accordance with the requirements of Division One Section, Submittals, and as required below:

1. Shop Drawings of sanitary drain layout in plan.
2. Details and section of drain assemblies and installation.
3. Details for connection of drains to existing sewer.

B. The Contractor shall furnish for the Authority's review and approval product data, manufacturer's literature, specifications, catalog cuts, installation instructions and dimensions, materials, accessories and guarantees for the following:

1. Floor Drains.
2. Trench Drains.
3. Channel Drains.

C. The Contractor shall furnish for the Authority's review and approval samples for the following:

1. Drain Covers.

D. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Leak testing of drain system.
2. Pressure Testing of piping connections

1.5 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings or submittals for that portion of work has been completed and returned to the Contractor. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials manufactured by a company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with minimum five (5) years documented experience.

E. Regulator Requirements: City of Chicago Plumbing Code.

F. Provide certification indicating that trench drain system is capable of sustaining the loadings to the specified load class.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to Authority’s facilities or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the Authority no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Authority’s written permission.

1.8 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the size, location, depth, slope and connections of the sanitary drain system with the excavation work, other plumbing work, concrete work and other construction.

C. Coordinate the installation of plumbing in poured-in-place concrete slabs, provide for proper drain elevations, and slope to drains.

D. Coordinate the installation of sewer systems as necessary to interface sanitary drains with drainage piping systems.

1.9 WARRANTY

A. Contractor and manufacturer to warrant the material and work of this section for a period of one (1) year after date of substantial completion.

1. Failures include leaks, dislodging of drains or drain covers, cracking, discoloration of finished metals, code deficiencies and other defects.

B. Contractor to repair or replace defective materials and/or workmanship to the Authority's satisfaction and at no cost to the Authority.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. General: Provide drain collector assemblies with cast iron bodies complete with flashing collar or device and hub or screwed bottom outlet, unless otherwise specified.

2.2 FLOOR DRAINS

A. Floor Drains: Provide floor drains, where shown on the Contract Drawings, of the size shown on the Contract Drawings and as follows:

1. Typical Floor Drains (FD-1): Coated cast iron body, nickel-bronze adjustable 5 inch round strainer head, sediment bracket, vandal-proof screw, flashing collar, 4" outlet, seepage flange and bottom caulk outlet:

a. Jay R. Smith
b. Josam
c. Zurn
d. Approved Equal

2. Toilet and Janitor Room Floor Drain (FD-2): Coated cast iron body, nickel-bronze adjustable 8 inch square strainer head with secured square hole grate, seepage flange and bottom caulk outlet:

a. Jay R. Smith, 2010-B-U
b. Josam, 30000-S-2-17
c. Zurn, ZN-415-S-16-VP
d. Approved Equal.

3. Customer Assistance Kiosk - 0SD-1 (open sight drain): 4" diameter galvanized cast iron funnel, with 2" P-trap:

a. Jay R. Smith Figure 3822
b. Approved Equal.

4. Passageway Floor Drain (FD-3): Coated cast iron body, nickel bronze adjustable reinforced grate 8□ square strainer, sediment bucket, vandal-proof screw and flashing collar:

a. Jay R. Smith 2010-K-B-U
b. Zurn ZN-415-5-16-Y-VP
c. Approved Equal.

B. Cast-Iron Floor Drains

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

a. Commercial Enameling Company.
b. Jay R. Smith Mfg. Co.
c. Josam Company.
d. MIFAB, Inc.
e. Prier Products, Inc.
f. Sioux Chief Manufacturing Company, Inc.
g. Wade; a subsidiary of McWane Inc.
h. WATTS.
i. Zurn Industries, LLC.
j. Approved equal.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom or Side, as shown or required.
9. Backwater Valve: Drain-outlet or Integral, ASME A112.14.1, swing-check type, as shown or required.
10. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
11. Top or Strainer Material: Bronze, Gray iron, Nickel, bronze or Stainless steel as shown or required.
12. Top of Body and Strainer Finish: Nickel bronze, Polished bronze, Rough bronze or Stainless steel as shown or required.
13. Top Shape: Round or Square as shown or required.
14. Dimensions of Top or Strainer: as shown or required
15. Top Loading Classification: Heavy Duty.
16. Funnel: Required.

17. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
18. Trap Material: Bronze, Cast iron or Copper as shown or required.
19. Trap Pattern: Deep-seal P-trap, Standard P-trap as shown or required.
20. Trap Features: Cleanout, Trap-seal primer valve drain connection, Cleanout and trap-seal primer valve drain connection as shown or required.

C. Stainless-Steel Floor Drains, ASME A112.3.1:

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

    a. Zurn Industries, LLC.
    b. Approved equal

2. Outlet: Bottom or Side as shown or required.

3. Top or Strainer Material: Stainless steel.
4. Top Shape: Round or Square as shown or required.
5. Dimensions of Top or Strainer: as shown or required.
6. Seepage Flange: as shown or required.
7. Anchor Flange: as shown or required.
8. Clamping Device: as shown or required.
9. Trap-Primer Connection: as shown or required.
10. Trap Material: Cast iron or Stainless steel as shown or required.
11. Trap Pattern: Deep-seal P-trap or Standard P-trap as shown or required.

D. Stainless-Steel Floor Drains, ASME A112.6.3:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Kusel Equipment Co.
    d. Scherping Systems, Inc.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Wade; a subsidiary of McWane Inc.
    g. WATTS.
    h. Zurn Industries, LLC.
    i. Approved equal.

2. Outlet: Bottom or Side as shown or required.
3. Top or Strainer Material: Stainless steel.
4. Top Shape: Round or Square as shown or required.
5. Dimensions of Top or Strainer: as shown or required.
6. Seepage Flange: Required.
7. Anchor Flange: Required.
8. Clamping Device: Required.
9. Trap-Primer Connection: Required.
10. Trap Material: Cast iron or Stainless steel as shown or required.
11. Trap Pattern: Deep-seal P-trap or Standard P-trap as shown or required.

2.3 TRENCH DRAINS

A. Trench Drains: Provide trench drains where shown on the contract drawings, of the size shown on the contract drawings and as follows:

1. Trench Drain (TD-1): Precast Polymer Concrete trench drain channel with 0.6% bottom slope. Trench width shall be 6 inches with a depth of 6.4 inches at the deep end and 6.2 inch at the shallow end. The length shall 39.19 inches. The grates shall be ductile iron slotted grate, securely locked down with built-in channel lock blocks. The channel shall have a vertical cutout for 4 inch discharge:

    a. Polydrain
    b. ACO Drain
    c. Approved Equal.

B. Sanitary Drains:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Sioux Chief Manufacturing Company, Inc.
    e. Wade; a subsidiary of McWane Inc.
    f. WATTS.
    g. Zurn Industries, LLC.
    h. Approved equal.

2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: Anchor or Seepage as shown or required.
5. Clamping Device: Required.
6. Outlet: Bottom End or Side as shown or required.
7. Grate Material: Ductile iron, Gray iron. Gray iron or Stainless steel as shown or required.
8. Grate Finish: Painted as shown or required.
9. Dimensions of Frame and Grate: As shown or required.
10. Top Loading Classification: Heavy Duty
11. Trap Material: Cast iron or Stainless steel as shown or required.
12. Trap Pattern: Standard P-trap.

2.4 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1:

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

    a. Josam Company.
    b. Approved equal.

2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Standard: ASME A112.3.1 for trench drains.
4. Channel Sections: Interlocking joint, stainless steel with level invert.

    a. Dimensions: 5.8 inches or 11.7 inches wide as shown or required. Number of units required to form total lengths as shown or required.

5. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.

    a. Material: Ductile iron, Galvanized steel, Gray iron or Stainless steel as shown or required.
    b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

6. Covers: Solid ductile iron, gray iron or stainless steel as shown or required, of width and thickness that fit recesses in channels, and of lengths indicated.
7. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
8. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

B. Stainless-Steel Channel Drainage Systems, Non-ASME A112.3.1:

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

    a. MultiDrain Systems, Inc.
    b. Zurn Industries, LLC.
    c. Approved equal.

2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking joint, stainless steel with level invert.

    a. Dimensions: 6 inches or 12 inches wide as shown or required. Number of units required to form total lengths indicated.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.

    a. Material: Ductile iron, Galvanized steel, Gray iron or Stainless steel as shown or required.
    b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections as shown or required.

5. Covers: Solid ductile iron, gray iron or stainless steel as shown or required, of width and thickness that fit recesses in channels, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

C. Narrow, Sloped-Invert, Polymer-Concrete Channel Drainage Systems

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

    a. ABT, Inc.
    b. ACO USA.
    c. Forté Composites, Inc.
    d. Jay R. Smith Mfg. Co.
    e. Josam Company.
    f. Polycast: Hubbell Power Systems, Inc.
    g. Approved equal.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated.
    b. Include extension sections necessary for required depth.
    c. Dimensions: 4-inch inside width. Number of units required to form total lengths indicated.
    d. Frame: Gray-iron or galvanized steel for grates as shown or require.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    a. Material: Ductile iron, Galvanized steel, Gray iron or Stainless steel as shown or required.

        1) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron as shown or required, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

D. Narrow, Level-Invert, Polymer-Concrete Channel Drainage Systems:

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

    a. ABT, Inc.
    b. ACO USA.
    c. Forté Composites, Inc.
    d. Josam Company.
    e. Approved equal.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps.

    a. Include rounded bottom, with level invert and with NPS 4 outlets in number and locations indicated.
    b. Dimensions: 5-inch inside width and 9-3/4 inches deep. Number of units required to form total lengths as shown or required.

        1) Frame: Gray-iron or galvanized steel for grates as shown or required.

4. Grates: Manufacturer's designation heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

    a. Material: Ductile iron, Galvanized steel, Gray iron or Stainless steel as shown or required.
    b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

5. Covers: Solid ductile or gray iron as shown or required, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

E. Wide, Level-Invert, Polymer-Concrete Channel Drainage Systems:

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

    a. ABT, Inc.
    b. ACO USA.
    c. Josam Company.
    d. Polycast: Hubbell Power Systems, Inc.
    e. Approved equal.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps.

    a. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
    b. Dimensions: 8-inch inside width and 13-3/4 inches deep unless shown otherwise. Number of units required to form total lengths indicated as shown or required.

        1) Frame: Gray-iron or galvanized steel for grates as shown or required.

4. Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.

a. Material: Ductile iron, Galvanized steel, Gray iron or Stainless steel as shown or required.
b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections as shown or required.

5. Covers: Solid ductile or gray iron as shown or required, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

F. FRP Channel Drainage Systems:

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

a. ACO USA.
b. Aquaduct, Inc.
c. Jay R. Smith Mfg. Co.
d. Zurn Industries, LLC.
e. Approved equal.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, sloped-invert, FRP modular units, with end caps. Include flat, rounded, or inclined inside bottom, with outlets in number, sizes, and locations indicated.

a. Dimensions: 4 inches, 4 or 6 inches, 6 inches, 6 or 8 inches, 8 inches wide as shown or required. Number of units required to form total lengths indicated as shown or required.
b. Frame: Galvanized steel or Stainless steel as shown or required for grates.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

a. Material: Galvanized steel, Gray iron or Stainless steel as shown or required.
b. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections as shown or required.

5. Covers: Solid ductile or gray iron as shown or required, of width and thickness that fit recesses in channel sections, and of lengths indicated.
6. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

G. HDPE or PE Channel Drainage Systems:

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

a. Jay R. Smith Mfg. Co.
b. Sioux Chief Manufacturing Company, Inc.
c. Tuf-Tite Corporation.
d. Zurn Industries, LLC.
e. Approved equal.

2. Description: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

3. Channel Sections: Interlocking-joint, HDPE or PE modular units, with end caps. Include flat, rounded, or inclined bottom, with level invert and with outlets in number, sizes, and locations indicated.

   a. Dimensions: 4 inches wide. Include number of units required to form total lengths indicated.

4. Grates: With slots or perforations and widths and thickness that fit recesses in channel sections.

   a. Material: Galvanized steel, Gray iron or Stainless steel as shown or required.
   b. Color: as shown or required.

5. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
6. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install sanitary drain systems as shown on the drawings and as required for a functional system.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced and running plumb and true.

C. Installation and connection of the sanitary drain system and related piping shall be coordinated with other work. The Contractor shall coordinate the sanitary drain work with the other plumbing, structural, architectural and other work. Work shall be reviewed for conflicts and interferences.

D. Install sanitary drain systems according to manufacturer’s recommendations and instructions.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify existing floors, inverts, utilities and obstacles and other conditions prior to installations.

C. Examine rough-in requirements for sanitary drain units and other equipment have drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls and floors pit for suitable conditions where drain units and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.3 INSTALLATION OF SANITARY DRAINS

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 1 inch or 2 inches above floor as shown on the drawings or as required.

3.4 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Install piping adjacent to equipment to allow service and maintenance.

3.5 INSTALLATION OF TRENCH DRAIN UNITS

A. Full lengths of trench drain units shall be used wherever possible. Short lengths will not be permitted.

B. When required, units shall be cut and finished according to manufacturer's instructions.

C. Cutting or other weakening of the building structure to facilitate the installation of the trench drain system will not be permitted.

D. Male to female joints at the drain body units shall be made tight. Provide and install sealant as recommended.

E. Make connections between trench drain assembly and sewer as required and per code.

3.6 INSTALLATION OF GRATE

A. Install grate and secure into place. Cut and adjust as required and according to manufacturer's recommendations.

B. Top of grate to be flush with the metal edge and edge of the concrete surround. Avoid any tripping hazards.

3.7 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation sanitary drainage system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection shall be made. Perform tests specified by the City of Chicago Building Code in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the sanitary drainage system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Reinspection: Whenever the plumbing official finds that the sanitary drainage system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Test sanitary drainage system as follows:

1. Test for leaks and defects at all sanitary drainage systems.
2. Leave uncovered and unconcealed all sanitary drainage components until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
3. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
4. Prepare reports for all tests and required corrective action.

3.8 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.9 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SANITARY DRAINS shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SANITARY DRAINS shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 13 29

SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible effluent pumps.
2. Submersible sewage pumps.
3. Wet-pit-volute sewage pumps.
4. Sewage-pump, reverse-flow assemblies.
5. Sewage-pump basins and basin covers.
6. Progressing-cavity sewage pumps.
7. Packaged, submersible sewage-pump units.
8. Packaged wastewater-pump units.

B. Related Sections include the following:

1. Section 22 14 29 "Sump Pumps" for applications in storm-drainage systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE EFFLUENT PUMPS

A. Submersible, Fixed-Position, Single-Seal Effluent Pumps:

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

    a. A.Y. McDonald Mfg. Co.
    b. Barnes; a Crane Pumps & Systems brand.
    c. Bell & Gossett; a Xylem brand.
    d. Flo Fab Inc.
    e. Goulds Water Technology; a Xylem brand.
    f. Grundfos Pumps Corp.
    g. Liberty Pumps.
    h. Little Giant Pump Co.
    i. Pentair Pump Group.
    j. Stancor, Inc.
    k. Sta-Rite Industries, Inc.; Pentair Ltd.
    l. WILO-EMU USA LLC.
    m. Zoeller Company.

2. Description: Factory-assembled and -tested effluent-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron, ASTM A 532, abrasion-resistant cast iron, ASTM B 584, cast bronze and stainless steel, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Oil

9. Controls:

a. Enclosure: NEMA 250 Type 4X
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Controls:

a. Enclosure: NEMA 250, Type 4X; pedestal or wall-mounted.
b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Effluent Pumps:

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

a. ABS; Cardo Flow Sloutions.
b. BJM Pumps, LLC.
c. Federal Pump Corp.
d. HOMA Pump Technology Inc.
e. KSB Inc.
f. Pentair Pump Group.
g. PX Pumps USA.
h. Stancor, Inc.
i. Tsurumi America, Inc.
j. WILO-EMU USA LLC.
k. Zoeller Company.

2. Description: Factory-assembled and -tested effluent-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron, ASTM A 532, abrasion-resistant cast iron, ASTM B 584, cast bronze and stainless steel, closed or semi-open design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Oil.

10. Controls:

    a. Enclosure: NEMA 250, Type 4X
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Controls:

    a. Enclosure: NEMA 250, Type 4X pedestal or wall mounted.
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps:

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

    a. Pentair Pump Group.
    b. Stancor, Inc.
    c. WILO-EMU USA LLC.

d. Zoeller Company.

2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron, ASTM A 532, abrasion-resistant cast iron, ASTM B 584, cast bronze and stainless steel, closed or semi-open design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Oil.

9. Controls:

    a. Enclosure: NEMA 250, Type 4X.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X, as selected by the Authority; pedestal or wall-mounted, as selected by the Authority.
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

12. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps:

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

a. ABS; Cardo Flow Sloutions.
b. Chicago Pump Company; Grundfos Pumps Corporation.
c. Federal Pump Corp.
d. Flygt; a brand of Xylem Inc.
e. HOMA Pump Technology Inc.
f. Pentair Pump Group.
g. PX Pumps USA.
h. Stancor, Inc.
i. Tsurumi America, Inc.
j. WILO-EMU USA LLC.
k. Zoeller Company.

2. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze and stainless steel, (as selected by the Authority) closed or semi-open design for clear wastewater, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Air or Oil, as selected by the Authority.

10. Controls:

a. Enclosure: NEMA 250, Type 1 or Type 4X, as selected by the Authority.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Controls:

a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted; as selected by the Authority.
b. Switch Type: Mechanical-float, Mercury-float or Pressure (as selected by the Authority) type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

13. Guide-Rail Supports:

a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Capacities and Characteristics:

1. Unit Capacity: As shown on the Drawings (gpm).
2. Number of Pumps: As shown on the Drawings.
3. Each Pump:

a. Capacity: As shown on the Drawings (gpm).
b. Solids Handling Capability: As shown on the Drawings (inches) minimum.
c. Total Dynamic Head: As shown on the Drawings (feet).
d. Speed: As shown on the Drawings (rpm).
e. Discharge Pipe Size: As shown on the Drawings (NPS).
f. Motor Horsepower: As shown on the Drawings.

g. Electrical Characteristics:

1) Volts: As shown on the Drawings.
2) Phases: As shown on the Drawings.
3) Hertz: 60.

4. Unit Electrical Characteristics:

a. Full-Load Amperes: As shown on the Drawings.
b. Minimum Circuit Ampacity: As shown on the Drawings.
c. Maximum Overcurrent Protection: As shown on the Drawings.

2.2 SUBMERSIBLE SEWAGE PUMPS

A. Submersible, Fixed-Position, Single-Seal Sewage Pumps:

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

a. A.Y. McDonald Mfg. Co.
b. Barnes; a Crane Pumps & Systems brand.
c. Bell & Gossett; a Xylem brand.
d. EBARA Fluid Handling.
e. Flo Fab Inc.
f. Flygt; a brand of Xylem Inc.
g. Goulds Water Technology; a Xylem brand.
h. Grundfos Pumps Corp.
i. Liberty Pumps.
j. Little Giant Pump Co.
k. PACO Pumps; Grundfos Pumps Corporation, USA.
l. Peerless Pump Company.
m. Pentair Pump Group.
n. Swaby Manufacturing Company.

2. Description: Factory-assembled and -tested sewage-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze and stainless steel, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Air or Oil, as selected by the Authority.

9. Controls:

a. Enclosure: NEMA 250, Type 1 or Type 4X, as selected by the Authority.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Controls:

a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted (as selected by the Authority).
b. Switch Type: Mechanical-float, Mercury-float or Pressure (as selected by the Authority) type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.

B. Submersible, Fixed-Position, Double-Seal Sewage Pumps:

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

a. ABS; Cardo Flow Sloutions.
b. Barnes; a Crane Pumps & Systems brand.
c. Bell & Gossett; a Xylem brand.
d. BJM Pumps, LLC.
e. Chicago Pump Company; Grundfos Pumps Corporation.
f. E.I.M. Electric Co., Ltd.
g. EBARA Fluid Handling.
h. Federal Pump Corp.
i. Flygt; a brand of Xylem Inc.
j. Goulds Water Technology; a Xylem brand.
k. HOMA Pump Technology Inc.
l. KSB Inc.
m. PACO Pumps; Grundfos Pumps Corporation, USA.
n. Pentair Pump Group.

2. Description: Factory-assembled and -tested sewage-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze and stainless steel, nonclog, open, or semi-open design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Air or Oil, as selected by the Authority.

10. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X, as selected by the Authority.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted (as selected by the Authority).
    b. Switch Type: Mechanical-float, Mercury-float, Pressure (as selected by the Authority) type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

C. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps:

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

    a. EBARA Fluid Handling.
    b. Flygt; a brand of Xylem Inc.
    c. Gorman-Rupp Company (The).
    d. Goulds Water Technology; a Xylem brand.
    e. PACO Pumps; Grundfos Pumps Corporation, USA.
    f. Pentair Pump Group.
    g. Swaby Manufacturing Company.
    h. Weil Pump Company, Inc.
    i. WILO-EMU USA LLC.
    j. Zoeller Company.

2. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze and stainless steel, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Air or Oil; as selected by the Authority.

9. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; as selected by the Authority.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted (as selected by the Authority).
    b. Switch Type: Mechanical-float, Mercury-float or Pressure (as selected by the Authority) type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching

control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

12. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

D. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:

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

    a. ABS; Cardo Flow Sloutions.
    b. Barnes; a Crane Pumps & Systems brand.
    c. Bell & Gossett; a Xylem brand.
    d. BJM Pumps, LLC.
    e. Chicago Pump Company; Grundfos Pumps Corporation.
    f. E.I.M. Electric Co., Ltd.
    g. EBARA Fluid Handling.
    h. Federal Pump Corp.
    i. Flygt; a brand of Xylem Inc.
    j. Gorman-Rupp Company (The).
    k. Goulds Water Technology; a Xylem brand.
    l. HOMA Pump Technology Inc.
    m. KSB Inc.
    n. PACO Pumps; Grundfos Pumps Corporation, USA.

2. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.

3. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.

5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze and stainless steel, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Air or Oil; as selected by the Authority.

10. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; as selected by the Authority.
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted; as selected by the Authority.
    b. Switch Type: Mechanical-float, Mercury-float or Pressure type, as selected by the Authority in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

12. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

13. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

E. Submersible, Quick-Disconnect, Grinder Sewage Pumps:

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

a. ABS; Cardo Flow Sloutions.
b. Alyan Pump Company.
c. Barnes; a Crane Pumps & Systems brand.
d. BJM Pumps, LLC.
e. EBARA Fluid Handling.
f. HOMA Pump Technology Inc.
g. Liberty Pumps.
h. Pentair Pump Group.
i. Stancor, Inc.
j. Tsurumi America, Inc.
k. Vaughan Co., Inc.
l. Weil Pump Company, Inc.
m. WILO-EMU USA LLC.
n. Zoeller Company.

2. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
5. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Air or Oil, as selected by the Authority.

9. Controls:

a. Enclosure: NEMA 250, Type 1 or Type 4X; as selected by the Authority.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Controls:

    a. Enclosure: NEMA 250, Type 1 or Type 4X; pedestal or wall-mounted; as selected by the Authority.
    b. Switch Type: Mechanical-float, Mercury-float or Pressure type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure (as selected by the Authority) switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

12. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

F. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps:

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

    a. Barnes; a Crane Pumps & Systems brand.
    b. Environment One Corporation.
    c. Pentair Pump Group.

2. Description: Factory-assembled and -tested progressing-cavity, grinder sewage-pump unit with guide-rail supports.

3. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
4. Pump Body: Cast iron or as indicated otherwise.
5. Pump Bearings: Radial and thrust types.
6. Pump Shaft: Steel.

7. Rotor: Stainless steel.
8. Stator: Buna-N.
9. Seal: Packing gland and mechanical types.
10. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
11. Controls:

    a. Enclosure: NEMA 250, Type 4X
    b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

12. Controls:

    a. Enclosure: NEMA 250, Type 4X, pedestal or wall
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

14. Guide-Rail Supports:

    a. Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
    b. Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
    c. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    d. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    e. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    f. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    g. Lifting Cable: Stainless steel; attached to pump and cover at manhole.

G. Capacities and Characteristics:

1. Unit Capacity: As indicated on the Drawings.

2. Number of Pumps: As indicated on the Drawings.
3. Each Pump:

    a. Capacity: As indicated on the Drawings.
    b. Solids Handling Capability: As indicated on the Drawings.
    c. Total Dynamic Head: As indicated on the Drawings.
    d. Speed: As indicated on the Drawings.
    e. Discharge Pipe Size: As indicated on the Drawings.
    f. Motor Horsepower: As indicated on the Drawings.
    g. Electrical Characteristics:

        1) Volts: As indicated on the Drawings.
        2) Phases: As indicated on the Drawings.
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: As indicated on the Drawings.
    b. Minimum Circuit Ampacity: As indicated on the Drawings.
    c. Maximum Overcurrent Protection: As indicated on the Drawings. A.

2.3 WET-PIT-VOLUTE SEWAGE PUMPS

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. Alyan Pump Company.
2. Armstrong Pumps, Inc.
3. Chicago Pump Company; Grundfos Pumps Corporation.
4. Federal Pump Corp.
5. Flo Fab Inc.
6. PACO Pumps; Grundfos Pumps Corporation, USA.
7. Peerless Pump Company.
8. Pentair Pump Group.
9. Swaby Manufacturing Company.
10. Tramco Pump Company.
11. Vertiflo Pump Company.
12. Weil Pump Company, Inc.
13. Weinman; a Crane Pumps & Systems brand.
14. Yeomans Chicago Corporation.

B. Description: Factory-assembled and -tested sewage-pump unit.

C. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.

D. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.

E. Pump Shaft: Stainless-steel

F. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron, ASTM A 532, abrasion-resistant cast iron and ASTM B 584, cast bronze, nonclog, open, or semi-open design for solids handling, and keyed and secured to shaft.

G. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.

H. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

I. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings.

1. Modify piping configuration to accommodate reverse-flow assembly.

J. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 2 "Sewage-Pump Basins and Basin Covers" Article for requirements.

K. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

L. Motor: Single-speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.

M. Controls:

1. Enclosure: NEMA 250, Type 4X.
2. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
5. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

N. Controls:

1. Enclosure: NEMA 250, Type 4X; pedestal or wall-mounted.
2. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

O. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

a. On-off status of pump.
b. Alarm status.

P. Capacities and Characteristics:

1. Unit Capacity: As indicated on the Drawings.
2. Number of Pumps: As indicated on the Drawings.
3. Each Pump:

    a. Capacity: As indicated on the Drawings.
    b. Solids Handling Capability: As indicated on the Drawings.
    c. Total Dynamic Head: As indicated on the Drwaings.
    d. Speed: As indicated on the Drawings.
    e. Discharge Pipe Size: As indicated on the Drawings.
    f. Motor Horsepower: As indicated on the Drawings.
    g. Electrical Characteristics:

        1) Volts: As indicated on the Drawings.
        2) Phases: As indicated on the Drawings.
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: As indicated on the Drawings.
    b. Minimum Circuit Ampacity: As indicated on the Drawings.
    c. Maximum Overcurrent Protection: As indicated on the Drawings. A.

2.4 SEWAGE-PUMP, REVERSE-FLOW ASSEMBLIES

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. Chicago Pump Company; Grundfos Pumps Corporation.
2. Federal Pump Corp.
3. PACO Pumps; Grundfos Pumps Corporation, USA.
4. Peerless Pump Company.
5. Weil Pump Company, Inc.
6. Yeomans Chicago Corporation.

B. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin. Include the following corrosion-resistant-metal components:

1. Inlet Fitting: One combination inlet-overflow strainer fitting.
2. Valves: Two shutoff valves and two check valves.
3. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
4. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

2.5 SEWAGE-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Fiberglass or Polyethylene
2. Reinforcement: Mounting plates for pumps, fittings guide-rail supports if used and accessories.

3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

C. Capacities and Characteristics:

1. Capacity: As indicated on the Drawings.
2. Diameter: As indicated on the Drawings.
3. Depth: As indicated on the Drawings.
4. Inlet No. 1:

a. Drainage Pipe Size: As indicated on the Drawings..
b. Bottom of Sump to Centerline: As indicated on the Drawings.
c. Type: Flanged, Hubbed or Threaded outside.

5. Inlet No. 2:

a. Drainage Pipe Size: As indicated on the Drawings.
b. Bottom of Sump to Centerline: As indicated on the Drawings.
c. Type: Flanged, Hubbed or Threaded outside.

6. Inlet No. 3:

a. Drainage Pipe Size: As indicated on the Drawings.
b. Bottom of Sump to Centerline: As indicated on the Drawings.
c. Type: Flanged, Hubbed or Threaded outside.

7. Sidewall Outlet:

a. Discharge Pipe Size: As indicated on the Drawings.
b. Bottom of Sump to Centerline: As indicated on the Drawings.
c. Type: Hubbed inside and Hubbed outside.

8. Cover Material: Cast iron or steel with bituminous coating.
9. Cover Diameter: As indicated on the Drawings, but not less than outside diameter of basin top flange.
10. Manhole Required in Cover.
11. Vent Size: As indicated on the Drawings.

2.6 PROGRESSING-CAVITY SEWAGE PUMPS

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. Continental Pump Co.
2. Moyno, Inc.
3. Roper Pump Co.

B. Description: Factory-assembled and -tested progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.

C. Pump Body: Cast iron with feet for base or floor installation.

D. Pump Bearings: Radial and thrust types.

E. Pump Shaft: Steel.

F. Rotor: Chrome-plated steel

G. Stator: Buna-N

H. Seals: Packing gland and mechanical types.

I. Coupling: Flexible.

J. Motor: Single-speed; grease-lubricated ball bearings.

K. Capacities and Characteristics:

1. Capacity: As indicated on the Drawings.
2. Solids Handling Capability: As indicated on the Drawings.
3. Total Dynamic Head: As indicated on the Drawings.
4. Speed: As indicated on the Drawings.
5. Discharge Pipe Size: As indicated on the Drawings.
6. Motor Horsepower: As indicated on the Drawings.
7. Electrical Characteristics:

    a. Volts: As indicated on the Drawings.
    b. Phases: As indicated on the Drawings.
    c. Hertz: 60.

8. Unit Electrical Characteristics:

    a. Full-Load Amperes: As indicated on the Drawings.
    b. Minimum Circuit Ampacity: As indicated on the Drawings.
    c. Maximum Overcurrent Protection: As indicated on the Drawings. A.

2.7 PACKAGED, SUBMERSIBLE SEWAGE-PUMP UNITS

A. Packaged, Submersible, Grinder, Sewage-Pump Units:

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

    a. A.Y. McDonald Mfg. Co.
    b. Barnes; a Crane Pumps & Systems brand.
    c. Environment One Corporation.
    d. Goulds Water Technology; a Xylem brand.
    e. Liberty Pumps.
    f. Pentair Pump Group.
    g. Zoeller Company.

2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder, sewage-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron.
5. Impeller: Stainless-steel grinder cutter or slicer type with shredding ring.
6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
7. Control: Manufacturer's standard panel for one pump.
8. Controls: Automatic, with mechanical- or mercury-float switches and alternator.
9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
10. Basin: Watertight, plastic and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

B. Packaged, Submersible, Nonclog, Sewage-Pump Units:

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

    a. A.Y. McDonald Mfg. Co.
    b. Barnes; a Crane Pumps & Systems brand.
    c. Bell & Gossett; a Xylem brand.
    d. Glentronics, Inc.
    e. Goulds Water Technology; a Xylem brand.
    f. Grundfos Pumps Corp.
    g. Liberty Pumps.
    h. Little Giant Pump Co.
    i. PACO Pumps; Grundfos Pumps Corporation, USA.
    j. Pentair Pump Group.
    k. Sta-Rite Industries, Inc.; Pentair Ltd.
    l. Zoeller Company.

2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron.
5. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling 2-inch diameter solids.
6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
7. Control: Manufacturer's standard panel for one pump.
8. Controls: Automatic, with mechanical- or mercury-float switches and alternator.
9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
10. Basin: Watertight, plastic and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

C. Capacities and Characteristics:

1. System Capacity: As indicated on the Drawings.
2. Number of Pumps: As indicated on the Drawings.
3. Each Pump:

    a. Capacity: As indicated on the Drawings.
    b. Total Dynamic Head: As indicated on the Drawings.
    c. Speed: As indicated on the Drawings.
    d. Discharge Pipe Size: As indicated on the Drawings.
    e. Motor Horsepower: As indicated on the Drawings.
    f. Electrical Characteristics:

        1) Volts: As indicated on the Drawings.
        2) Phases: As indicated on the Drawings.
        3) Hertz: 60.

4. Unit Electrical Characteristics:

    a. Full-Load Amperes: As indicated on the Drawings.
    b. Minimum Circuit Ampacity: As indicated on the Drawings.
    c. Maximum Overcurrent Protection: As indicated on the Drawings. A.

5. Alternator Control Required: As indicated on the Drawings.
6. Basin:

    a. Dimensions: As indicated on the Drawings.
    b. Inlet Size: As indicated on the Drawings.
    c. Bottom to Inlet Centerline: As indicated on the Drawings.
    d. Vent Size: As indicated on the Drawings.

2.8 PACKAGED WASTEWATER-PUMP UNITS

A. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:

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

    a. Alyan Pump Company.
    b. Federal Pump Corp.
    c. Hartell Pumps; Milton Roy.

2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.

3. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Body and Impeller: Corrosion-resistant materials.
5. Motor: With built-in overload protection and mounted vertically on basin cover.
6. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm) and with grounding plug and cable-sealing assembly for connection at pump.
7. Control: Float switch.
8. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.

9. Basin: Watertight, aluminum or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.

B. Packaged, Submersible Wastewater-Pump Units:

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

    a. A.Y. McDonald Mfg. Co.
    b. ABS; Cardo Flow Sloutions.
    c. Bell & Gossett; a Xylem brand.
    d. Goulds Water Technology; a Xylem brand.
    e. Grundfos Pumps Corp.
    f. Liberty Pumps.
    g. Little Giant Pump Co.
    h. Pentair Pump Group.
    i. Sta-Rite Industries, Inc.; Pentair Ltd.
    j. Zoeller Company.

2. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.

3. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Body and Impeller: Corrosion-resistant materials.
5. Pump Seals: Mechanical.
6. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
7. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches and with grounding plug and cable-sealing assembly for connection at pump.
8. Control: Float switch.
9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
10. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.
11. Capacities and Characteristics:

    a. Pump Capacity: As indicated on the drawings.
    b. Total Dynamic Head: As indicated on the drawings.
    c. Speed: As indicated on the drawings.
    d. Discharge Pipe Size: As indicated on the drawings.
    e. Motor Horsepower: As indicated on the drawings.
    f. Electrical Characteristics:

        1) Volts: 120 or 240, as indicated on the drawings.
        2) Phases: Single or three, as indicated on the drawings.
        3) Hertz: 60.

    g. Unit Electrical Characteristics:

        1) Full-Load Amperes: As indicated on the drawings.
        2) Minimum Circuit Ampacity: As indicated on the drawings.
        3) Maximum Overcurrent Protection: As indicated on the drawings A.

    h. Basin:

1) Capacity: Minimum, as indicated on the drawings.
2) Inlet Connection: Minimum, as indicated on the drawings.
3) Vent Connection: Minimum, as indicated on the drawings.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 31 20 00 "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.3 INSTALLATION

A. Pump Installation Standards:

1. Comply with HI 1.4 for installation of centrifugal pumps.
2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.

B. Equipment Mounting:

1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s).
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment"
3. Comply with requirements for vibration isolation devices specified in Section 22 05 48 "Vibration Controls for Plumbing Piping and Equipment."

C. Wiring Method: Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

D. 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.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 13 16 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SANITARY SEWERAGE PUMPS shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SANITARY SEWERAGE PUMPS shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 14 13

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Galvanized-steel pipe and fittings.
4. Ductile-iron pipe and fittings.
5. Copper tube and fittings.
6. ABS pipe and fittings.
7. PVC pipe and fittings.
8. Specialty pipe and fittings.
9. Encasement for underground metal piping.

B. Related Requirements:

1. Section 07 62 00, Sheet Metal Flashing and Trim.
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping.
3. Section 22 05 18, Escutcheons for Plumbing Piping.
4. Section 22 05 29, Hangers and Supports for Plumbing Piping and Equipment.
5. Section 22 05 53, Identification for Plumbing Piping and Equipment.
6. Section 22 07 00, Pipe Insulation.
7. Section 22 14 23, Storm Drainage Piping Specialties.
8. Section 22 14 29, Sump Pumps.
9. Section 31 20 00, Earthwork.

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the at-tention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

C. Standards: The work shall comply with the following standards:

1. American National Standard Institute (ANSI)

a. ANSI A117.1 - Specifications for making building and facilities accessible to and usable by physically handicapped people.
b. ANSI B1.20.1 -Pipe Threads, General Purpose (Inch) Revision and Re-designation of ASME/ANSI B2.1.

2. American Society of Sanitary Engineering (ASSE):

a. ASSE 1001 - Pipe Applied Atmospheric Vacuum Breakers.
b. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

3. American Society of Mechanical Engineers (ASME):

a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.
b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings.
d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings.
g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
j. ASME/ANSI B31.9 - Building Service Piping.

4. American Society of Testing and Materials (ASTM):

a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
b. ASTM A74 - Cast Iron Soil Pipe and Fittings.
c. ASTM A106 - StandardSpecification for Seamless Carbon Steel Pipe for High-Temperature Service.
d. ASTM B88 - Seamless Copper Water Tube.
e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

5. Miscellaneous Standards and Regulations:

a. Environmental Protection Agency (EPA)
b. Clean Water Act (CWA)
c. Occupational Safety and Health Act (OSHA)
d. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent re-quirement shall be followed. Where the Contract Documents are in excess of the refer-enced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.4 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of the Division One Section, “Submittals” and as required below:

1. Shop Drawings of piping floor layouts in plan drawn to a minimum scale of 1/8 inch to one foot showing locations and relationships to other mechanicals, roof drains, chases, walls, floors, ceilings, columns, beams and other building elements.

2. Drainage Plumbing Diagrams showing pipe sizes, provision for expansion, cleanouts, etc
3. Calculations substantiating plumbing pipe and equipment sizes.

B. Coordination Drawings: Detail storm drainage piping showing support locations, type of support, weight on each support, required clearances and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

1. Structural members to which drainage piping will be attached or suspended from.

C. Contractor to submit utility plans for all levels of the facility for coordination of all utility runs and chases. The utility plans to show the layout and location horizontally and vertically of all utilities including storm drainage pipes, waste, vent and water pipes, other pipes, ductwork and equipment.

1. The utility plans to also show all obstructions, structural and building elements, walls and other fixed elements.
2. Purpose of the utility plans are to indicate the relationship and coordination of the utilities to the fixed building elements and to other utilities; indicate clearances; determine location and extent of obstructions and indicate potential interferences. The utility plans to show required clearances and spaces for maintenance of the utilities and access to valves, shutoffs, controls, cleanouts and other equipment. The drawings to show utility chases for pipes and other utilities; their layout and accessibility.
3. It is the Contractor’s responsibility to obtain input from other trades to develop the utility layouts; coordinate their work to avoid conflicts and interferences as well as facilitate an orderly installation of all the work.

D. Product Data: Submit for Authority's review, manufacturer’s literature indicating installation instructions and dimensions, materials, accessories, performance information, certified performance curves, rated capacities, electrical requirements and wiring diagrams, standards listing, certification and guarantees for the following:

3. Piping, tubing, fittings and couplings.
4. Joints and materials.
5. Hangers and supports.
6. Flashing and clamping flanges.
7. Cleanouts.
8. Floor, trench, area, roof and other drains.
9. Stops, strainers, traps, supplies and escutcheons.
10. Sump Pump, sump pump basin, basin cover and drain tile.

Product data submitted shall include specifications section and paragraph reference with intended use clearly indicated. A submittal shall be made for review and approval for all items; even if already identified herein by manufacturer’s model number.

E Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Pressure Testing of Piping.

F. The Contractor shall furnish operating instructions and maintenance recommendations and requirements in accordance with the requirements of Division One Section, Project Closeout.

G. Certificates: Welding Certificate.

H. Manufacturer List: Contractor shall forward to the Authority for preliminary review, a com-plete list of manufacturers of all material and equipment proposed to be incorporated into the work. The review of the list by the Authority shall be considered tentative and is further subject to submission and final review of shop drawings, catalog cuts, etc.

1.5 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings and other submittals for that portion of the work has been completed and returned to the Contractor marked “Approved”. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Con-tract Documents, the Contractor shall furnish plumbing materials and equipment manu-factured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

E. Welding: Qualifying welding procedures, welders and operators in accordance with ASME B31.9, as applicable, for shop and project site welding of pipe work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

F. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the sur-face of the equipment shall be in visible location.

G. Electrical Components: Listed and labeled as defined in NFPA 70, Article 100, by a test-ing agency acceptable to authorities having jurisdiction, and marked for intended use and UL approved.

H. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

C. Coordinate the installation of downspouts, flashing, and roof penetrations.

D. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.

E. Coordinate the installation of sanitary and storm sewer systems as necessary to interface building drains with drainage piping systems.

F. Schedule piping rough-in with installation of other building components.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 WARRANTY

A. All plumbing piping, drains, sump pumps, drain tile, connections and accessories shall be warranted by the manufacturer and installer for a period of one (1) year after the date of substantial completion unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority for parts or labor, and upon the discretion of the Authority.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Storm Water Drainage Service: Do not interrupt service to facilities occupied by the Authority or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the Authority no fewer than two (2) days in advance of proposed interruption of storm water service.
2. Do not proceed with interruption of storm water drainage service without the Authority’s written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.
2. Storm Drainage, Force-Main Piping: 150 psig .

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. NewAge Casting.
4. Tyler Pipe; a part of McWane family of companies.
5. Approved Equal.

B. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Class: ASTM A 74, Extra Heavy class(es).

C. Gaskets: ASTM C 564, rubber.

D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. NewAge Casting.
4. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

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

a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Dallas Specialty & Mfg. Co.
d. Fernco Inc.
e. Ideal Clamp Products, Inc.
f. Matco-Norca.
g. MIFAB, Inc.
h. Mission Rubber Company, LLC; a division of MCP Industries.
i. NewAge Casting.
j. Tyler Pipe; a subsidiary of McWane Inc.

2. Couplings shall bear CISPI collective trademark and NSF certification mark.
3. Standards: ASTM C 1277 and CISPI 310.
4. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

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

    a. ANACO-Husky.
    b. Charlotte Pipe and Foundry Company.
    c. Clamp-All Corp.
    d. Dallas Specialty & Mfg. Co.
    e. Ideal Clamp Products, Inc.
    f. MIFAB, Inc.
    g. Mission Rubber Company, LLC; a division of MCP Industries.
    h. NewAge Casting.
    i. Tyler Pipe; a subsidiary of McWane Inc.
    j. Approved Equal

2. Standard: ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

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

    a. Charlotte Pipe and Foundry Company.
    b. MG Piping Products Company.
    c. Approved Equal

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

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

1. Tubular USA.
2. U.S. Steel.
3. Wheatland Tube Company.
4. Approved Equal.

B. Pipe: ASTM A 53, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

C. Cast-Iron Drainage Fittings: ASME B16.12, threaded.

D. Steel-Pipe Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances

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

a. Anvil International.
b. Grinnell Mechanical Products.
c. Shurjoint Piping Products USA Inc.
d. Smith-Cooper International.
e. Victaulic Company.
f. Approved Equal.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47 malleable-iron castings, ASTM A 234 forged-steel fittings, or ASTM A 106 steel pipes with dimensions matching ASTM A 53 steel pipe, and complying with AWWA C606 for grooved ends.
3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 DUCTILE-IRON PIPE AND FITTINGS

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

1. American Ductile Iron Pipe.
2. McWane Ductile.
3. U.S. Pipe and Foundry Company.
4. Approved Equal.

B. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

3. Gaskets: AWWA C111/A21.11, rubber.

D. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron, Grooved-End Pipe Appurtenances:

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) Anvil International.
2) Shurjoint Piping Products USA Inc.
3) Smith-Cooper International.
4) Star Pipe Products.
5) Victaulic Company.
6) Approved Equal.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 536, ductile-iron castings with dimensions matching AWWA C110/A21.10, ductile-iron pipe or AWWA C153/A21.53, ductile-iron fittings; complying with AWWA C606 for grooved ends.
c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.6 COPPER TUBE AND FITTINGS

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

1. Cambridge-Lee Industries, LLC.
2. Cerro Flow Products, LLC.
3. Mueller Industries, Inc.
4. Wieland Copper Products, LLC.
5. Approved Equal.

B. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

C. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.

D. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

E. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

F. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

G. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

H. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.7 ABS PIPE AND FITTINGS

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

1. Charlotte Pipe and Foundry Company.
2. JM Eagle.
3. Mueller Industries, Inc.
4. Rocky Mountain Colby Pipe Company.
5. Royal Building Products.
6. Approved Equal.

B. NSF Marking: Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

D. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

E. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

F. Solvent Cement: ASTM D 2235.

2.8 PVC PIPE AND FITTINGS

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

1. Charlotte Pipe and Foundry Company.
2. GF Piping Systems.
3. JM Eagle.
4. Mueller Industries, Inc.
5. National Pipe and Plastic, Inc.
6. North America Pipe Corporation.
7. Rocky Mountain Colby Pipe Company.
8. Silver-line Plastics.
9. Approved Equal

B. NSF Marking: Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic storm drain and "NSF-sewer" for plastic storm sewer piping.

C. Solid-Wall PVC Pipe: ASTM D 2665; drain, waste, and vent.

D. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

E. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

F. Adhesive Primer: ASTM F 656.

G. Solvent Cement: ASTM D 2564.

2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    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) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company, LLC; a division of MCP Industries.
        4) Plastic Oddities.
        5) Approved Equal.

    b. Standard: ASTM C 1173.
    c. Description: Elastomeric sleeve, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

    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) Cascade Waterworks Mfg. Co.
        2) Mission Rubber Company, LLC; a division of MCP Industries.
        3) Approved Equal.

    b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

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) Cascade Waterworks Mfg. Co.
2) EBAA Iron, Inc.
3) Ford Meter Box Company, Inc. (The).
4) JCM Industries, Inc.
5) Romac Industries, Inc.
6) Approved Equal

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
d. Center-Sleeve Material: Stainless steel.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

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) A.Y. McDonald Mfg. Co.
2) Capitol Manufacturing Company.
3) Central Plastics Company.
4) HART Industrial Unions, LLC.
5) Jomar Valve.
6) Matco-Norca.
7) WATTS.
8) Zurn Industries, LLC.
9) Approved Equal

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: minimum at 180 deg F 250 psig .
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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) Central Plastics Company.
2) Matco-Norca.
3) WATTS.
4) Zurn Industries, LLC.
5) Approved Equal.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: minimum at 180 deg F 300 psig
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) GPT; an EnPro Industries company.
5) Approved Equal

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating:150 psig .
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

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) Grinnell Mechanical Products.
2) Matco-Norca.
3) Precision Plumbing Products.
4) Victaulic Company.
5) Approved Equal

b. Description: Electroplated steel nipple.
c. Standard: IAPMO PS 66.
d. Pressure Rating: 300 psig at 225 deg F.
e. End Connections: Male threaded or grooved.
f. Lining: Inert and noncorrosive, propylene.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: High-density, crosslaminated polyethylene film of 0.004-inch or linear low-density polyethylene film of 0.008-inch minimum thickness; as shown on the drawings or as selected by the Authority.

C. Form: Sheet or tube; as shown on the drawings or as selected by the Authority.

D. Color: Black or natural; as shown on the drawings or as selected by the Authority.

2.11 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

    a. ProSet Systems Inc.
    b. Approved equal.

2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.12 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152, 12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all piping, fittings, equipment, fixtures, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for water, drainage, waste and vent systems.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced with risers and drops running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in ac-cordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for plumbing fixtures and other equipment have water and drain connections to verify actual locations of piping connections prior to installa-tion.

D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.3 GENERAL PIPING INSTALLATION

A. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted.

B. All pipe shall be cut to exact measurement to be installed without forcing. After cutting, ends shall be reamed and cleaned to eliminate foreign matter and burrs.

C. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

D. All pipe and fittings shall be marked by the manufacturer in accordance with the marking sections of the standards to which reference is made or in accordance with the requirements of MSS-S-5: Standard Marking System for Valves, fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fittings Industry.

E. Make all changes in size and direction of piping with manufactured fittings. Field fabricated fittings will not be allowed.

F. Joints in threaded pipe installations shall be made tight without caulking or the use of lead or paint, and no lubricant shall be used except flake graphite and cylinder oil paste; Dixon's Compound or Key Paste, and the lubricant shall be applied to make threads only.

G. In screwed pipe installations, the use of short lengths of pipe and couplings shall not be permitted. Piping between fittings shall be continuous wherever possible. If, however, the distance between fittings exceeds the normal random length of pipe, and couplings shall be used, they shall be heavy recessed couplings of the same material as the pipe to which they are attached.

H. Final connections to equipment 2½ inches and larger shall be flanged. Connections 2 inches and smaller shall be made with screwed unions or union fittings. It is the responsibility of the Contractor to provide flanged outlets on equipment connections 2½ inches and larger.

I. In screwed pipe installations, provide a union at each screwed valve, strainer, etc., and elsewhere as indicated on the drawings or wherever required for proper servicing of equipment, accessibility, etc.

J. The use of close or short screwed pipe nipples shall be avoided wherever possible; how-ever, if roughing-in dictates the use of close or short nipples, they shall be of pipe the same material as adjoining pipe.

K. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and/or servicing.

L. In no case shall any pipe be installed where it is supported on, or suspended from, an-other pipe or the piping of other trades.

M. When necessary to fit or center with windows and door openings, Contractor shall, at his/her expense, shift and relocate outlets, roughing-in, etc., as directed by the Authority.

N. All piping subject to expansion and contraction, at the time of installation, shall be cold sprung to allow in part for expansion.

O. In all cases where pipe connections are made to piping or any item of equipment of dissimilar metal, provide the proper type of dielectric fitting; EPCO or Center Plastics insulated unions.

P. Layout of piping shall follow drawings, and if applicable, approved shop drawings.

3.4 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earthwork."

3.5 UNDERGROUND PIPE INSTALLATION

A. General: Underground storm and vent piping within the structure line and to a line 5 feet outside the structure line for connection to the underground exterior sewer system, shall be laid at a pitch not less than 1/8" per foot. All changes in direction of piping shall proceed up-grade with the spigot ends of bell-and-spigot pipe pointing in the direction of flow. Each pipe shall be laid true to line and grade an in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.

B. Bell-and-Spigot Lead Joints: Bell-and-spigot joints shall be made by ramming rings of rope oakum into the bell to fill same within 1" of the top of bell. The bell shall then be poured full with molten lead and the lead caulked watertight and airtight flush with top of the bells.

3.6 STORM DRAINAGE PIPING INSTALLATION

A. Drawing plans, schematics, diagrams and shop drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit clean out servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground ABS piping according to ASTM D 2661.

Q. Install aboveground PVC piping according to ASTM D 2665.

R. Install underground ABS piping according to ASTM D 2321.

S. Install engineered drainage and vent piping systems as follows:

1. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

T. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

U. Install force mains at elevations indicated.

V. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in other Division 22 sections.

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in other Division 22 sections.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in other Division 22 sections.

Z. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations from layout are approved on coordination drawings.

AA. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

BB. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

CC. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

DD. Install piping to permit valve servicing.

EE. Install piping at indicated slopes.

FF. Install piping free of sags and bends.

GG. Install fittings for changes in direction and branch connections.

HH. Install piping to allow application of insulation.

II. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.

1. Do not change direction of flow more than 90 degrees.
2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of drainage piping in direction of flow is prohibited.

JJ. Lay buried building piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

KK. Install piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm Drainage Piping: 2 percent downward in direction of flow.

LL. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

MM. Install steel piping according to applicable plumbing code.

NN. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

OO. Install aboveground ABS piping according to ASTM D 2661.

PP. Install aboveground PVC piping according to ASTM D 2665.

QQ. Install underground ABS and PVC piping according to ASTM D 2321.

RR. Install engineered controlled-flow or siphonic drain specialties and storm drainage piping in locations indicated.

SS. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

TT. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

UU. Install force mains at elevations indicated.

VV. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 22 14 23 "Storm Drainage Piping Specialties."

2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
b. Comply with requirements for cleanouts specified in Section 22 14 23 "Storm Drainage Piping Specialties."

3. Install drains in storm drainage gravity-flow piping.

a. Comply with requirements for drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."

WW. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

XX. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

YY. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

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

1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.7 INTERIOR SUSPENDED PIPE INSTALLATION – DRAINAGE AND VENT SYSTEM

A. Horizontal drain runs shall be installed at a pitch not less than 1/8" to the foot, shall be suspended with hangers. All changes in direction of suspended soil and waste piping shall be

made with long-sweep drainage fittings. All offsets shall be made with 45 degree fittings, except as otherwise noted. Due allowance for expansion shall be made in all lines.

B. Traps shall be furnished and installed to connect each fixture or piece of equipment not having a trap or seal as an integral part of same into sewer system. They shall conform to the following patterns and materials:

1. Recessed threaded cast iron drainage traps, where shown or required, shall be installed when connections are made in steel pipe.
2. Bell-and-spigot cast iron drainage traps shall be installed when connection are made in bell-and-spigot pipe.
3. All traps installed in accessible positions shall be fitted with cleanout plugs or with other acceptable means of cleaning.

C. Vent piping shall run parallel to the drainage systems and connecting to the main stacks, which shall be extended through the roofs. Extra-heavy cast iron increasers shall be in-stalled on the top of each soil and vent stack before the same passes through the roof. These increasers shall be one pipe size larger than the vent stacks, with no roof increaser smaller than 4". Vent stacks shall extend at least 12" square, extended up and 3" down into tops of increasers. All horizontal vent pipes shall be grade up to meet the require-ments of local and State codes.

D. Provide cleanouts at each 90□ change of direction in suspended horizontal drainage pipe, 50' intervals in straight runs, at the base of each downspout and stack, in all P-traps not installed in ground, and at such other points as may be necessary for proper cleaning. Provide flashing flange with each cleanout and a clamping device where cleanouts pass through a waterproof membrane.

3.8 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints:

1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
   c. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendices.

I. Joint Restraints and Sway Bracing:

1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:

    a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
    b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
    c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.9 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Unshielded or Shielded, nonpressure transition couplings as shown on the drawings or as selected by the Authority.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:

    a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
    b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples or unions as shown on the drawings or as selected by the Authority.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 DN 65 to DN 100: Use dielectric flanges flange kits or nipples as shown on the drawings or as selected by the Authority.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.10 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installations are specified in the following Section:

1. Section 22 05 23 General Duty Values for Plumbing Piping

B. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 22 14 23 "Storm Drainage Piping Specialties."

3.11 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel or fiberglass pipe hangers for horizontal piping in corrosive environments as required by the Authority.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
5. NPS 3 (DN 80): 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
3. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet with 1/2-inch rod.
5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch rod.
6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

K. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches with 7/8-inch rod.

L. Install supports for vertical ABS and PVC piping every 48 inches.

M. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.12 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.

3. Comply with requirements for backwater valves cleanouts and drains specified in Section 22 14 23 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main.
2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.13 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.14 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Test Procedure:

a. Test storm drainage piping, except outside leaders, on completion of roughing-in.

b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

D. Piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.15 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two (2) coats of water-based latex paint.

3.16 HEAT TRACING

A. All drainage and vent piping exposed to the cold weather shall be heat-traced as indicated on the Drawings.

B. All heat traced piping shall be insulated and provided with a weatherproof jacket to protect the insulation.

3.17 CORROSION CONTROL

A. All metallic piping passing from within the structure into the ground shall be fitted with two stage dielectric isolation couplings to prevent possible stray currents.

3.18 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 (DN 150) and smaller to be of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty,hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
6. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
7. Dissimilar Pipe-Material Couplings: Shielded nonpressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 (DN 200) and larger to be of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
6. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground storm drainage piping NPS 6 (DN 150) and smaller to be of the following:

1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed, caulking materials; and caulked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
4. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Underground, storm drainage piping NPS 8 (DN 200) and larger to be of the following:

1. Extra Heavy class, cast-iron soil pipe and fittings; gaskets; and gasketed, caulking materials; and caulked joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI, heavy-duty, cast-iron, hubless-piping couplings; and coupled joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Cellular-core, sewer and drain series, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) to be of the following:

1. Hard copper tube, Type L (Type B) copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) to be of the following:

1. Hard copper tube, Type L (Type B) copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
4. Fitting-type transition couplings if dissimilar pipe materials.

H. Underground storm drainage force mains NPS 4 (DN 100) and smaller to be of the following:

1. Hard copper tube; Type L (Type B) copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.

I. Underground storm drainage force mains NPS 5 (DN 125) and larger to be of the following:

1. Hard copper tube; Type L (Type B) copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Pressure transition couplings if dissimilar pipe materials.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of STORM DRAINAGE PIPING shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of STORM DRAINAGE PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SETION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS.

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

1.02 SUMMARY

A. Section Includes:

1. Roof drains.
2. Cleanouts.
3. Backwater valves.
4. Trench drains.
5. Through-penetration firestop assemblies.
6. Flashing materials.
7. Storm drainage tile and sump systems.

B. Related Sections:

1. Section 07 62 00, Sheet Metal Flashing and Trim.
2. Section 22 05 53, Identification for Plumbing Piping and Equipment.
3. Section 22 07 00, Pipe Insulation.
4. Section 22 14 23, Storm Drainage Piping Specialties, for roof drains.
5. Section 22 14 29, Sump Pumps.
6. Section 22 40 00, Plumbing Fixtures.

1.03 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

C. Standards: The work shall comply with the following standards:

1. American National Standard Institute (ANSI)

a. ANSI A117.1 - Specifications for making building and facilities accessible

to and usable by physically handicapped people.

b. ANSI B1.20.1 -Pipe Threads, General Purpose (Inch) Revision and Re-designation of ASME/ANSI B2.1.

2. American Society of Sanitary Engineering (ASSE):

a. ASSE 1001 - Pipe Applied Atmospheric Vacuum Breakers.
b. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

3. American Society of Mechanical Engineers (ASME):

a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.
b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings.
d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings.
g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
j. ASME/ANSI B31.9 - Building Service Piping.

4. American Society of Testing and Materials (ASTM):

a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
b. ASTM A74 - Cast Iron Soil Pipe and Fittings.
c. ASTM A106 – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
d. ASTM B88 - Seamless Copper Water Tube.
e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

5. Miscellaneous Standards and Regulations:

a. Environmental Protection Agency (EPA)
b. Clean Water Act (CWA)
c. Occupational Safety and Health Act (OSHA)
d. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.04 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Piping: 10-foot head of water.
2. Storm, Force-Main Piping: 100 psig.

1.05 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of the Division One Section, “Submittals” and as required below:

1. Shop Drawings of piping floor layouts in plan drawn to a minimum scale of 1/8″ = 1′ -0″.
2. Drainage Plumbing Diagrams showing pipe sizes, provision for expansion, cleanouts, etc.

B. Product Data: Submit for Authority's review, manufacturer’s literature indicating installation instructions and dimensions, materials, accessories, performance information, certified performance curves, rated capacities, electrical requirements and wiring diagrams, standards listing, certification and guarantees for the following:

1. Piping, tubing, fittings and couplings.
2. Joints and materials.
3. Hangers and supports.
4. Flashing and clamping flanges.
5. Cleanouts.
6. Floor, trench, area, roof and other drains.
7. Stops, strainers, traps, supplies and escutcheons.
8. Sump Pump, sump pump basin, basin cover and drain tile.

Product data submitted shall include specifications section and paragraph reference with intended use clearly indicated. A submittal shall be made for review and approval for all items; even if already identified herein by manufacturer’s model number.

C. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Pressure Testing of Piping.

D. The Contractor shall furnish operating instructions and maintenance recommendations and requirements in accordance with the requirements of Division One Section, Project Closeout.

E. Certificates: Welding Certificate.

F. Manufacturer List: Contractor shall forward to the Authority for preliminary review, a complete list of manufacturers of all material and equipment proposed to be incorporated into the work. The review of the list by the Authority shall be considered tentative and is further subject to submission and final review of shop drawings, catalog cuts, etc.

1.06 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings and other submittals for that portion of the work has been completed and returned to the Contractor marked “Approved”. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

E. Welding: Qualifying welding procedures, welders and operators in accordance with ASME B31.9, as applicable, for shop and project site welding of pipe work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

F. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

G. Electrical Components: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and UL approved.

H. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.07 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

C. Coordinate the installation of downspouts, flashing, and roof penetrations.

D. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.

E. Coordinate the installation of sanitary and storm sewer systems as necessary to interface building drains with drainage piping systems.

F. Schedule piping rough-in with installation of other building components.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.09 WARRANTY

A. All plumbing piping, drains, sump pumps, drain tile, connections and accessories shall be warrantied by the manufacturer and installer for a period of one (1) year after the date of final acceptance unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority for parts or labor, and upon the discretion of the Authority.

1.10 PROJECT CONDITIONS

A. Interruption of Existing Storm Water Drainage Service: Do not interrupt service to facilities occupied by the Authority or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the Authority no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of storm water drainage service without the Authority’s written permission.

PART 2 - PRODUCTS

2.01 METAL ROOF DRAINS.

A. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

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

a. Jay R. Smith Mfg. Co., 1010ERC
b. Josam Company.
c. Marathon Roofing Products.
d. MIFAB, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Watts; a Watts Water Technologies company.
g. Zurn Industries, LLC.
h. Approved equal.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 14-inch diameter.
5. Combination Flashing Ring and Gravel Stop: As shown and required.
6. Flow-Control Weirs: If shown or otherwise required.
7. Outlet: Bottom.
8. Extension Collars: As shown and required.
9. Underdeck Clamp: As shown and required.
10. Expansion Joint: As shown and required.
11. Sump Receiver Plate: As shown and required.
12. Dome Material: Cast iron.
13. Perforated Gravel Guard (if required): Stainless steel.
14. Vandal-Proof Dome: If shown or specified.

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Marathon Roofing Products.
    d. MIFAB, Inc.
    e. Portals Plus; a Hart & Cooley, Inc. company.
    f. Tyler Pipe; a subsidiary of McWane Inc.
    g. Watts; a Watts Water Technologies company.
    h. Zurn Industries, LLC.
    i. Approved equal.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 8-12-inch diameter.
5. Combination Flashing Ring and Gravel Stop: As required.
6. Flow-Control Weirs: If shown or otherwise required.
7. Outlet: Bottom.
8. Extension Collars: As required.
9. Underdeck Clamp: As required.
10. Expansion Joint: As required.
11. Sump Receiver Plate: As required.
12. Dome Material: Cast iron.
13. Perforated Gravel Guard (if required): Stainless steel.
14. Vandal-Proof Dome: If shown or specified.

C. Cast-Iron, Small-Sump, General-Purpose Roof Drains:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Marathon Roofing Products.

d. MIFAB, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Watts; a Watts Water Technologies company.
g. Zurn Industries, LLC.
h. Approved equal.

2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 8-inch diameter.
5. Combination Flashing Ring and Gravel Stop: As required.
6. Outlet: Bottom.
7. Extension Collars: As required.
8. Underdeck Clamp: As required.
9. Expansion Joint: As required.
10. Sump Receiver Plate: As required.
11. Dome Material: Cast iron.
12. Wire Mesh: Stainless steel.
13. Vandal-Proof Dome: If shown or specified.

D. Metal, Gutter Roof Drains:

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

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. Marathon Roofing Products.
d. MIFAB, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Watts; a Watts Water Technologies company.
g. Zurn Industries, LLC.
h. Approved equal.

2. Standard: ASME A112.6.4, for gutter roof drains.
3. Body Material: Metal.
4. Dimension of Body: Nominal 6-inch diameter.
5. Outlet: Bottom.
6. Dome Material: Bronze.
7. Vandal-Proof Dome: If shown or specified.

E. Metal, Parapet Roof Drains:

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

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. Menzies Metal Products.
d. MIFAB, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Watts; a Watts Water Technologies company.
g. Zurn Industries, LLC.

2. Standard: ASME A112.6.4, for parapet roof drains.
3. Body Material: Cast iron.
4. Outlet: Back or as shown or required.
5. Grate Material: Cast iron.
6. Vandal-Proof Grate: If shown or specified.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES.

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.03 DRAINAGE FITTINGS

A. General: Provide drainage fittings as indicated on the drawings and as hereinafter specified. Provide flashing flange with each drain and a clamping device where drain bodies pass through a waterproof membrane. Connection sizes of drainage fittings shall be as indicated in the drawings.

B. Flashing Clamping Flanges: Provide cast iron clamping flange fittings with caulking ring on all piping where same pierces water proofing membrane:

1. Manufacturers:

a. Jay R. Smith #1760
b. Josam #26420
c. Zurn.
d. Approved Equal.

2.04 DRAIN COLLECTOR ASSEMBLIES

A. General: Provide drain collector assemblies with cast iron bodies complete with flashing collar or device and hub or screwed bottom outlet, unless otherwise specified.

B. Floor Drains: Provide floor drains, where shown on the Contract Drawings, of the size shown on the Contract Drawings and as follows:

1. Typical Floor Drains (FD-1): Coated cast iron body, nickel-bronze adjustable 5

inch round strainer head, sediment bracket, vandal-proof screw, flashing collar, 4” outlet, seepage flange and bottom caulk outlet:

a. Jay R. Smith
b. Josam
c. Zurn
d. Approved Equal.

2. Toilet and Janitor Room Floor Drain (FD-2): Coated cast iron body, nickel-bronze adjustable 8 inch square strainer head with secured square hole grate, seepage flange and bottom caulk outlet:

a. Jay R. Smith, 2010-B-U
b. Josam, 30000-S-2-17
c. Zurn, ZN-415-S-16-VP
d. Approved Equal.

3. Customer Assistance Kiosk - 0SD-1 (open sight drain): 4" diameter galvanized cast iron funnel, with 2" P-trap:

a. Jay R. Smith Figure 3822
b. Approved Equal.

4. Passageway Floor Drain (FD-3): Coated cast iron body, nickel bronze adjustable reinforced grate 8″ square strainer, sediment bucket, vandal-proof screw and flashing collar:

a. Jay R. Smith 2010-K-B-U
b. Zurn ZN-415-5-16-Y-VP
c. Approved Equal.

C. Roof Drains: Provide roof drains, where shown on the contract drawings of the size shown on the contract drawings and as follow:

1. Roof Drain (RD-1) shall be cast iron body with combined flashing clamp and gravel stop, with polyethylene dome, extension, sump receiver and underdeck clamp:

a. Jay R. Smith, 1010ERC
b. Josam
c. Zurn
d. Approved Equal.

2.05 CLEANOUTS

A. Cleanouts (CO): Provide cast bronze, taper threads, counter sunk type cleanout plugs where shown on drawings and as required by Local Codes. Furnish access body assemblies for all cleanouts located in floors, and stainless steel shallow cover for all cleanouts located behind finished walls.

1. Cleanout Plugs: Cleanout Plugs shall be cast bronze taper thread countersunk type, complying with ANSI B2.1.

a. Jay R. Smith, 4470
b. Josam, 58540
c. Zurn, ZARB-1470
d. Approved Equal.

2. Cleanouts - Threaded Seal - Finished Floors: Cleanouts with cast iron body and frame, flashing flange round adjustable scoriated nickel-bronze top and tapered thread bronze plug. Secured cover with vandal proof screws:

a. Jay R. Smith, 4028-F-U-PB
b. Josam, 56000-16-22-F
c. Zurn
d. Approved Equal.

3. Cleanouts - Threaded Seal - Unfinished Floors: Cleanouts with cast iron body and frame, round adjustable scoriated cast iron top with non-tilt tractor cover and vandal proof screws.

a. Jay R. Smith, 4248-U
b. Josam, 56040
c. Zurn, Z-1402-VP
d. Approved Equal.

B. Floor Cleanouts:

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

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. Oatey.
d. Sioux Chief Manufacturing Company, Inc.
e. Tyler Pipe; a subsidiary of McWane Inc.
f. Watts; a Watts Water Technologies company.
g. Zurn Industries, LLC.
h. Approved equal.

2. Standard: ASME A112.36.2M, for cleanouts.

3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing, unless shown otherwise.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: If required.
7. Outlet Connection: Threaded unless shown otherwise.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy; Painted cast iron; Polished bronze; Rough bronze or Stainless steel as selected by the Authority.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.

13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Test Tees:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. Watts; a Watts Water Technologies company.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk or raised head as selected by the Authority, brass.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

D. Wall Cleanouts:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. Watts; a Watts Water Technologies company.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.

3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or Hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, drilled-and-threaded brass or cast-iron plug as specified or required by the Authority.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze; flat, chrome-plated brass or stainless-steel cover plate with screw as shown or selected by the Authority.

2.06 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Tyler Pipe; a subsidiary of McWane Inc.
    e. Watts; a Watts Water Technologies company.
    f. Zurn Industries, LLC.
    g. Approved equal.

2. Standard: ASME A112.14.1, for backwater valves.

3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with threaded access check valve.
6. End Connections: Hub and spigot or hubless.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed or open for airflow unless subject to backflow condition, as shown.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.
    e. Approved equal.

2. Size: Same as floor drain outlet.

3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.07 ROOF FLASHING ASSEMBLIES

A. Roof flashing assemblies: Manufactured assembly made of 6 lb per sq. ft., 0.09 inch thick, lead flashing collar and skirt extending at least 8 inches from pipes with galvanized steel boot reinforcement, and counter flashing fitting.

2.08 TRENCH DRAINS

A. Trench Drains:

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

a. Jay R. Smith Mfg. Co.
b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.
e. Watts; a Watts Water Technologies company.
f. Zurn Industries, LLC.
g. Approved equal.

2. Standard: ASME A112.6.3, for trench drains.

3. Body Material: Cast iron.
4. Flange: Anchor or Anchor with weep holes, if required.
5. Clamping Device: As required.
6. Outlet: Bottom unless shown otherwise.
7. Grate Material: Ductile iron, gray iron or stainless steel as shown on the drawings or selected by the Authority.
8. Grate Finish: As shown on the drawings or selected by the Authority.
9. Dimensions of Frame and Grate: As shown on the drawings.
10. Top-Loading Classification: Heavy Duty unless indicated otherwise.

2.09 SUMP PUMPS (SP-1)

A. Simplex Submersible Sump with Battery Back-up (SP-1):

1. Factory assembled and tested, single-stage, centrifugal, end-suction, automatic operation, heavy duty drainage pump unit; Weil Pump Model 1400 or equal.
2. The pump shall be sumbmersible-type cast iron impeller with stainless steel shaft, and one piece cast iron case. A double mechanical seal shall be provided.
3. The pump shall have capacity as shown on the drawings; 30 GPM at 20 FT TDH, 1/3 hp, 1750 rpm, 115 volts, single phase, 60 Hertz.
4. The motor shall be hermetically sealed, capacitor-start type, with built-in overload protection, air filled, NEMA-6 with 15 feet long neoprene jacketed power cable.
5. Inlet Connection: NPS 1 ½" minimum.
6. Discharge: 1 ¼".

B. Controls:

1. Controls: NEMA 1, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; floats with float rods and rod buttons; with two micro pressure switches in enclosures; mounting rod; and electric cables; Weil Pump Co. Model 8200 or equal.
2. High Water Alarm: Rod-mounted, NEMA 1 enclosures with mercury float switch alarm matching control and electric bell; 220-V ac, with transformer and contacts for remote alarm bell; Weil Pump Co. Model 8341 or equal.

C. Battery Back Up:

1. High water alarm shall be powered with a battery back-up system, Weil Pump Co. Model 1081 or equal.
2. Second battery to power emergency pump.

D. Related Work:

1. Contractor shall furnish and install sump pump basin and basin cover.
2. Contractor shall furnish and install check valve and isolation valve on discharge piping.

E. Manufacturers:

1. Chicago Pump Co.
2. FLYGT Pumps.
3. Hydromatic Pump Co.
4. Weil Pump Company (Model 1400).
5. Approved Equal.

F. Duplex Drain Tile Pumps (SP-2):

1. Factory assembled and tested, single-stage, centrifugal, end-suction, automatic operation, drainage heavy duty duplex pump system; (2) Weil Pump Model 2422 or equal.
2. The pump shall be sumbmersible-type cast iron impeller with stainless steel shaft, and one piece cast iron case. A double mechanical seal shall be provided. Class “F” insulation.
3. The pump shall have capacity as shown on the drawings; 80 GPM at 18 FT TDH, 1.0 hp, 1750 rpm, 208 volts, single phase, 60 Hertz.
4. The motor shall be hermetically sealed, capacitor-start type, with built-in overload protection, air filled, NEMA-6 with 40 feet long neoprene jacketed power cable.
5. Inlet Connection: NPS 1 ½” minimum.
6. Discharge: 2”.
7. Pumps shall be equipped with 15’-0” stainless steel lifting cables.

G. Controls:

1. Controls: NEMA 1 duplex, alternating, UL listed, with a main disconnect, trans-formers, starters, disconnect, O.L. blocks, H-O-A switches, run light and alarm horn and light with silence push-button, and dry remote alarm contacts. Weil Pump series 8100 or equal.
2. Float control shall be (4) Weil Pump Model 8200 or equal submersible float switches to control pump “off”, “on”, “lag”, and “high water alarm” level.
3. Pumps shall be mounted on a quick removal system with base elbow and upper guide bracket, Weil Pump Co. Model 2613-2” or equal. Contractor to furnish Schedule 40 galvanized steel guide rails.
4. Pump basin shall be 48” I.D. X 132” deep fiberglass with anti-floatation flanges, glassed in place studs, duplex aluminum hatch type cover to be bolted in place, including lockable pump access for removal, discharge flanges and cable slots and vent flange and inspection opening. Contractor shall furnish full size check and gate valves on each discharge line.

H. Manufacturers:

1. Homa Pump Co.
2. KSB.
3. Weil Pump Company.
4. Approved Equal.

2.10 SUMP PUMP BASIN AND BASIN COVER

A. Description: Prefabricated fiberglass basin with steel cover. Basin shall have openings for pipe connections, reinforcement and mounting plates for pumps, fittings, and accessories. Size of basin as shown on the drawings or as required. Cover to have openings for discharge piping and vents and capable of supporting foot traffic.

2.11 DRAIN TILE

A. Foundation drain tile to be of High Density Polyethylene Pipe, fully perforated. Size of drain tile pipe to be as shown on the drawings, 4" diameter minimum.

1. High Density Polyethylene Pipe to resist corrosion, oils, and chemicals; withstand repeated freeze and thaw cycles; be unaffected by extremes in pH; and doesn't rust, deteriorate or crumble.
2. Manufacturers of Drain Tile:

a. Midwest Plastics Products.
b. Oxford Plastics, Inc.
c. Wisconsin Plastic Drain Tile.
d. Approved Equal.

2.12 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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

a. ProSet Systems Inc.

2. Standard: ASTM E 814, for through-penetration firestop assemblies.

3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.13 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152, 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

B. Zinc-Coated Steel Sheet: ASTM A 653, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 EXECUTION

3.01 GENERAL

A. Provide and install all piping, fittings, equipment, fixtures, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for water, drainage, waste and vent systems.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced with risers and drops running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.02 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for plumbing fixtures and other equipment have water and drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.03 GENERAL PIPING INSTALLATION

A. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted.

B. All pipe shall be cut to exact measurement to be installed without forcing. After cutting, ends shall be reamed and cleaned to eliminate foreign matter and burrs.

C. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

D. All pipe and fittings shall be marked by the manufacturer in accordance with the marking sections of the standards to which reference is made or in accordance with the requirements of MSS-S-5: Standard Marking System for Valves, fittings, Flanges and Unions of the Manufacturers Standardization Society of the Valve and Fittings Industry.

E. Make all changes in size and direction of piping with manufactured fittings. Field fabricated fittings will not be allowed.

F. Joints in threaded pipe installations shall be made tight without caulking or the use of lead or paint, and no lubricant shall be used except flake graphite and cylinder oil paste; Dixon's Compound or Key Paste, and the lubricant shall be applied to make threads only.

G. In screwed pipe installations, the use of short lengths of pipe and couplings shall not be permitted. Piping between fittings shall be continuous wherever possible. If, however, the distance between fittings exceeds the normal random length of pipe, and couplings shall be used, they shall be heavy recessed couplings of the same material as the pipe to which they are attached.

H. Final connections to equipment 2½ inches and larger shall be flanged. Connections 2 inches and smaller shall be made with screwed unions or union fittings. It is the responsibility of the Contractor to provide flanged outlets on equipment connections 2½ inches and larger.

I. In screwed pipe installations, provide a union at each screwed valve, strainer, etc., and elsewhere as indicated on the drawings or wherever required for proper servicing of equipment, accessibility, etc.

J. The use of close or short screwed pipe nipples shall be avoided wherever possible; however, if roughing-in dictates the use of close or short nipples, they shall be of pipe the same material as adjoining pipe.

K. Wherever two or more pipes are to be installed in parallel, or parallel to the piping of other trades, the piping shall be installed with sufficient space between pipes to allow for the proper application of pipe covering, painting and/or servicing.

L. In no case shall any pipe be installed where it is supported on, or suspended from, another pipe or the piping of other trades.

M. When necessary to fit or center with windows and door openings, Contractor shall, at his/her expense, shift and relocate outlets, roughing-in, etc., as directed by the Authority.

N. All piping subject to expansion and contraction, at the time of installation, shall be cold sprung to allow in part for expansion.

O. In all cases where pipe connections are made to piping or any item of equipment of dissimilar metal, provide the proper type of dielectric fitting; EPCO or Center Plastics insulated unions.

P. Layout of piping shall follow drawings, and if applicable, approved shop drawings.

3.04 EXCAVATION AND BACKFILL

A. Excavation:

1. Pipe trench excavation: The width of the trench at and below the top of the pipe shall be the outside diameter of the pipe plus 18 inches, unless otherwise indicated. The width above the level may be as wide as necessary for proper performance of the work. The bottom of the trenches shall be accurately graded to provide continuous uniform bearing and support. Bell holes and depressions for joints shall be carefully dug to be no larger than necessary. Over-excavation of the trench bottom shall be brought back to grade with pit run gravel or clean concrete sand compacted with 4 inch layers, or with concrete.

2. Underground work shall not be covered until it has been inspected, tested and approved.

B. Bedding and Backfill:

1. All trenches shall be backfilled, from the trench bottom to a point at least 12 inches above the top of the pipe, with fine aggregate trench bedding gradation as follows:

   100% passing the 1" sieve
   65-100% passing the No. 4 sieve
   40-90% passing the No. 10 sieve
   30-80% passing the No. 16 sieve
   10-50% passing the No. 50 sieve
   0-30% passing the No. 100 sieve
   0-10% passing the No. 200 sieve

2. Depth of pipe bedding shall be a minimum of 6 inches below pipe.
3. The remainder of the trench shall be filled with limestone screenings or clean sand, placed in 6 inch lifts and compacted by mechanical tampers or vibratory compactors, completely filling the trenches to the bottom of the slab grade or sub-grade.
4. Backfilling around appurtenances shall be as specified for backfilling of pipe trenches above the pipe.
5. If the material found at the elevations specified are unstable and not suitable or in case it is found desirable or necessary to go an additional depth, the Contractor shall provide 6" deep stabilization stone below pipe bedding. The stabilization stone shall be crushed stone and have CA-1 gradation conforming to ARTICLE 704 of the Illinois Department of Transportation Standard Specifications.
6. All material and backfill operations shall be subjected to testing.

C. Removal of Water:

1. The elevation of the groundwater shall be maintained to a minimum depth of 12 inches below the bottom of the excavation until the trench is backfilled to finished grade.
2. At all times during the excavation period and until its completion and acceptance at final inspection, ample means and equipment shall be provided with which to remove promptly and dispose of properly all waste entering any excavation or other parts of work. The excavation shall be kept dry.
3. Water pumped or drained from the work hereunder shall be disposed of in a suitable manner without damage to adjacent areas, to other work under construction or to pavements. Water shall not be discharged without adequate protection of the surface at the point of discharge.
4. Any and all damages caused by dewatering the work shall be promptly repaired by the Contractor.

D. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 sections of these specifications.

3.05 UNDERGROUND PIPE INSTALLATION

A. General: Underground storm and vent piping within the structure line and to a line 5 feet outside the structure line for connection to the underground exterior sewer system, shall be laid at a pitch not less than 1/8" per foot. All changes in direction of piping shall proceed up-grade with the spigot ends of bell-and-spigot pipe pointing in the direction of flow. Each pipe shall be laid true to line and grade an in such a manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets in the flow line.

B. Bell-and-Spigot Lead Joints: Bell-and-spigot joints shall be made by ramming rings of rope oakum into the bell to fill same within 1" of the top of bell. The bell shall then be poured full with molten lead and the lead caulked watertight and airtight flush with top of the bells.

C. Buried forced drainage mains shall be installed with dielectric coating rate at a minimum insulation resistance of 1,076,391 ohms per square meter as measured by ASTM D-257-78. The coating shall consist of a hot-applied coal tar and asphalt enamel in compliance with the National Association of Pipe Coating Applications (NAPCA) Bulletin 3-67-83. Manufacturer's recommendations shall be adhered to for piping preparation, priming, and coating application.

3.06 PIPING INSTALLATION

A. Drawing plans, schematics, diagrams and shop drawings indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit clean out servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for drainage and vent piping using appropriate branches, bends, and long-sweep bends. Tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground ABS piping according to ASTM D 2661.

Q. Install aboveground PVC piping according to ASTM D 2665.

R. Install underground ABS piping according to ASTM D 2321.

S. Install engineered drainage and vent piping systems as follows:

1. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

T. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

U. Install force mains at elevations indicated.

V. Plumbing Specialties:

1. Install backwater valves in gravity-flow piping. Comply with requirements for backwater valves specified in other Division 22 sections.
2. Install cleanouts at grade and extend to where building storm drains connect to building sewers in drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in drainage force-main piping. Comply with requirements for cleanouts in other Division 22 sections.
3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in other Division 22 sections.

W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in other Division 22 sections.

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in other Division 22 sections.

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in other Division 22 sections.

3.07 INTERIOR SUSPENDED PIPE INSTALLATION - DRAINAGE AND VENT SYSTEM

A. Horizontal drain runs shall be installed at a pitch not less than 1/8" to the foot, shall be suspended with hangers. All changes in direction of suspended soil and waste piping shall be made with long-sweep drainage fittings. All offsets shall be made with 45° fittings, except as otherwise noted. Due allowance for expansion shall be made in all lines.

B. Traps shall be furnished and installed to connect each fixture or piece of equipment not having a trap or seal as an integral part of same into sewer system. They shall conform to the following patterns and materials:

1. Recessed threaded cast iron drainage traps, where shown or required, shall be installed when connections are made in steel pipe.
2. Bell-and-spigot cast iron drainage traps shall be installed when connection are made in bell-and-spigot pipe.
3. All traps installed in accessible positions shall be fitted with cleanout plugs or with other acceptable means of cleaning.

C. Vent piping shall run parallel to the drainage systems and connecting to the main stacks, which shall be extended through the roofs. Extra-heavy cast iron increasers shall be installed on the top of each soil and vent stack before the same passes through the roof.

These increasers shall be one pipe size larger than the vent stacks, with no roof increaser smaller than 4". Vent stacks shall extend at least 12" square, extended up and 3" down into tops of increasers. All horizontal vent pipes shall be grade up to meet the requirements of local and State codes.

D. Provide cleanouts at each 90° change of direction in suspended horizontal drainage pipe, 50' intervals in straight runs, at the base of each downspout and stack, in all P-traps not installed in ground, and at such other points as may be necessary for proper cleaning. Provide flashing flange with each cleanout and a clamping device where cleanouts pass through a waterproof membrane.

3.08 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.09 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples and unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits and nipples.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 section, "Hangers and Supports for Plumbing Piping and Equipment."

1. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
2. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:

    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 108 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 10 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 11 feet with 1/2-inch rod.
5. NPS 3 (DN 80): 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): 84 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 96 inches with 1/2-inch rod.
3. NPS 4 (DN 100): 108 inches with 1/2-inch rod.
4. NPS 6 (DN 150): 10 feet with 5/8-inch rod.

J. Install supports for vertical stainless-steel piping every 10 feet.

K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches with 3/8-inch rod.
3. NPS 2-1/2 (DN 65): 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet with 1/2-inch rod.
5. NPS 6 (DN 150): 10 feet with 5/8-inch rod.
6. NPS 8 (DN 200): 10 feet with 3/4-inch rod.

L. Install supports for vertical copper tubing every 10 feet.

M. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches with 3/8-inch rod.
2. NPS 3 (DN 80): 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8 (DN 150 and DN 200): 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 48 inches with 7/8-inch rod.

N. Install supports for vertical ABS and PVC piping every 48 inches.

O. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.11 CONNECTIONS

A. Drawings and shop drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
2. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
3. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor, as applicable.
4. Comply with requirements for backwater valves, cleanouts and drains specified in other Division 22 section.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main.
2. Storm Pump: To storm pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.12 SUMP PUMP AND SUMP PUMP BASIN INSTALLATION

A. See other sections for excavating and backfilling.

B. Verify opening in ground and rough-in of plumbing piping to verify actual locations and dimensions of storm drainage piping connections and openings before sump pump installation.

C. Install sump pump basin. Brace interior of basin according to manufacturer's written instructions to prevent distortion or collapse during concrete placement.

D. Provide inlet connection from drain tile into sump pit. Outlet from sump pump to exterior landscaped area. Verify in field.

E. Install sump pump basin and pump according to manufacturer's recommendations. Install pumps and piping to allow for access for maintenance including removal of motors, impellers, couplings, and accessories.

F. Set sump pump on basin floor. Make direct connections to storm drainage piping. Install cover so top surface is flush with floor. Support piping so weight of piping is not supported by the pump.

G. See other sections for installation of drainage piping, fittings and specialties.

H. Install flexible connectors adjacent to pumps in discharge piping. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping.

I. Ground equipment and connect wiring as required by code and applicable Electrical Sections of these Specifications.

J. Contractor to check general mechanical operation of pumps and motors; test and adjust controls and safeties.

K. Contractor to set pump controls for automatic start, stop, and alarm operation as required for system application. Set field adjustable switches and circuit breaker trip ranges for normal operation.

L. Contractor to instruct the Authority's representative(s) on the proper operation and maintenance of the pumps.

3.13 DRAIN TILE INSTALLATION

A. High Density Polyethylene Perforated Pipe shall be installed continuously around the foundation according to the manufacturer's recommendations and as shown on the drawings. Install the drain tile next to the footing, on the exterior, on a bed of gravel. Provide for connection of drain tile pipe to the sump pit under the footing. Install stone fill (1 ½" diameter washed rounded gravel) around and over the drain tile up to within 18" of the finish grade. Install a tar paper gravel cover over the gravel prior to backfilling.

3.14 ROOF DRAINAGE INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated. Install expansion joints, if indicated, in roof drain outlets.
2. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 (DN 100) and smaller and 100 feet for larger piping.

4. Locate cleanouts at base of each vertical storm drain stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

N. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.15 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.

2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.16 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.17 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: Test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.18 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.19 HEAT TRACING

A. All drainage and vent piping exposed to the cold weather shall be heat-traced as indicated on the Drawings.

B. All heat traced piping shall be insulated and provided with a weatherproof jacket to protect the insulation.

3.20 CORROSION CONTROL

A. All metallic piping passing from within the structure into the ground shall be fitted with two stage dielectric isolation couplings to prevent possible stray currents.

3.21 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of STORM DRAINAGE PIPING SPECIALTIES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of STORM DRAINAGE PIPING SPECIALTIES shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION
STORM DRAINAGE PIPING SPECIALTIES

SECTION 22 14 26

PREFABRICATED TRENCH DRAIN SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SCOPE OF WORK

A. The Contractor shall furnish all labor, material, equipment, and services necessary to furnish and install a prefabricated trench drain system at the locations shown on the Drawings, as specified herein, or as otherwise required.

B. The plumbing work includes but is not limited to the following:

1. Prefabricated trench drain system including excavation, concrete base, drainage channel sections, grating.
2. Connections to existing sewer.
3. Plumbing permits.
4. Testing.
5. All other required accessories and necessary work.

C. Related Sections:

1. Division 03 Sections, Cast in Place Concrete.
2. Division 22 Sections, Plumbing.
3. Division 31 Sections, Earthwork.

1.03 SUBMITTALS

A. The Contractor shall furnish for the Authority's review and approval shop drawings in accordance with the requirements of Division One Section, Submittals, and as required below:

1. Shop Drawings of trench drain layout in plan.
2. Details and section of trench drain assembly and installation.
3. Details for connection of trench drains to existing sewer.

B. The Contractor shall furnish for the Authority's review and approval product data, manufacturer's literature, specifications, catalog cuts, installation instructions and dimensions, materials, accessories and guarantees for the following:

1. Trench Drains.
2. Trench Drain Covers.
3. Piping and fittings.

C. The Contractor shall furnish for the Authority's review and approval samples for the following:

1. Trench Drains.
2. Trench Drain Covers.

D. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any

piping segment, equipment device, or system. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following item:

1. Leak testing of trench drain system.
2. Pressure Testing of piping connections.

1.04 QUALITY ASSURANCE

A. General: All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work shall commence until review of shop drawings or submittals for that portion of work has been completed and returned to the Contractor. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor shall furnish plumbing materials manufactured by a company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing shall be installed by a company specializing in performing the work of the Section with minimum five (5) years documented experience.

E. Regulator Requirements: City of Chicago Plumbing Code.

F. Provide certification indicating that trench drain system is capable of sustaining the loadings to the specified load class.

1.05 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which can not meet the referenced standards and codes shall be brought to the attention of the Authority for his/her written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Plumbing Code
2. State of Illinois Plumbing Code

C. Standards: The work shall comply with the following standards.

1. American Society of Mechanical Engineers (ASME)

a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications
b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings
d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250
e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings
f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings
g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings

h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes
i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions
j. ASME/ANSI B31.9 - Building Service Piping

2. American Society of Testing and Materials (ASTM)

a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
b. ASTM A74 - Cast Iron Soil Pipe and Fittings
c. ASTM B88 - Seamless Copper Water Tube
d. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for his/her written approval before proceeding with the work in question.

1.06 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing in conformance with the requirements of the accepted project schedule.

B. Coordinate the size, location, depth, slope and connections of the trench drain system with the excavation work, other plumbing work, concrete work and other construction.

C. Coordinate the installation of plumbing in poured-in-place concrete slabs, provide for proper drain elevations, and slope to drains.

D. Coordinate the installation of sewer systems as necessary to interface trench drains with drainage piping systems.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 WARRANTY

A. Provide a minimum one year warranty from the date of final acceptance for all materials and workmanship for the prefabricated trench drain system signed by both the manufacturer and installer of the system. Repairs or replacements required due to faulty materials or workmanship shall be at no cost to the Authority.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering

plumbing, piping, equipment and fixtures which may be incorporated in the work included, but are not limited to, the following:

1. Prefabricated Trench Drain System: ABT Standard PolyDrain – 2512AF as manufactured by ABT, Inc. or an equal product submitted for review and approved by the Authority.
2. Drain Grate: Model no. 2452 / 2453 Stainless Steel w/ as manufactured by ABT, Inc or an equal product submitted for review and approved by the Authority.

2.02 TRENCH DRAIN SYSTEM

A. Heavy duty type designed for industrial applications. System to be able to withstand heavy duty traffic and loadings similar to that encountered for this project.

1. The channel system shall be independently certified to withstand loadings of the load class design category expected for this project, at a minimum.

B. See the drawings for the width, height and length of the trench drain units. Units shall have a wall thickness of at least 0.67", or larger if shown on the drawings or required for the specific structural requirements. Unless indicated otherwise, trench drain units shall have a continuously sloped bottom surface.

C. Drain body to be formed of polymer concrete, a material made from polyester resin binder reinforced by mineral aggregates and filler.

D. Units shall have horizontal cast in anchoring features on the outside wall to ensure maximum mechanical bond to the surrounding bedding material and pavement surface.

E. Units shall have a male to female interconnecting end profile.

F. Minimum properties of polymer concrete:

1. Compressive strength: 14,000 psi
2. Flexural strength: 3,600 psi
3. Water absorption: 0.1%
4. Polymer concrete material to be frost proof, salt proof and dilute acid and alkali resistant.

2.03 TRENCH DRAIN GRATES

A. Grates to be of heavy duty perforated stainless steel. Grates to sit on edge rails integrally cast in the channel body. Edge rail to be a minimum of ¼" thick. Installation to allow for absorbing impact loads. Grates to be flush with the adjacent floor surface. Grates to be removable for access to the trench for maintenance but also be secured into place to prevent longitudinal movement.

1. Drain grate to be perforated stainless steel to fit trench drain body. Width and length of trench drain grates as shown on the drawings and to fit the drain body. Thickness of the grate as required for the specific structural requirements.
2. Grate to be secured to body with a locking mechanism or approved equal method.

B. 316 Grade stainless steel material

C. Anchors to be stainless steel.

2.04 DRAIN OUTLET

A. Bottom outlets to be as shown on the drawings, verified in the field to align with piping or manufacturer's standard as approved by the Authority.

PART 3 EXECUTION

3.01 GENERAL

A. Provide and install trench drain system as shown on the drawings and as required for a functional system.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced and running plumb and true.

C. Installation and connection of the trench drain system and related piping shall be coordinated with other work. The Contractor shall coordinate the trench drain work with the other plumbing, structural, architectural and other work. Work shall be reviewed for conflicts and interferences.

3.02 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.

C. Examine rough-in requirements for trench drain units and other equipment have drain connections to verify actual locations of piping connections prior to installation.

D. Examine walls and floors pit for suitable conditions where drain units and specialties are to be installed.

E. Do not proceed until unsatisfactory conditions have been corrected.

3.03 GENERAL INSTALLATION

A. Install prefabricated trench drain system according to manufacturer's recommendations and instructions.

3.04 PREPARATION

A. Provide and install concrete surround for setting prefabricated trench drain system. Verify with manufacturer of trench drain units, approved shop drawings and field conditions and dimensions for size, depth and location for excavation and concrete installation. See details. Concrete surround to be 4" – 6" thick all around of 3000 psi minimum strength concrete. The finished high level of the concrete surround must be approximately 1/8" above the top of the channel edge. Slope the top of the concrete to the drain. Provide a ½" expansion joint between concrete surround for trench drain and adjacent concrete floor slab.

B. Provide solid and dry base and excavation under the concrete. Excavation shall be at proper elevation and of proper size to allow for installation of the concrete surround for the trench drain and for the trench drain system.

C. Provide access for sewer connections for trench drain.

3.05 INSTALLATION OF TRENCH DRAIN UNITS

A. Full lengths of trench drain units shall be used wherever possible. Short lengths will not be permitted.

B. When required, units shall be cut and finished according to manufacturer's instructions.

C. Cutting or other weakening of the building structure to facilitate the installation of the trench drain system will not be permitted.

D. Male to female joints at the drain body units shall be made tight. Provide and install sealant as recommended.

E. Make connections between trench drain assembly and sewer as required and per code.

3.06 INSTALLATION OF GRATE

A. Install grate and secure into place. Cut and adjust as required and according to manufacturer's recommendations.

B. Top of grate to be flush with the metal edge and edge of the concrete surround. Avoid any tripping hazards.

3.07 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation drainage system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection shall be made. Perform tests specified by the City of Chicago Building Code in the presence of the plumbing official.

    a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Reinspection: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Test drainage system as follows:

1. Test for leaks and defects all drainage and vent piping systems. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Rough Plumbing Test Procedure: Except for outside leaders, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop

during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
5. Prepare reports for all tests and required corrective action.

3.08 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PREFABRICATED TRENCH DRAIN SYSTEM shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of PREFABRICATED TRENCH DRAIN SYSTEM shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible sump pumps.
2. Wet-pit-volute sump pumps.
3. Sump-pump basins and basin covers.
4. Packaged drainage-pump units.

B. Related Section:

1. Section 22 13 29, Sanitary Sewerage Pumps, for effluent and sewage pumps.
2. Section 22 14 23, Storm Drainage Piping Specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated: Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

B. Test and commissioning reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

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

    a. A.Y. McDonald Mfg. Co.
    b. Barnes; a Crane Pumps & Systems brand.
    c. Bell & Gossett; a Xylem brand.
    d. Chicago Pump Co.
    e. Flo Fab Inc.
    f. Flygt Pump.
    g. Glentronics, Inc.
    h. Goulds Water Technology; a Xylem brand.
    i. Grundfos Pumps Corp.
    j. Hydromatic Pump Co.
    k. Liberty Pumps.
    l. Little Giant Pump Co.
    m. Pentair Pump Group.
    n. Stancor, Inc.
    o. Sta-Rite Industries, Inc.; Pentair Ltd.
    p. Weil Pump Company, Inc.
    q. Weinman; a Crane Pumps & Systems brand.
    r. Approved Equal.

2. Description: Factory-assembled and -tested sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron; ASTM A 532, abrasion-resistant cast iron or ASTM B 584, cast bronze, semi-open design for clear wastewater handling, and keyed and secured to shaft; as shown on the drawings or as selected by the Authority.
6. Pump and Motor Shaft: Stainless steel with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

a. Motor Housing Fluid: Air or Oil; as shown on the drawings or as selected by the Authority.

9. Controls:

a. Enclosure: NEMA 250, Type 4X; pedestal or wall-mounted; as shown on the drawings or selected by the Authority.
b. Switch Type: Mechanical-float or Pressure type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
e. High-Water Alarm: Rod-mounted, or cover-mounted, compression probe alarm, NEMA 250, Type 6 enclosure with mechanical-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Control-Interface Features:

a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.
2) Alarm status.
3) Pump run time.

11. Simplex Submersible Sump with Battery Back-up:

a. Automatic operation, heavy duty drainage pump unit; Weil Pump Model 1400 series or equal.
b. The pump shall be submersible-type cast iron impeller with stainless steel shaft. A double mechanical seal shall be provided.
c. The pump shall have capacity as shown on the drawings; 30 GPM at 20 FT TDH, 1/3 hp, 1750 rpm, 115 volts, single phase, 60 Hertz.
d. The motor shall be hermetically sealed, capacitor-start type, with built-in overload protection, air filled, NEMA-6 with 15 feet long neoprene jacketed power cable.
e. Inlet Connection: NPS 1 ½" minimum.
f. Discharge: 1 ¼".
g. Controls: Weil Pump Co. Model 8200 or equal.
h. High Water: Weil Pump Co. Model 8341 or equal.

B. Submersible, Fixed-Position, Double-Seal Sump Pumps:

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

a. BJM Pumps, LLC.
b. EBARA Fluid Handling.
c. Flygt; a brand of Xylem Inc.
d. Hydromatic Pump Co.
e. PACO Pumps; Grundfos Pumps Corporation, USA.
f. Weil Pump Co.

g. Approved Equal.

2. Description: Factory-assembled and -tested sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48, Class No. 25 A cast iron ASTM A 532, abrasion-resistant cast iron and ASTM B 584, cast bronze, semi-open as shown on the drawings or as selected by the Authority; design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel[or steel], with factory-sealed, grease-lubricated ball bearings.
7. Seals: Mechanical.
8. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

    a. Motor Housing Fluid: Air or Oil, as shown on the drawings or as selected by the Authority.

10. Controls:

    a. Enclosure: NEMA 250, Type 4X; pedestal or wall-mounted.
    b. Switch Type: Mechanical-float or Pressure type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
    e. High-Water Alarm: Rod-mounted, or cover-mounted, compression-probe alarm, NEMA 250, Type 6 enclosure with mechanical-float or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

11. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.
        3) Pump run time.

12. Duplex Drain Tile Pumps:

    a. Automatic operation, drainage heavy duty duplex pump system; (2) Weil Pump Model 2422 or equal.
    b. The pump shall be submersible-type cast iron impeller with stainless steel shaft. A double mechanical seal shall be provided. Class “F” insulation.
    c. The pump shall have capacity as shown on the drawings; 80 GPM at 18 FT TDH, 1.0 hp, 1750 rpm, 208 volts, single phase, 60 Hertz.

d. The motor shall be hermetically sealed, capacitor-start type, with built-in overload protection, air filled, NEMA-6 with 40 feet long neoprene jacketed power cable.
e. Inlet Connection: NPS 1 ½" minimum.
f. Discharge: 2".
g. Pumps shall be equipped with 15'-0" stainless steel lifting cables.
h. Controls:

1) Controls: Alternating, UL listed, with a main disconnect, transformers, starters, disconnect, O.L. blocks, H-O-A switches, run light and alarm horn and light with silence push-button, and dry remote alarm contacts. Weil Pump series 8100 or equal.
2) Float control shall be (4) Weil Pump Model 8200 or equal submersible float switches to control pump "off", "on", "lag", and "high water alarm" level.
3) Pumps shall be mounted on a quick removal system with base elbow and upper guide bracket, Weil Pump Co. Model 2613-2" or equal. Contractor to furnish Schedule 40 galvanized steel guide rails.

2.2 WET-PIT-VOLUTE SUMP PUMPS

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. Alyan Pump Company.
2. Armstrong Pumps, Inc.
3. Chicago Pump Company; Grundfos Pumps Corporation.
4. Federal Pump Corp.
5. Flo Fab Inc.
6. PACO Pumps; Grundfos Pumps Corporation, USA.
7. Peerless Pump Company.
8. Pentair Pump Group.
9. Swaby Manufacturing Company.
10. Tramco Pump Company.
11. Vertiflo Pump Company.
12. Weil Pump Company, Inc.
13. Weinman; a Crane Pumps & Systems brand.
14. Yeomans Chicago Corporation.
15. Approved equal.

B. Description: Factory-assembled and -tested sump-pump unit.

C. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sump pump as shown on the drawings or as selected by the Authority..

D. Pump Casing: Cast iron, with strainer inlet and threaded connection for NPS 2 (DN 50) and smaller and flanged connection for NPS 2-1/2 (DN 65) and larger discharge piping.

E. Impeller: Statically and dynamically balanced, ASTM A 532, abrasion-resistant cast iron and ASTM B 584, cast bronze, semi-open non-clog design, capable of passing a 3 inch non-deformable sphere overhung, single suction, keyed to shaft and secured by locking cap screw.

F. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch maximum intervals if basin depth is more than 48 inches, and grease-lubricated, ball-type thrust bearings.

G. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

H. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings.

I. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 2 "Sump-Pump Basins and Basin Covers" Article for requirements. Pump suspension plates shall be provided with each pump to allow for easy removal of the pump. They shall be suitable for supporting the pumps and motors. The suspension plates shall be designed to match the existing floor plates, as well as have suitable mounting holes for the controls, etc as necessary. Existing floor plates may have to be replaced according to the determination of the Authority. The new floor plates shall be cast iron or fabricated steel and shall be coated with black bituminous coating.

J. Line Shaft – Turned ground and polished 416 grade Stainless Steel.

K. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.

L. The column shaft shall be enclosed in a pipe with flanges and shall be minimum 1.5 inches diameter. The shaft shall be sized so that critical speeds are at least 20% above or below the normal operating speed. The maximum spacing for the intermediate sleeve bearings on the pipe columns shall be 4 feet. The sleeve bearings shall be oil lubricated with stainless steel oil lines terminating at the oil lubricator located near the floor plate.

M. Motor: Single-speed; grease-lubricated, solid shaft, ball bearings and mounting on vertical, cast-iron pedestal. The motor shall be mounted on the motor support with NEMA ‘C’ flange and shall be connected to the pump via a flexible coupling.

N. Controls:

1. Enclosure: NEMA 250, Type 4X pedestal mounted.
2. Switch Type: mechanical-float or pressure type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
5. High-Water Alarm: Rod-mounted, or cover-mounted, compression-probe alarm, NEMA 250, Type 6 enclosure with mechanical-float or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

O. Control-Interface Features:

1. Remote Alarm Contacts: For remote alarm interface.
2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

    a. On-off status of pump.
    b. Alarm status.
    c. Pump run time.

P. Pump Lubrication System: Provide one 5 gallon, rectangular, carbon steel tank with baffles for sediment chamber and removable cover type oil lubricator, complete with 3 inch high legs, fabricated stand, Aluminum alloy level-gauge, Buna-N and Vellumoid gaskets and seals, plated steel top filler cap with strainer and filter and inlets, outlets and drains as required for each pump. The oiler shall dispense oil by gravity. A sight feed valve with solenoid shut off (Oil-Rite model B-1835-13 or approved equal) shall be provided for regulation of the oil flow. Further, a low pump oil alarm and low pump oil cutoff switch shall be provided with the unit. The design temperature shall be 225 deg F. The unit supplied shall be Oil-rite model B-774-2, Style DT or approved equal.

Q. New piping at the discharge and check valves and gate valves shall be provided as shown on the Drawings.

R. The pump material for the following components shall be as listed below:

1. Enclosing Tube – Steel.

2. Bearing Retainer – Bronze.

3. Bearings – Intermediate guide bearings shall be bronze backed babbit lined.

4. Strainer – Galvanized or Cast Iron.

5. Line Shaft – Turned ground and polished 416 grade Stainless Steel.

6. Wear Rings – Bronze. Wear rings shall be supplied on the impeller and pump suction plate / volute.

7. Head – Close Grained Cast Iron.

8. Casing: Cast iron, with cast-iron or galvanized steel inlet strainer.

9. Hardware – Stainless Steel.

10. Pump discharge piping – Minimum schedule 40 ASTM A53B galvanized steel pipe.

11. Floor plate – Cast iron or fabricated steel with bituminous coating. (Optional item, refer to the Proposal Section in Specification, Volume I).

2.3 SUMP PUMP CAPACITIES AND CHARACTERISTICS

A. Unit Capacity: As shown on the drawings or as selected by the Authority, gpm.

B. Number of Pumps: Two.

C. Each Pump:

1. Capacity: as shown on the drawings or as selected by the Authority, gpm.
2. Total Dynamic Head: as shown on the drawings or as selected by the Authority, feet.
3. Speed: The maximum acceptable pump operation speed shall be 1200 rpm. No exceptions shall be granted to this limit.
4. Discharge Piping: NPS. Discharge Pipe End Connections to be ASA Standard 125 lb. flanged connection.

5. The pump design point shall be to the left of the best efficiency point. The selected impeller diameter shall be smaller than the maximum allowable impeller diameter so that the head can be increased by 10% by replacing the impeller only. The selected impeller diameter shall be greater than the minimum diameter of the impeller so that the head can be decreased by 5% by trimming the impeller.
6. Electrical Characteristics:

    a. Motor Horsepower: The motor horse power shall be such that the motor shall not be overloaded over the entire pump performance curves for the selected impeller
    b. Volts: 120, 240, 277 or 480. The Contractor shall verify and check the available voltage at each location prior to ordering pumps.
    c. Phases: Three.
    d. Hertz: 60.
    e. Thermal Overload Protection shall be built into pump motors or starters, as appropriate, according to size.
    f. Noise level of the pump motor shall meet OSHA requirements and shall not exceed 85 dBA max at 3 feet radius.

D. Unit Electrical Characteristics:

1. Full-Load Amperes: as shown on the drawings or as selected by the Authority.
2. Minimum Circuit Ampacity: as shown on the drawings or as selected by the Authority.
3. Maximum Overcurrent Protection: as shown on the drawings or as selected by the Authority.

E. Battery Back up:

1. High water alarm to be powered with a battery back-up system, Weil Pump Co. Model 1081 or equal.
2. Second battery to power emergency pump.

F. Related Work:

1. Furnish and install check valves and isolation valves on discharge piping as shown on the drawings or required by the manufacturer or code.

G. Finish: The pump above the floor plate shall have one coat of rust inhibitive primer and one shop coat of machinery enamel. The pump and discharge pipe below the floor plate shall receive one coat of black bituminous coating.

2.4 SUMP-PUMP BASINS AND BASIN COVERS

A. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material: Cast iron basin. Prefabricated fiberglass basin if shown on the drawings or as selected by the Authority.
2. Reinforcement: Mounting plates for pumps, fittings, and accessories.
3. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
4. Size of basin as shown on the drawing or as required. Unless indicated otherwise, Pump basin shall be 48” I.D. X 132” deep fiberglass with anti-floatation flanges, glassed in place studs, duplex hatch type cover to be bolted in place, including lockable pump access for removal, discharge flanges and cable slots and vent flange and inspection opening. Contractor shall furnish full size check and gate valves on each discharge line.

5. Basin shall have openings for pipe connections, reinforcement and mounting plates for pumps, fittings and accessories.

B. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Reinforcement: Steel, cast iron, or aluminum capable of supporting foot traffic for basins installed in foot-traffic areas; as shown on the drawings or as selected by the Authority.

C. Capacities and Characteristics:

1. Capacity: as shown on the drawings or as selected by the Authority, gal.
2. Diameter: as shown on the drawings or as selected by the Authority, inches.
3. Depth: as shown on the drawings or as selected by the Authority, inches.
4. Inlet No. 1: as shown on the drawings or as selected by the Authority.

    a. Drainage Pipe Size: as shown on the drawings or as selected by the Authority.
    b. Bottom of Sump to Centerline: as shown on the drawings or as selected by the Authority, inches.
    c. Type: Flanged, Hubbed or Threaded outside, as shown on the drawings or as selected by the Authority.

5. Inlet No. 2:

    a. Drainage Pipe Size: as shown on the drawings or as selected by the Authority.
    b. Bottom of Sump to Centerline: as shown on the drawings or as selected by the Authority inches.
    c. Type: Flanged, Hubbed or Threaded outside, as shown on the drawings or as selected by the Authority.

6. Inlet No. 3:

    a. Drainage Pipe Size: as shown on the drawings or as selected by the Authority.
    b. Bottom of Sump to Centerline: as shown on the drawings or as selected by the Authority, inches.
    c. Type: Flanged, Hubbed or Threaded outside, as shown on the drawings or as selected by the Authority.

7. Sidewall Outlet:

    a. Discharge Pipe Size: as shown on the drawings or as selected by the Authority.
    b. Bottom of Sump to Centerline: as shown on the drawings or as selected by the Authority, inches.
    c. Type: Hubbed inside and outside, as shown on the drawings or as selected by the Authority.

8. Cover Material: Cast iron or steel with bituminous coating.
9. Cover Diameter: As shown on the drawings or as required, but not less than outside diameter of basin top flange.
10. Manhole Required in Cover.
11. Vent Size: as shown on the drawings or as selected by the Authority.

2.5 DRAIN TILE

A. Foundation drain tile to be of High Density Polyethylene Pipe, fully perforated. Size of drain tile pipe to be as shown on the drawings, 4" diameter minimum.

1. High Density Polyethylene Pipe to resist corrosion, oils, and chemicals; withstand repeated freeze and thaw cycles; be unaffected by extremes in pH; and doesn't rust, deteriorate or crumble.
2. Manufacturers of Drain Tile:

    a. Midwest Plastics Products.
    b. Oxford Plastics, Inc.
    c. Wisconsin Plastic Drain Tile.
    d. Approved Equal.

2.6 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Pedestal Drainage-Pump Units:

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

    a. AMT.
    b. Goulds Water Technology; a Xylem brand.
    c. Liberty Pumps.
    d. Little Giant Pump Co.
    e. Pentair Pump Group.
    f. Sta-Rite Industries, Inc.; Pentair Ltd.
    g. Zoeller Company.
    h. Approved equal.

2. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
3. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump.
4. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
5. Impeller: Aluminum, brass, or plastic.
6. Motor: With built-in overload protection and mounted vertically on sump pump column.
7. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
8. Control: Float switch.

B. Packaged Submersible Drainage-Pump Units:

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

    a. A.Y. McDonald Mfg. Co.
    b. ABS; Cardo Flow Solutions.
    c. Bell & Gossett; a Xylem brand.
    d. Glentronics, Inc.

e. Goulds Water Technology; a Xylem brand.
f. Grundfos Pumps Corp.
g. Liberty Pumps.
h. Little Giant Pump Co.
i. Pentair Pump Group.
j. Sta-Rite Industries, Inc.; Pentair Ltd.
k. Zoeller Company.
l. Approved equal.

2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump.
4. Casing: Metal.
5. Impeller: Brass.
6. Pump Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
10. Control: Motor-mounted float switch.
11. Basin: Plastic.

C. Capacity and Characteristics:

1. Capacity: as shown on the drawings or as selected by the Authority, gpm.
2. Total Dynamic Head: as shown on the drawings or as selected by the Authority, feet.
3. Speed: as shown on the drawings or as selected by the Authority, rpm.
4. Discharge Pipe Size: as shown on the drawings or as selected by the Authority.
5. Electrical Characteristics:

a. Motor Horsepower: as shown on the drawings or as selected by the Authority.
b. Volts: 120, 240, 277 or 480, as shown on the drawings, as required or as selected by the Authority.
c. Phases: Single or Three, as shown on the drawings, as required or as selected by the Authority.
d. Hertz: 60.
e. Full-Load Amperes: as shown on the drawings or as selected by the Authority
f. Minimum Circuit Ampacity: as shown on the drawings or as selected by the Authority
g. Maximum Overcurrent Protection: as shown on the drawings or as selected by the Authority.

6. Basin:

a. Capacity: 2 gal, 5 gal or as indicated on the drawings, minimum.
b. Inlet Connection: 1-1/2 or as shown, minimum.

2.7 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Section 31 20 00 "Earthwork."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Contractor to provide and install pump pit unless shown or noted otherwise..

B. Contractor to provide and install foundation drain tile, if applicable, unless shown or noted otherwise.

C. Contractor shall furnish and install check valve and isolation valve on discharge piping.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 14 13 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.5 SUMP PUMP INSTALLATION

A. Verify opening in ground and rough-in of plumbing piping to verify actual locations and dimensions of storm drainage piping connections and openings before sump pump installation.

B. Install sump pump basin. Brace interior of basin according to manufacturer's written instructions to prevent distortion or collapse during concrete placement.

C. Provide inlet connection from drain tile into sump pit. Outlet from sump pump to exterior landscaped garden. Verify in field.

D. Install sump pump basin and pump according to manufacturer's recommendations. Install pumps and piping to allow for access for maintenance including removal of motors, impellers, couplings, and accessories.

F. Set sump pump on basin floor. Make direct connections to storm drainage piping. Install cover so top surface is flush with floor. Support piping so weight of piping is not supported by the pump.

G. See other sections for installation of drainage piping, fittings and specialties.

H. Install flexible connectors adjacent to pumps in discharge piping. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping.

I. Ground equipment and connect wiring as required by code and applicable Electrical Sections of these Specifications.

J. Contractor to check general mechanical operation of pumps and motors; test and adjust controls and safeties.

K. Contractor to set pump controls for automatic start, stop, and alarm operation as required for system application. Set field adjustable switches and circuit breaker trip ranges for normal operation.

L. Contractor to instruct the Authority's representative on the proper operation and maintenance of the pumps.

3.6 DRAIN TILE INSTALLATION

A. High Density Polyethylene Perforated Pipe shall be installed continuously around the foundation according to the manufacturer's recommendations and as shown on the drawings. Install the drain tile next to the footing, on the exterior, on a bed of gravel. Provide for connection of drain tile pipe to the sump pit under the footing. Install stone fill (1 ½" diameter washed rounded gravel) around and over the drain tile up to within 18" of the finish grade. Install a tar paper gravel cover over the gravel prior to backfilling.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Calibration of Control System: The contractor shall calibrate the control system to meet the depth/level requirement for each sump pit. The cost shall be included in the bid cost

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SUMP PUMPS shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SUMP PUMPS shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Toilets, Flush valves and Toilet Seats.
2. Urinals.
3. Lavatories.
4. Mop Basins.
5. Eye Wash.
6. Water Coolers
7. Water Heaters.
8. Faucet Assemblies and Valves.
9. Hangers, Sleeves and Accessories.
10. Supply Fittings
11. Waste Fittings

B. Related Requirements:

1. Section 22 05 00, Common Work Results for Plumbing.
2. Section 22 05 17, Sleeves and Sleeve Seals for Plumbing Piping
3. Section 22 05 18, Escutcheons for Plumbing Piping
4. Section 22 05 23, General-Duty Valves for Plumbing Piping
5. Section 22 11 16, Domestic Water Piping
6. Section 22 11 19, Domestic Water Piping Specialties
7. Section 22 13 16, Sanitary Waste and Vent Piping
8. Section 22 13 19, Sanitary Waste Piping Specialties
9. Section 22 13 20, Sanitary Drains
10. Division 26 Sections, Electrical

1.3 REFERENCES

A. General: The work shall comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes shall be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work shall comply with the following codes:

1. City of Chicago Building Code.
2. State of Illinois Plumbing Code.

C. Standards: The work shall comply with the following standards:

1. American National Standard Institute (ANSI)

   a. ANSI A117.1 - Specifications for making building and facilities accessible to and usable by physically handicapped people.
   b. ANSI A112.19.2M90 - Vitreous China Plumbing Fixtures.
   c. ANSI B1.20.1 -Pipe Threads, General Purpose (Inch) Revision and Redesignation of ASME/ANSI B2.1.

2. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):

   a. ASHRAE 90A - Energy Efficiency and Conservation.

3. American Society of Sanitary Engineering (ASSE):

   a. ASSE 1001 - Pipe Applied Atmospheric Vacuum Breakers.
   b. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.

4. American Society of Mechanical Engineers (ASME):

   a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.
   b. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800.
   c. ASME/ANSI B16.3 - Galvanized Malleable Iron Threaded Fittings.
   d. ASME/ANSI B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
   e. ASME/ANSI B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
   f. ASME/ANSI B16.12 - Cast Iron Threaded Drainage Fittings.
   g. ASME/ANSI B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
   h. ASME/ANSI B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
   i. ASME/ANSI B16.39 - Malleable Iron Threaded Pipe Unions.
   j. ASME/ANSI B31.9 - Building Service Piping.

5. American Society of Testing and Materials (ASTM):

   a. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   b. ASTM A74 - Cast Iron Soil Pipe and Fittings.
   c. ASTM A106 – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   d. ASTM B88 - Seamless Copper Water Tube.
   e. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

6. American Water Works Association (AWWA):

   a. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   b. ANSI/AWWA C510 - Double Check Valve Backflow-Prevention Assembly.

7. Electrical Components Standard: Provide components complying with NFPA 70”National Electric Code.”

   a. Listing and Labeling: Provide water heaters that are listed and labeled.

1) The terms “listed” and “labeled” shall be as defined in the National Electric Code, Article 100.
2) Listing and labeling agency Qualifications: A “Nationally recognized testing Laboratory” (NRTL) as defined in OSHA.

8. Underwriters Laboratories, Inc. (UL):

a. UL 132 - Relief Valve and Automatic Shut-Off Device For Hot Water Supply Systems.
b. UL 174 - Electric Water Heater.

9. Miscellaneous Standards and Regulations:

a. Environmental Protection Agency (EPA)
b. Clean Water Act (CWA)
c. Occupational Safety and Health Act (OSHA)
d. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement shall be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents shall be followed. All conflicts shall be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.4 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

1.5 ACTION SUBMITTALS

A. Product Data: Submit for Authority’s review product data, catalog cuts, construction details, material descriptions, dimensions of individual components, profiles, finishes, manufacturer’s literature indicating installation instructions and dimensions, accessories, performance information and warranties.

B. Provide product data for all products, including:

1. Piping, tubing, fittings and couplings.
2. Valves.
3. Water heaters including all accessories.
4. Air cushions, thermometers, gauges.
5. Hangers, sleeves and supports.
6. Flashing and clamping flanges.
7. Plumbing Fixtures: Toilets, urinals, lavatories, eyewash, mop basins.
8. Faucet assemblies.
9. Flush valve assemblies.
10. Flow control devices.
11. Stops, strainers, traps, supplies and escutcheons.
12. Water coolers.

C. Product data submitted to include specifications section and paragraph reference with intended use clearly indicated. A submittal shall be made for review and approval for all items; even if already identified herein by manufacturer’s model number. .

D. For water heaters and water coolers provide certified performance curves, rated capacities, electrical requirements and wiring diagrams, standards listing , operating characteristics, furnished specialties and accessories, product certificates, testing agency certificates and labels, source quality-control reports, field quality control reports..

E. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any fixture or, equipment installation. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates for the following:

1. Test for water supply connection leaks.

2. Test for drain connection leaks.

3. Test for leaks and proper operation of faucets and flush valves.

F. The Contractor to furnish operating instructions and maintenance recommendations and requirements in accordance with the requirements of Division One Section, Project Closeout.

G. Manufacturer List: Contractor to forward to the Authority for preliminary review, a complete list of manufacturers of all material and equipment proposed to be incorporated into the work. The review of the list by the Authority shall be considered tentative and is further subject to submission and final review of shop drawings, catalog cuts, etc.

H. Warranties: Submit copies of warranties for major components including water heaters, water coolers, plumbing fixtures, eye wash, faucet assemblies, flush valves.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fixtures, water coolers, water heaters, faucets, flush valves to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. General: All materials to be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work to commence until review of shop drawings and other submittals for that portion of the work has been completed and returned to the Contractor marked “Approved”. All work shall be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor to furnish plumbing materials, fixtures, and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, plumbing to be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

E. Regulatory Requirements: City of Chicago Plumbing Code. All new plumbing fixtures, faucets and valves to meet ADA codes and requirements.

F. Welding: Qualifying welding procedures, welders and operators in accordance with ASME B31.9, as applicable, for shop and project site welding of pipe work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

G. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

H. Electrical Components: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and UL approved.

I. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

J. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

K. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective coating on all equipment, fixtures, faucets and flush valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the plumbing fixtures, faucets, valves and equipment in conformance with the requirements of the accepted project schedule.

B. Coordinate the installation of pipe sleeves for wall and floor penetrations, anchors and carriers.

C. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope to drains.

D. Coordinate the installation of sanitary sewer systems and vent systems as necessary to interface building drains with drainage and vent piping systems. Coordinate the installation of water supply piping systems.

E. Schedule fixture, faucet, valve and eqipment rough-in with installation of water supply, drain and vent piping and other building components.

F. Coordinate sizes and locations of supports with actual fixtures, hot water heater, water cooler and other equipment provided.

1.10 WARRANTY

A. All plumbing fixtures, faucets, water coolers, water heaters, flush valves, equipment, and accessories including piping and valves to be warrantied by the manufacturer and installer for a minimum period of one (1) year after the date of substantial completion unless noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority and upon the discretion of the Authority.

1. Warranty: Water cooler to be warrantied for a minimum of one year after installation, however the refrigeration system of the unit to be warantied for 5 years.

2. Water Heater: Storage tank to be warranted for a period of ten (10) years; controls and other components to be warranted for a period two (2) years.

3. The tankless electric water heater shall additionally have its heat exchanger warrantied for a period of ten (10) years and its other parts for a period of two (2) years. Warranty shall cover leaks, faulty operation, faulty controls, faulty wiring and connections, deterioration of metals, or insufficient heating of water.

1.11 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer – Valve Reoair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.
2. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
3. Faucet Cartridges and O-RRings: Equal to 5 percent of amount of each type and size installed.
4. Water Cooler Filter Cartridges: Equal to Ten (10) percent of quantity installed for each type and size indicated, but no fewer than Ten (10) of each.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. General:

1. The work shall comply with or exceed the references standards and codes.

2. All materials shall be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship that does not meet the referenced standards and codes shall be discarded and replaced at the Contractor's expense.
3. Vitreous ware for the fixtures shall be first-quality, non-absorbent china, of even color and unwarped. Enamel ware shall be constructed of smooth, sound, iron castings, properly finished and provided with first-quality high-temperature enamel. Fittings for fixtures shall be of heavy red brass castings, properly finished and chrome plated. Escutcheons shall

be of brass, sawtooth type. All exposed IPS piping and tubing shall be of red brass, chrome plated. Caulk all wall-hung fixtures between wall and fixture.

B. Plumbing Fixture Connections:

Where fixture connections are not sized, the following shall be the minimal nominal pipe size.

	SOIL OR WASTE	VENT	TRAP	COLD WATER	HOT WATER
Water Closet	4 in.	2 in.	4 in.	1-1/4 in. (Flush Valve)	
Lavatory	1-1/2 in.	1-1/2 in.	1-1/4 in.	1/2 in.	1/2 in.
Jan. Mop Basin/ Service Sink	3 in.	2 in.	3 in.	3/4 in.	¾ in.
Electric Water Cooler	1-1/2 in.	2 in.	1-1/4 in	1/2 in.	

C. Traps;

1. Each and every waste throughout shall be provided with a trap at or near the plumbing fixtures, unless otherwise specified. All traps shall be as specified in plumbing fixture specifications.

D. Couplings;

1. All pipes shall be joined to plumbing fixtures with screwed tail piece couplings and unions, or other outlet assemblies so that fixtures can be easily removed and reset.

E. Fixture Backing:

1. All wall hung plumbing fixtures not specified with chair carriers shall be supported on wall hangers furnished with the fixtures.
2. Steel reinforcing plates (minimum size □ inch thick by 3 inches of undrilled material past any drill hole) shall be installed behind wall in pipe space with carriage bolts installed through wall to support wall hanger and reinforcing plate.
3. Holes through wall shall be drilled, not punched.

F. SUPPORTS

1.. Type II Lavatory Carrier: Standard: ASME A112.6.1M.

2. Type III Lavatory Carrier: Standard: ASME A112.6.1M.

2.2 DRAINAGE AND VENT PIPE CONNECTIONS AND FITTINGS

A. Schedule 40 galvanized steel seamless pipe, ASTM A53, with 150 lbs. malleable iron threaded, galvanized and banded fittings, ANSI B16.3 for 2 inch and smaller waste and vent pipe connections.

B. Flanges: ASTM A106 galvanized. ANSI Class 150.

C. Cast-iron Soil Pipe: ASTM A74, Service weight, hub and spigot coated pipe and fittings, for 3 inch and larger, sanitary soil drainage and vent pipe connections.

1. Lead and Oakum Joints.

2.3 WATER SUPPLY PIPE CONNECTIONS AND FITTINGS

A. Drawn Temper copper tubing: ASTM B88, Type L.

1. Wrought-Copper fittings: ANSI B16.22, streamlined pattern.
2. Solder Filler Material: Silver Brazing Alloy.

B. Unions: ANSI B16.39, malleable iron, Class 150, hexagonal stock, with ball-and –socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads in unions shall conform to ANSI B1.20.1.

1. Dielectric Unions: Threaded or soldered end connections as required to suit application; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

C. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psi working pressure, maximum 250 degrees F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4inch misalignment.

2.4 SHUT-OFF VALVES

A. General: Valves shall comply with ASME B31.9 for building service piping. Provide valves specified and indicated on the Drawings. Water working pressure rating for valves shall be less than hydrostatic test pressures for the system in which they are installed. In addition comply with manufacturer's Standardization Society of the Valves and Fittings Industry standards.

B. Gates Valves – 2 inches and smaller: MSS SP-80; Class 125, body and bonnet of ATM B 62 cast bronze, rising stem threaded ends, solid disc, copper-silicon alloy stem, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

a. Stockham, B-109 or B-100
b. Nibco, S-111 or T-111
c. Milwaukee, 1149 or 148
d. Approved Equal.

2.5 WATER CLOSETS (WC)

A. Wall-mounted with flushometer valve:

1. Low Consumption Toilet: Vitreous china elongated bowl, fully glazed trapway, siphon-jet, low consumption 1.6 gpf, meeting ADA accessibility standards, with 1½" back spud:

    a. Kohler Co., Kingston K-4325
    b. Mansfield, Erie 1301
    c. Approved Equal.

2. High Efficiency Toilet: Vitreous china elongated bowl, fully glazed trapway, siphon-jet, high efficiency 1.28 gpf, meeting ADA accessibility standards, with 1½" back spud:

    a. Kohler Co., Kingston K-4325
    b. Mansfield, Erie 1301
    c. Approved Equal.

3. Toilet shall be mounted at handicapped height with high rough-in for valve and high chair carrier. Nineteen inches (19”) to top of seat to conform to ADA accessibility standards.

4. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.

B. Toilet Seat

1. Toilet Seat: Extended white seat for elongated bowl, open front and stainless steel or chrome plated brass self-sustaining hinge with check:

    a. Church, 295SSC
    b. Clivus Multrum.
    c. Beneke, 523SSCH
    d. Olsonite, 10CCSS
    e. Sperzel, 50-E w/CH
    f. Approved Equal.

2. Standard: IAPMO/ANSI Z124.5.

3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Seat Cover: Not required.
6. Color: White.

C. Carrier

1. Carrier: Bolted type closet fitting with short feet, of sizes and types as required:

    a. Josam Mfg. Co.
    b. Jay R. Smith Co.
    c. Wade, Division of Tyler Corp.
    d. Zurn Industries, Inc.
    e. Approved Equal.

2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

D. Flush Valves

1. Flush valve: Quiet, exposed, diaphragm type, chrome plated water closet flushometer, low consumption (1.6 gpf max.) flush, ADA Compliant metal oscillation non-hold-open handle, 1" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, elevated vacuum breaker flush connection and spud coupling for 1½" top spud flanges:

   a. Sloan Valve Co. "Royal" Model 115
   b. Coyne & Delany Co.
   c. Approved Equal.

2. Optional “Dual Flush” Flush valve (not to be used with 1.28 gpf toilet): Quiet, exposed, diaphragm type, chrome plated water closet flushometer, low consumption (1.1 gpf by lifting handle for a reduced flush or 1.6 gpf by pushing handle down for a full flush) dual flush, ADA Compliant metal oscillation non-hold-open handle, 1" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, elevated vacuum breaker flush connection and spud coupling for 1½" top spud flanges. Provide two (2) adhesive backed metal wall plates etched with instructions:

   a. Sloan Valve Co. Model WES 111
   b. Approved Equal.

3. Flush Valve Standard: ASSE 1037.
4. Minimum Pressure Rating: 125 psig.
5. Features: Include integral check stop and backflow-prevention device.
6. Material: Brass body with corrosion-resistant components.

2.6 URINALS (UR)

A. Wall-mounted with flushometer valve:

1. High Efficiency Wall Hung Urinal: Vitreous china with flushing rim, siphon jet flush action, ¾” inlet top spud, NPS 1 ¼”, low consumption 1.9 Lpf/0.5 gpf, meeting ADA accessibility standards. Size approximately 14” x 14” x 21 ½”; Color-White:

   a. American Standard, "Allbrook” 6550.005
   b. Crane Co.
   c. Eljer Plumbing Co.
   d. Kohler Co.
   e. Approved Equal.

2. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.

B. Flush valve for urinal:

1. Quiet, exposed, diaphragm type, chrome plated water closet flushometer, low consumption (1.6 gpf max.) flush, NPS 2, ADA Compliant metal oscillation non-hold-open handle, 1" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, elevated vacuum breaker flush connection and spud coupling for 1½" top spud flanges:

   a. Sloan Valve Co. "Royal" Model 115
   b. Coyne & Delany Co.
   c. Approved Equal.

2. Standard: ASME A112.18.2/CSA B125.2 for coupling.

C. Carrier: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

2.7 LAVATORIES (LAV)

A. Rectangular-Wall Mounted:

1. Lavatory: Vitreous china 20"x18", Standard ASME A112.19.2/CSA B45.1 mounted at handicapped height with rectangular basin, splash lip, front overflow, 8" centers and drilled for chair carrier with concealed arms:

a. American Standard, Lucern 0356.015
b. Crane Co.
c. Eljer Plumbing Co.
d. Kohler Co.
e. Approved Equal.

2. Faucet: Solid Brass, 8" wide spread lavatory fitting 5" spout, 0.5 GPM flow restrictor spray outlet, color indexed wrist blade handles, slow-closing:

a. Chicago Faucet Co., No.404-VE2805CP.
b. American Standard
c. Delta Faucet Co.
d. Eljer Plumbingware Div.
e. Kohler Co.
f. Approved Equal.

3. Strainer: Grid drain and 1¼" O.D. 18" tailpiece:

a. American Standard
b. Kohler
c. Eljer
d. Approved Equal.

4. Trap: 1¼□ cast brass adjustable P-trap with cleanout plug, tubing to wall and escutcheon:

a. American Standard, 4402.012
b. Kohler, K-9000
c. Eljer
d. Approved Equal.

5. Supplies: Loose key angle stop, 3/8□ IPS chrome plated inlets, ½□ O.D.by 12 inches flexible risers and wall escutcheons:

a. Chicago Faucet, No. 1005
b. Approved Equal.

6. Carrier: Floor mounted type with stub feet, Type II concealed arms and chrome plated escutcheons, adjustable for handicapped height; Standard ASME A112.6.1M:

a. Jay R. Smith
b. Josam

c. Zurn
d. Wade
e. Approved Equal.

7. Handicap lavatory P-trap and angle valve assembly shall be insulated with flexible vinyl insulation in accordance with ADA requirements:

a. Truebro, Inc.
b. Brocar Products, Inc.
c. Plumberex Specialty Products
d. McGuire Manufacturing Co., Inc.
e. Approved Equal.

2.8 SOLID-BRASS, MANUALLY OPERATED FAUCETS

A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
B. Lavatory Faucets: Manual-type, solid-brass valve.

1. Standard: ASME A112.18.1/CSA B125.1.
2. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
3. Body Type: Widespread
4. Body Material: Commercial, solid brass.
5. Finish: Polished chrome plate
6. Maximum Flow Rate: 0.5 gpm
7. Mounting Type: Deck exposed.
8. Valve Handle(s): Wrist blade 4 inches
9. Spout: Rigid
10. Spout Outlet: Aerator
11. Operation: Compression, manual.

2.9 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key or wheel head as shown on the drawings.

F. Risers:

1. NPS 3/8 or, NPS ½ as noted on the drawings.
2. Chrome-plated, rigid-copper-plated and brass straight or offset tailpieces; chrome-plated, soft copper flexible tube; ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser as noted on the drawings.

2.10 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2

B. Drain: Grid with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4; NPS 1-1/4
2. Material: Chrome-plated, two piece, cast brass trap and swivel elbow with .032-inch-thick brass tube to wall two piece, cast-brass trap and ground-joint swivel elbow with .032-inch-thick brass tube to wall one piece, cast-brass trap swivel .029-inch-thick tublar brass wall bend; and chrome-plated, brass or steel wall flange.

2.11 MOP BASIN (MB)

A. Mop Basin shall be precast terrazzo corner type, 24 inches by 24 inches by 12 inches, with 6 inches drop front and stainless steel cap on threshold, with 3 inch intergral drain outlet and strainer.

a. Florestone Model 86
b. Fiat
c. Creative Industries.
d. Standard Elsmere.
e. Approved Equal.

B. Mop Basin Faucet: Built-in service sink fitting with elevated vacuum breaker. Locate 7 foot 6 inches above finish floor per Chicago Code.

a. Chicago Faucet No. 911 1S
b. Fiat No. 830-AA
c. Aapproved Equal.

C. Hose and Hose Bracket: Provide a 30” long flexible heavy duty 5/8” ruber hose, cloth reinforced, with ¾” coupling at one end. Bracket shall be 18 ga, Type 302 stainless steel with rubber grip:

a. Fiat, #832-AA hose with bracket
b. Stern Williams Co., Inc., #T-40
c. Approved Equal.

D. Mop Hanger: Provide a 24” long by 3” wide, 18 ga. Type 302 stainless steel mop hanger with three rubber grip tools:

a. Fiat #899-CC
b. Florestone
c. Stern-Williams Co., Inc. #T-40
d. Approved Equal.

E. Sanitary Floor Sink and P-Trap:

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. Josam Company.
b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Zurn Plumbing Products Group; Light Commercial Operation.
d. Approved equal.

2. Basis of Design: Josam 49424 Series 16” square top cast iron 12” deep SUPER-FLO-SEPTOR Floor Sink with acid-resisting interior, double drainage flange with weepholes, bottom outlet, aluminum internal dome strainer, and cast iron, non-traffic, acid-resisting, anti-tilting SUPER-FLO Grate. Josam 88100 series coated cast iron P-trap to match drain pipe size and size and material of floor sink (4-inch).

2.12 EMERGENCY EYE WASH

A. Accessible, Freestanding, Plumbed Eyewash Units:

1. Capacity: Not less than .4 gpm for at least 15 minutes
2. Supply Piping: NPS ½ inch chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
3. Control-Valve Actuator: Paddle.
4. Spray-Head Assembly: Two receptor-mounted spray heads.
5. Receptor: Stainless-steel bowl.
6. Drain Piping: NPS 1-1/4 inch minimum, chrome plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2
7. Mounting: Offset pedestal.
8. Special Construction: Comply with ICC/ANSI A117.1.

2.13 ELECTRIC WATER COOLERS

A. Water coolers shall be wall hung type with recessed refrigeration unit. Receptor and face panel shall be Type 304 stainless steel. Coolers shall be complete with bubber valve, trim strip, galvanized steel wall mounting frame, cold water storage tank system, copper tubing, cooling tank insulation, thermostat and fan cooled refrigeration unit.

B. Chilling capacity to be 50 deg F drinking water, based upon 80 deg F inlet water and 90 deg F ambient.

C. Water cooler to have self-closing easy-touch controls on front and both right and left sides. Controls to require less than 3 pounds of force to activate.

D. D. Bubbler orfice to be protected to meet sanitary codes. Built-in flow regulator to provide constant stream water pressure.

E. Water coolers to be lead free as defined by the Safe Drinking Water Act. Water Coolers shall be designed and installed to comply with ADA.

F. Cooling System: Motor compressor to be 115V, 60 Hz single phase. Condenser to be fan cooled, copper tube with aluminum fins. Fan motor to be permanently lubricated. Refrigerant to be HFC-134a. Cooler to be UL approved.

G. Tank to be stainless steel, insulated with foam which meets UL requirements of self-extinguishing material.

H. Electric Water Cooler Manufacturers:

a. Elkay Model EZS8.
b. White-Westinghouse Model WE2CO8-OE.
c. Ebco Manufacturing Co. (Oasis) Model OMDFW8-PE.

d. Approved Equal.

J. Water cooler support:

a. Type I or Type II water cooler carrier; as recommended by manufacturer for project specific installation. Standard ASME A112.6.1M.

2.14 WATER HEATER

A. Code and Standard Compliance:

1. City of Chicago Building Code.
2. Provide safety relief valves which comply with ASME Boiler and Pressure Vessel Code, and are stamped with appropriate code symbols.
3. Provide water heaters with Performance Efficiencies not less than prescribed in ASHRAE 90A, "Energy Conservation in New Building Design".

B. Electric water heater and tank:

1. General: Provide commercial electric water heater with 6 gallon tank having 208V, 1 phase, 3 kw input and a recovery rate of 12 GPH at 100° F temperature rise.
2. Heater: Construct for working pressure of 150 psi, magnesium anode rod, ¾″ tapping for relief valve, glass lining on internal surfaces exposed to water.
3. Water heater shall be pre-wired and factory tested and be UL listed.
4. Unit shall be equipped with immersion screw-in elements, surface mounted thermostat and automatic over temperature limit control.
5. Jacket: Insulate tank with vermin-proof glass fiber insulation, designed to meet the requirements of ASHRAE Standard 90.
6. Accessories: Provide ¾″ pressure and temperature relief valve.
7. Controls: Thermostat and temperature limit control. Agent on-duty/off-duty switch shall turn off water heaters when station is unoccupied by ticket agents.
8. Manufacturers:

a. Rheem Manufacturing Company - Model EGSP-6
b. Ebco Manufacturing Co.
c. Elkay Manufacturing Co.
d. Smith Corp. (A.O.); Consumer Products Div.
e. State Industries, Inc.
f. White-Westinghouse.
g. Approved Equal.

C. Water Heater Accessories:

1. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating.
2. Water Heater Mounting Brackets: Water heater manufacturer’s factory-fabricated steel bracket for wall mounting and capable of supporting water heater at full capacity.

D. Tankless Electric Water Heater:

1. General: Provide commercial grade instantaneous electric water heater; 240V, 12.5 amps 1 phase, 3 kw input and a recovery rate of 12 GPH at 100° F temperature rise.

2. Heater Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
3. Connections shall be pipe threaded according to ASME B1.20.1.
4. Pressure Rating to be 150 psig.
5. Water heater shall be pre-wired and factory tested and be UL listed.
6. Unit shall be equipped with immersion screw-in elements for resistance heating system, surface mounted thermostat and automatic over temperature limit control or shutoff.
7. Jacket: Aluminum or steel with enameled finish.
8. Controls: Thermostat and temperature limit control.
9. Tankless Electric Water Heater Manufacturers:

    a.. Chronomite Laboratories, Inc.
    b. IMI Waterheating, Ltd.
    c. Keltech, Inc.
    d. Niagara Industries, Inc.
    e. Approved Equal.

2.15 WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig maximum outlet pressure unless otherwise indicated.

C. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

D. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

E. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

F. Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

G. Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.16 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all piping, fittings, equipment, fixtures, and accessories, as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for water, drainage, waste and vent systems.

B. All piping shall be arranged and aligned in accordance with reviewed Shop Drawings. Install all piping straight and direct as possible, neatly spaced with risers and drops running plumb and true.

C. Installation of piping shall be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture, water cooler and water heater installation.

C. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.3 PLUMBING FIXTURE INSTALLATION

A. Verify all dimensions by field measurements. Verify that all plumbing fixtures may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine all rough-in for water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections prior to installing fixtures.

C. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

D. Do not proceed until satisfactory conditions have been corrected.

E. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and referenced standards.

F. Comply with the installation requirements of ANSI A117.1 with respect to plumbing fixtures heights and installation height of water cooler for the physically handicapped.

G. Fasten plumbing fixtures securely to supports of building structure. Secure supplies behind wall construction to provide rigid installation.

H. Set mop receptors in a leveling bed of cement grout.

I. Install a stop valve in an accessible location in the water connection to each fixture.

J. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons if required to conceal protruding fittings. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 “Plumbing Piping Insulation.”

K. Protect finishes of china and porcelain fixtures from scratches, chips, stains or other damage. Protect metal finishes of water coolers, faucet assemblies, and other finished metal. Protect mop basins from scratches, chips, and stains.

3.4 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
4. Install toilet seats on water closets.

B. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.

C. Support Installation:

1. Install supports, affixed to building substrate, for wall mounted water closets, and urinals.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

D. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet or urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between plumbing fixtures and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to fixture color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.5 WATER COOLER INSTALLATION

A. Install water cooler level and plumb according to roughing-in drawings, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted water coolers.

C. Install mounting frames, affixed to building to construction, and attached recessed, water coolers to mounting frames.

D. Install water-supply piping with shutoff valve on supply to water cooler to be connected to water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in section 22 05 23.

E. Install trap and waste piping on drain outlet of water cooler to be connected to sanitary drainage system.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 18 “Escutcheons for Plumbing Piping.”

G. Seal joints between water cooler housing and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color fixture color. Comply with sealant requirements specified in Section 079200 “Joint Sealants.”

3.6 WATER HEATER INSTALLATION

A. General: Follow manufacturer’s recommendations for the installation, commissioning, adjusting, operation, and maintenance of electric water heaters.

B. Install water heater on wall bracket as shown on drawings or required. Set and connect units in accordance with manufacturer’s written installation instructions. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer’s recommended clearances. Orient so controls and devices needing servicing are accessible.

C. Install thermometers on water heater inlet and outlet piping.

D. Install combination temperature and pressure relief valves in water piping for water heater. Extend commercial water heater relief valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

3.7 WATER HEATER CONNECTIONS

A. Piping installation requirements are specified in other sections. The drawings indicate general arrangements of piping, fittings, and specialties. The following are specific requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance. Allow for easy removal of water heaters.
2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulation piping to unit with shutoff valve, check valve, and union.

    a. Where heater-piping connections are dissimilar metals, make connections with dielectric fittings or dielectric unions specified in the section, “Basic Piping Materials and Methods”.
    b. Provide 6 inch minimum heat trap in hot water as per City of Chicago Energy Code.

3. Install drain as indirect waste to spill into open drain or over floor drain. Install drain valve at low point in water piping for water heaters not having tank drain.

B. Connect wiring according to code and electrical requirements in electrical sections of these specifications. All equipment shall be grounded.

3.8 COMMISIONING OF WATER HEATERS

A. Perform the following before start-up final checks:

1. Operational Test: After electrical circuitry has been energized and water has been turned on, confirm proper operation.
2. Check for piping connections leaks.
3. Test operation of safety controls and devices.

B. Perform the following start-up procedures:
1. Adjust operating controls.
2. Adjust hot water outlet temperature setting.

C. Replace water heaters or components of water heaters that do not function properly or are defective.

3.9 CONNECTIONS

A. Connect fixtures and equipment with water supplies and soil, waste, and vent piping. Use size fittings required to match the fixture or equipment.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to fixtures and equipment, allow space for service and maintenance.

E. Install gate shutoff valve on water supply to each fixture, water cooler, and water heater. Comply with valve requirements specified in 2.4 above and specification Section 22 05 23 for valves.

3.10 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, faucets, valves, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Adjust water pressure at fixtures to provide proper flow and stream.

3.11 ADJUSTING WATER COOLERS

A. Adjust water cooler flow regulators for proper flow and stream height.

B. Adjust water-cooler temperature settings.

3.12 FIELD QUALITY CONTROL

A. Test fixture, faucet, flush valve installations as follows:

1. Test for leaks and defects all fixture, faucet, valve and equipment, installations. Test for leaks at supplies and drains.
2. Repair all leaks and defects using new materials and retest until satisfactory results are obtained.
3. Test all faucets for proper operation. Adjust as required.

B. Perform tests and inspections for hot water heater:

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.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and for requirements for correcting the Work
6. Prepare test and inspection reports.

3.13 CLEANING AND PROTECTION

A. After installing fixtures and equipment, inspect unit. Remove paint splatters and other spots, dirt, and debris. Inspect and Repair damaged finish to match original finish.

B. Clean fixtures, equipment, faucets, valves, trim, strainers and fittings with manufacturers' recommended cleaning methods and materials. Protect metal and other furnishes against damage from strong cleaning salutions.

C. Install protective covering for installed fixtures, equipment and fittings.

D. Do not allow use of fixtures and equipment for temporary facilities unless approved in writing by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of PLUMBING FIXTURES shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of PLUMBING FIXTURES shall be included in the contract lump sum price as shown in the Schedule of Prices for PLUMBING WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Plumbing work: 220000.

END OF SECTION

SECTION 23 00 00

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, material, equipment, and services necessary to furnish Heating, Ventilating and Air Conditioning Systems at the location(s) shown on the Drawings and/or as specified herein.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.03 RELATED WORK

A. Mechanical Insulation, Section 23 07 00.

1.04 QUALITY ASSURANCE

A. Reference Standards:

1. The American Society of Heating, Refrigeration Air Conditioning Engineers Guides (ASHRAE).
2. Sheet Metal and Air Conditioning Contractors' National Association, Inc. SMACNA "HVAC Duct Construction Standards, Metal and Flexible",and SMACNA, "Manual for the Balancing and Adjusting of Air Distribution Systems".
3. The Underwriters' Laboratories (UL) listings or approvals shall govern quality and performance of the electrical products specified herein.
4. American National Standards Institute (ANSI) B31.5 Refrigeration Piping.
5. Chicago Electrical Code, latest edition.
6. American Society for Testing and Materials:

    a. ASTM A36, Structural Steel.
    b. ASTM A527, Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-forming Quality.
    c. ASTM B209 Aluminum-Alloy Sheet and Plate.
    d. ASTM B32, Soldered Joints

7. Federal Specifications:

    a. FF-B-588C, Bolts, Toggle, and Expansion Sleeve (Screw).
    b. FF-S-107C(2), Screws, Tapping and Drive.
    c. FF-S-325, Shield, Expansion; Nail, Expansion and Nail Drive Screw (Devices, Anchoring, Masonry).

8. National Fire Protection Association:

    a. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    b. NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
    c. NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.

9. American Society of Mechanical Engineers (ASME).

10. National Electric Manufacturer's Association (NEMA).
11. AMCA Compliance, Test and rate air handling units in accordance with AMCA standards.
12. ARI Compliance, Test and rate air handling units in accordance with ARI 430 "Standard for Central-Station Air handling Units", display certification symbol on units of certified models.
13. ASHRAE Compliance, Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
14. UL and NEMA Compliance, Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA Standards.
15. NEC Compliance, Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.
16. City of Chicago Building Code.
17. American Welding Society (AWS).

1.05 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of Section 00830-Special Conditions, and as required below:

1. Shop Drawings/Product Data:

a. Ductwork Layout & Details.
b. Ductwork Accessories.
c. Grilles, Registers, Diffusers, Gravity & Counter Balanced Dampers and Louvers.
d. Fans.
e. Duct-Free Split Fan Coil and Air Cooled Condensing Units.
f. Forced Air Wall Heaters
g. Air Filters
h. Infrared Heaters.
i. Automatic Damper electric operators.
j. Refrigerant and Condensate Piping.
k. Piping and Duct Insulations.
l. Controls.
m. Thermostats.

2. The Contractor shall furnish operating instructions and maintenance recommendations/requirements in accordance with the requirements of Section 00830-Special Conditions, and as required below:

a. Operation Instructions.
b. Manufacturer's Catalog Sheets.
c. System Line Diagrams.
d. Panel Layout Drawings.

3. Certificates:

a. Brazing Certification: Certify brazing procedures, brazers and operators in accordance with ASME standards (ANSI B31.5).
b. Welding Certification: Certify welding procedures, welders, and operators are in accordance with ASME and AWS Standards.
c. Americo.

1.06 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the Heating, Ventilating and Air Conditioning Systems in conformance with the requirements of the accepted project schedule.

PART 2 PRODUCTS

2.01 SHEET METAL STANDARDS

A. Iron and Steel Sheets (Galvanized): Lock forming quality (LFQ) with 1-1/4 oz. (36 g) galvanizing total on both sides per sq. ft. (0.09 sq.m) of sheet.

2.02 DUCTWORK MATERIALS

A. General: The thickness of the sheet metal and size and spacing of the stiffeners used shall be in accordance with the requirements of the latest edition of the SMACNA, "HVAC Duct Construction Standards, Metal and Flexible". "Low Velocity Duct Construction Standards."

1. Low Pressure (Up to 2" S.P. (0.5 kPa) Ductwork: Construct in accordance with the requirements of the SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

B. Material: Galvanized sheet steel unless otherwise specified.

C. Duct Sealant: All joints and seams in supply ductwork shall be sealed with fire resistive duct sealer. Sealer shall be buttered on seams and joints during fabrication and erection.

D. Acceptable Manufacturers:

1. Minnesota Mining and Manufacturing Co., Duct Sealer EC800.
2. Benjamin Foster, 30-02 Fire Resistive Duct Sealer.
3. United Sheet Metal, United Duct Sealer.

E. Connections and Details: Connections to diffusers, grille and register faces shall be absolutely airtight. All slip joints shall be made in the direction of flow, and unless otherwise indicated on the drawings, all radius elbows shall have a centerline radius equal to 1-1/2 times the width of the duct.

F. Rectangular Ductwork: Groove and Pittsburgh lock seams and slip joints shall be used for all rectangular ducts unless otherwise specified.

2.03 FLEXIBLE CONNECTIONS

A. General: Flexible fabric connections to prevent the transmission of vibration through the ducts shall be UL classified and shall be installed on both the supply and return sides of all fans and ventilating units and at building expansion joints, and approximately where shown on the drawings. Fabric used for flexible connections shall be of proper weight and strength for the service required, and shall be properly fitted to render it airtight. Fabric shall be of sufficient width to provide a minimum space of 4" (10 cm) between connected items, and with sufficient slack to prevent tearing due to fan movement.

B. Fabric - General Usage: 30-oz. (0.8 kg) fiber glass fabric, fire retardant and airtight, coated with neoprene on both sides, and with firmly attached extra wide galvanized metal edges.

C. Acceptable Manufacturers:

1. Ventfabric Inc., Ventglas.
2. Elgen, Neoprene Fabriduct.

2.04 GRILLES, REGISTERS, DIFFUSERS, GRAVITY DAMPERS, COUNTER BALANCED DAMPERS AND LOUVERS

A. General: Grilles, registers and diffusers shall be of the sizes indicated, with white finish coat unless otherwise specified, and shall be supplied with gaskets to prevent air leakage around side of units. Screw holes in frames shall be countersunk for flat head screws.

B. Exhaust Registers: Single deflection type with 3/4" blade spacing; horizontal 35^{o} degree face bars and opposed blade dampers.

C. Supply Registers: Fully adjustable discharge pattern, 4-way pattern with opposed blade dampers.

D. Acceptable Manufacturers (See Appendix A):

1. Titus
2. Metal Aire
3. Carnes
4. Krueger

E. Dampers shall be heavy duty Ruskin (See Appendix A), Air Warming or Penn backdraft dampers or approved equal with counterbalancing as required. Frame shall be of .081" thick extruded aluminum and damper blades shall be .070" minimum thickness extruded aluminum.

F. Louvers shall be sized per drawings to fit in wall opening and be 4" and 6" deep as shown on the drawings, stainless steel with insect screen. Provide a stormproof design. Acceptable manufacturers include Penn, Airstream, Ruskin (See Appendix A), Vent Products or approved equal.

2.05 FANS, GENERAL

A. Factory-built Units: Fans in Factory-Built Units shall be unit manufacturer's standard type, unless otherwise specifically indicated.

B. Identification: All fans shall bear metal identification plates indicating area served, CFM (cubic meters/second), H.P. (watts), RPM, SP (pascals), and size. Fan capacities shall be based on operating at the static pressures indicated at 70 degree F (21 degree C) and 29.92" (101 kPa) of mercury, barometric pressure. Fans shall bear the AMCA label.

2.06 EXHAUST FANS

A. Furnish and install where noted on the drawings propeller or in line blower type exhausters. Ventilator housings shall be of heavy gauge aluminum construction and shall be weatherproof, incorporating an integral weather shield. Ventilators shall be mounted on the roof curbs or in wall as shown on the drawings.

1. Fan wheels shall be propeller or centrifugal design that have been statically and dynamically balanced. Tip speed, rpm, and motor horsepower shall not exceed listing in manufacturer's catalog for unit specified.
2. Fans shall have integral factory-formed base fabricated to the dimensions shown on the drawings. Housings shall be provided with wiring channel and are to be of the direct discharge design. Motor and fan assembly shall be on vibration isolating mounts. Fans shall have sizes as scheduled. Provide a speed controller located in the motor housing as scheduled on drawings. Sone level shall be

limited to 18.0.

3. Fans shall be provided with integral unit mounted disconnect switches.

B. Belts: The fans, where specified, shall be connected to the driving motor by means of a V-belt drive, with a minimum of 2 strands, unless otherwise designated. 2-strand V-belt drives shall be designed for 100% overload capacity, multiple strand V-belt drives shall be designed for 50% overload capacity, and the motors for such drives shall be equipped with adjustable bases or slide rails. Multiple belts shall be matched. When replacement of one or more belts of a set is necessary, entire set shall be replaced with new matched belts. Multiple belts shall be so designed as to minimize whip, turn over and throw off.

C. Sheaves: It shall be the responsibility of the Contractor to see that all design static pressures are met. Provide adjustable sheaves for design static pressure. Provide adjustable sheaves for one or two-strand belt drives. Sheaves shall be selected to operate at the mid-point of the fan curve so as to allow adjustment in both directions. For multiple-strand drives, provide fixed sheaves. Replace fan sheaves as necessary to obtain desired results. All fan sheaves and motor sheaves shall be dynamically and statically balanced before assembly.

D. Wheels and Bearings: Wheels shall be heavily and rigidly constructed and accurately balanced both statically and dynamically, and be free from objectionable vibration or noises. Bearings shall be medium-duty, self-aligning, ball or roller bearing, sealed, pillow block type, and shall be complete with lubrication fittings, extended for easy access where necessary.

E. Acceptable Manufacturers (See Appendix A):

1. Loren Cook.
2. Greenheck.
3. Penn.
4. Or approved equal.

F. Shafts: Fabricate of steel, with first critical speed of wheel and shaft of not less than 1.25 times the maximum speed specified. All shafting be turned, ground and polished to close tolerances.

G. Fan Curves: Furnish performance curve data sheet with shop drawings of fans submitted for review. All fan performance ratings and data shall be AMCA certified ratings in accordance with Standard AMCA test code method and procedure.

2.07 IN-LINE EXHAUST FANS

A. General: Shall be complete with 120 volt, 60 hertz, direct drive single phase motor. Fans shall have true centrifugal wheel and backdraft damper. Housing shall be acoustically insulated galvanized steel. Sone level shall be limited to 18.0. Motor shall be matched to blower wheel assemblies. Fan motors shall be suitably grounded and mounted on vibration isolators.

B. Furnish and install where shown on drawings. Fans shall have sizes as scheduled.

C. Acceptable Manufacturers (See Appendix A):

1. Loren Cook
2. Penn
3. Greenheck
4. Or approved equal

2.08 VIBRATION ISOLATION MOUNTS

A. General: Support in-line cabinet fans with double deflection neoprene mount type vibration isolators. Isolators shall have plated screws and washers and shall be of size required for the application, with .35 deflection.

B. Acceptable Manufacturers:

1. Mason Type NDA Black.
2. Vibration Mountings and Controls, Inc.
3. Or approved equal.

2.09 FAN COIL

A. General: Indoor, direct-expansion, wall or ceiling-mounted as shown on the drawings, fan coil. Unit shall be complete with coil, fan, motor, piping connectors, electrical controls, microprocessor control system, integral temperature sensing, and a holding charge of R-22 refrigerant. Unit shall be furnished with integral mounting bracket.

B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene or galvanized steel.

C. Fan: Fan shall be blower type with air intake and discharge at the bottom front. Automatic motor-driven horizontal air sweep shall be provided standard.

D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate.

E. Motors: Motors shall be permanently lubricated with inherent overload protection. Fan motors shall be multi-speed and totally enclosed.

F. Controls: Controls integral with the unit shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The unit shall have:

1. An automatic restart after power failure at the same operating conditions as at failure.
2. A timer function to provide a minimum 15-hour timer cycle for system on or off.
3. Temperature-sensing controls and a high discharge temperature shut down.
4. Wired control to enter set points and operating controls (required accessory).
5. Filter status indication after 250 hours of indoor fan operation.
6. Test mode button to run self-diagnostics and aid in troubleshooting.

G. Filters: Unit shall have filter track with factory-supplied cleanable filter.

H. Wired Remote Controller: Provides 2-way communication capability of system inputs and outputs. The liquid crystal display (LCD) provides continuous status of the system operating conditions. The kit comes with 15 ft. of interconnecting cable which may be extended up to 100 ft. and shall be located inside of the conditioned space.

I. Acceptable Manufacturers (See Appendix A):

1. Carrier
2. Friedrich
3. First Co.
4. Or approved equal

2.10 AIR COOLED CONDENSING UNITS (OUTDOOR):

A. General: Factory assembled, single piece, air-cooled condensing unit (outdoor). Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, charge of R-22 refrigerant, capillary tube metering device, and special features required prior to field start-up.

B. Unit Cabinet:

1. Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a CTA blue baked enamel finish.
2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.

C. Fans:

1. Condenser fans shall be direct-drive propeller type, discharging air horizontally, drawing air through the condenser coil.
2. Condenser fan motors shall be totally enclosed, single phase motors with permanently lubricated ball bearings. Motor shall be protected by internal thermal overload protection.
3. Shaft shall have inherent corrosion resistance.
4. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
5. Condenser fan openings shall be equipped with grille cover and screen protection grille.

D. Compressor:

1. Compressor shall be hermetic rotary type.
2. Compressor shall be equipped with oil system, operating oil change, suction line accumulator, muffler, eccentric shaft, and motor.
3. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
4. Casing shall include discharge valves, discharge muffler, pump bearing, piston, and vanes.
5. Compressor assembly shall be installed on rubber vibration isolators.

E. Condenser Coil: Coil shall be constructed of aluminum fins mechanically bonded to smooth, seamless copper tubes which are cleaned, dehydrated, and sealed.

F. Refrigeration Components: Refrigerant circuit components shall include liquid line service valve, suction line service valve with service gage connection port, discharge line service port, accumulator, cooling capillary tubes, pressure relief, and an operating charge of refrigerant.

G. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled and tested. The minimum control function shall include:

1. Controls:

a. Time delay restart to prevent compressor short cycling.
b. Automatic restart on power failure.

2. Safeties:

a. High temperature protection.
b. Freeze-up protection.
c. System diagnostics.
d. Compressor motor current and temperature overload protection.
e. High pressure relief.
f. Condenser fan failure protection.

H. Acceptable Manufacturers (See Appendix A):

1. Carrier
2. Friedrich
3. Or Approved Equal

2.11 FAN-FORCED WALL HEATERS

A. Enclosures shall be constructed from minimum 16 guage steel, commercial quality, suitable to withstand heavy duty use.

B. Enclosures shall be chemically treated to resist corrosion then finished in baked enamel and satin finished aluminum frame. Color shall be submitted for approval.

C. Back panel shall be painted, completely finished and suitable for installation on concrete block construction with applied finish scheduled on the Drawings.

D. Motor and blower fans are direct drive connection and mounted as a single assembly on rigid heavy gauge frame for long, vibration free life.

E. Steel finned metal sheath heating element shall be center anchored, and ensure noiseless expansion and contraction.

F. Units shall have overheat protection over the entire length of the element through a capillary type cut out. Overheat protection shall restore operation automatically when cause of overheat is removed from the element.

1. As scheduled or specified in the contract documents, furnish units with integral, adjustable thermostats.

G. Acceptable Manufacturers (See Appendix A):

1. Q-Mark
2. Markel
3. Trane
4. Or approved equal

2.12 REPLACEABLE (THROWAWAY) PANEL FILTERS

A. Description: Factory-fabricated, viscous-coated, flat-panel type, replaceable air filters with holding frames in sizes and having performance characteristics as required.

B. Media: Throwaway media of interlaced glass fibers, sprayed with nonflammable adhesive.

C. Frame: Cardboard frame with perforated metal retainer.

D. Duct Holding Frames: 16-gage (0.9mm) galvanized steel capable of holding media and media frame in place, with gaskets to prevent unfiltered air bypass.

E. Acceptable Manufacturer:

1. American Air Filter Co.
2. Farr Co.
3. Continental Air Filters.
4. Cambridge Filter Corp.

2.13 REFRIGERATION PIPING MATERIALS AND PRODUCTS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as required. Provide materials and products complying with ANSI B31.5 Code for Refrigeration Piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems.

2.14 BASIC PIPES AND PIPE FITTINGS

A. General: Provide pipe, tube, and fittings complying with Section-15050 Basic Mechanical Materials And Methods, in accordance with the following listing:

1. Tube Size 3/4" and Smaller: Copper Tube: Type ACR, soft annealed temper fittings; cast copper-alloy fittings for flared copper tubes; flared joints.

2. Soldered Joints: Solder joints using silver-lead solder, ASTM B 32, Grade 96 TS.

2.15 CONTROL DEVICES

A. Control devices are specified in Specification Section 15900, Controls.

2.16 AUTOMATIC DAMPERS

A. General: Automatic motorized dampers shall have frames of minimum 13 gauge (2.3mm) galvanized steel not less than 2" (50 mm) in width and aerodynamically formed blades of 16 gauge (1.5 mm) galvanized steel. Dampers shall be adequately braced to form a rigid assembly. No dampers shall have blades more than 4" (10 cm) wide. Length of blades shall be not more than 48" (122 cm). Blades shall be secured to ½" (13 mm) diameter zinc plated axles by zinc plated bolts and nuts. All blade bearings shall be nylon or bronze. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade linkage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

B. Size and Selection: Dampers shall be suitable for operation within a temperature limit range of -40 to 200 degrees F. (-39.8 to 93 degrees C.) The control manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

1. Dampers shall be of the parallel design with replaceable butyl, spring stainless steel or closed cell neoprene edging.
2. Dampers located adjacent to intake louvers shall be furnished in sizes as indicated.

C. Acceptable Manufacturers:

1. Ruskin
2. Vent Products
3. Or approved equal

2.17 ELECTRIC OPERATORS

A. General: Actuators for dampers shall be two-position line voltage (120 Volt AC) with manually adjustable minimum position and with lock, reversing type as required by the application. Where specified or required by the application, actuators shall have a spring mechanism to return the damper to a predetermined position in the event of a power interruption. Actuators shall have position indicators to show the position of the actuator over the full stroke.

B. Damper Operation Locations: Damper motors shall be installed and attached to the frame of the damper, and connected to an extended shaft, as required, in order to meet the

specific conditions of the job.

C. Acceptable Manufacturers:

1. Honeywell
2. Ruskin
3. Barber-Coleman
4. Siebe
5. Siemens
6. Or approved equal

2.18 MISCELLANEOUS EQUIPMENT

A. Provide necessary two-position, capacity and electric sequencing relays and miscellaneous items required for the successful operation and sequencing of the systems herein specified. Relays and switches shall be UL listed, and of voltage and current characteristics to meet application.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which units shall be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 EQUIPMENT INSTALLATION

A. The following mechanical equipment shall be installed, wired with controls and placed in operating condition.

1. Fans as listed in Exhaust Fan Schedule.
2. Automatic Dampers.
3. Ductless Split Fan Coil and Outdoor Condenser.
4. Power Roof Ventilators.
5. Forced-Fan Wall Heaters.
6. Air Filters
7. Infrared Heaters
8. Ductwork
9. Grilles, Registers, Diffusers, Gravity and Counter Balanced Dampers and Louvers.

B. Electric wall mounted disconnect switch shall be furnished, installed and wired under Division 16.

C. All necessary starters for exhaust fan motors as shown on electric schematic diagrams shall be furnished, installed and wired under Division 16.

3.03 INSTALLATION OF REFRIGERANT PIPING

A. General: Install refrigerant piping in compliance with equipment manufacturer's recommendations.

B. Install refrigerant piping with 1/4" per foot (1%) downward slope in direction of oil return to compressor. Provide oil traps and double risers where indicated, and where required to provide oil return.

C. Clean refrigerant piping by swabbing with dry lintless (linen) cloth, followed by refrigerant oil soaked swab. Remove excess oil by swabbing with cloth soaked in high flash point

petroleum solvent, squeezed dry.

D. Bleed dry nitrogen through refrigerant piping during brazing operations.

3.04 INSTALLATION OF REFRIGERATION PIPING SPECIALTIES

A. Install piping specialties in accordance with requirements of Section-15050 Basic Mechanical Materials And Methods.

3.05 INSTALLATION OF REFRIGERATION PIPING SUPPORTS AND ANCHORS

A. Install supports and anchors in accordance with requirements of Section-15050 Basic Mechanical Materials And Methods.

3.06 INSTALLATION OF SPECIAL REFRIGERANT VALVES

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions. Remove accessible internal parts before soldering or brazing, replace after joints are completed.

B. Repair or replace refrigerant piping as required to eliminate leaks, and retest as specified to demonstrate compliance.

3.07 DEHYDRATION AND CHARGING REFRIGERATION SYSTEM

A. Evacuate refrigerant system with vacuum pump, until temperature of 35 degrees F (2 degrees C) is indicated on vacuum dehydration indicator.

B. During evacuation, apply heat to pockets, elbows, and low spots in piping.

C. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

D. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.

E. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

3.08 INSTALLATION OF FAN FORCED WALL HEATER.

A. Install heaters as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices, to ensure that heating terminal equipment fulfills requirements. Comply with applicable installation requirements of NEC and NECA's "Standard of Installation".

B. Coordinate with electrical work, including wiring/cabling work, as necessary to interface installation of heating terminals with other work.

C. Clean dust and debris from heater as it is installed to ensure cleanliness.

D. Comb out damaged fins where bent or crushed before covering elements with enclosures.

E. Touch-up scratched or marred heater enclosure surfaces to match original finishes.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.

G. Grounding:

1. Provide equipment grounding connections as indicated. Tighten connections to comply with tightening torque values specified in UL Std. 486A to assure permanent and effective grounds.

3.09 INSTALLATION OF AIR FILTERS

A. Install filter frames level and plumb, following manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.

B. Install air filters and holding devices of types indicated and where shown following air filter manufacturer's written instructions and with recognized industry practices to ensure that filters comply with requirements and serve intended purposes.

C. Locate each filter unit accurately in position indicated in relation to other work. Position unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

D. Install filters in position to prevent passage of unfiltered air.

3.10 CONNECTIONS

A. Coordinate filter installations with fans, dampers, duct and air conditioning unit installations.

3.11 CLEANING

A. After testing, adjusting, and balancing air conditioning and air-distribution systems, clean outside air intake and clean filter housings and install new filter media.

3.12 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to the Authority.

3.13 INSTALLATION OF TEMPERATURE CONTROL

A. Requirements for installation of Temperature Control devices is specified in Specification Section 15900-Temperature Controls.

3.14 ADJUSTMENT AND CLEANING

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filter units for terminals requiring same.

3.15 TESTING

A. Upon completion of installation of heating terminals and after building circuitry has been energized, test heating terminals to demonstrate operability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of HEATING, VENTILATING AND AIR CONDITIONING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of HEATING, VENTILATING AND AIR CONDITIONING shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.02 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 00 10

VENTILATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, material, equipment and services necessary to furnish ventilating systems including exhaust fans and ductwork at the locations shown on the Drawings and/or as specified herein.

1.02 RELATED DOCUMENTS

A. Drawings and Division 01 Specification Sections, apply to this Section.

1.03 RELATED WORK

A. Division 26 Sections, Electrical.

1.04 QUALITY ASSURANCE

A. Reference Standards:

1. Sheet Metal and Air Conditioning Contractors' National Association, Inc. SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. The Underwriters' Laboratories (UL) listings or approvals shall govern quality and performance of the electrical products specified herein.
3. Chicago Electrical Code, latest edition.
4. American Society for Testing and Materials:

    a. ASTM A527, Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-forming Quality.
    b. ASTM B32, Soldered Joints

5. National Fire Protection Association:

    a. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
    b. NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.

6. American Society of Mechanical Engineers (ASME).
7. National Electric Manufacturer's Association (NEMA).
8. AMCA Publications 211 and 311.
9. AMCA Certified Ratings Program for sound and air performance.
10. AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

1.05 SUBMITTALS

A. The Contractor shall furnish shop drawings, product data and samples in accordance with the requirements of Division 01 Section, Submittals.

1. Product Data:

    a. Ductwork Materials.
    b. Ductwork Accessories.
    c. Grilles, Registers, Diffusers, Louvers.

d. Exhaust Fans.
e. Controls.

2. Specifications, wiring diagram, ratings and installation instructions for exhaust fans.

3. Shop Drawings:

a. Ductwork layout and details.

4. The Contractor shall furnish operating instructions and maintenance recommendations/requirements in accordance with the requirements of Division 01 Section, Project Closeout, for exhaust fans and controls.

1.06 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the ductwork and exhaust fans in conformance with the requirements of the accepted project schedule.

1.07 WARRANTY

A. All materials, installation, equipment, connections and controls shall be warrantied for a period of one year after date of final acceptance. Make any required repairs or replacements during that time period to the satisfaction of the Authority and at no cost to the Authority.

PART 2 PRODUCTS

2.01 SHEET METAL STANDARDS

A. Iron and Steel Sheets (Galvanized): Lock forming quality (LFQ) with 1-1/4 oz. (36 g) galvanizing total on both sides per sq. ft. (0.09 sq.m) of sheet.

2.02 DUCTWORK MATERIALS

A. General: The thickness of the sheet metal and size and spacing of the stiffeners used shall be in accordance with the requirements of the latest edition of the SMACNA, "HVAC Duct Construction Standards, Metal and Flexible". "Low Velocity Duct Construction Standards."

1. Low Pressure (Up to 2" S.P. (0.5 kPa) Ductwork: Construct in accordance with the requirements of the SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

B. Material: Galvanized sheet steel unless otherwise specified.

C. Duct Sealant: All joints and seams in supply ductwork shall be sealed with fire resistive duct sealer. Sealer shall be buttered on seams and joints during fabrication and erection.

D. Acceptable Manufacturers:

1. Minnesota Mining and Manufacturing Co., Duct Sealer EC800.
2. Benjamin Foster, 30-02 Fire Resistive Duct Sealer.
3. United Sheet Metal, United Duct Sealer.

E. Connections and Details: Connections to diffusers, grille and register faces shall be absolutely airtight. All slip joints shall be made in the direction of flow, and unless otherwise indicated on the drawings, all radius elbows shall have a centerline radius equal to 1-1/2 times the width of the duct.

F. Circular Ductwork: Groove and Pittsburgh lock seams and slip joints shall be used for all ducts unless otherwise specified.

2.04 GRILLES, REGISTERS, DIFFUSERS, AND LOUVERS

A. General: Grilles, registers, diffusers and louvers shall be of the sizes indicated, stainless steel unless otherwise specified, and shall be supplied with gaskets to prevent air leakage around side of units. Screw holes in frames shall be countersunk for flat head screws.

B. Exhaust Registers: Single deflection type with 3/4" blade spacing; horizontal 35º degree face bars and opposed blade dampers.

C. Acceptable Manufacturers:

1. Titus
2. Metal Aire
3. Carnes
4. Krueger

2.05 FANS, GENERAL

A. Factory-built Units: Fans in Factory-Built Units shall be unit manufacturer's standard type, unless otherwise specifically indicated.

B. Identification: All fans shall bear metal identification plates indicating area served, CFM (cubic meters/second), H.P. (watts), RPM, SP (pascals), and size. Fan capacities shall be based on operating at the static pressures indicated at 70 degree F (21 degree C) and 29.92" (101 kPa) of mercury, barometric pressure. Fans shall bear the AMCA label.

2.06 EXHAUST FANS

A. Furnish and install where noted on the drawings, duct mounted, direct driven centrifugal square inline exhaust fan.

1. Fan shall be of bolted construction utilizing galvanized or stainless steel fasteners.
2. Housing shall be minimum 18 gauge galvanized steel with integral duct collars.
3. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing.
4. Fan shall be suitable for either vertical or horizontal installation.
5. Unit shall bear an engraved aluminum nameplate indicating design CFM and static pressure.

B. Fan wheel to be centifrugal backward inclined, aluminum, including a machined cast aluminum hub.

1. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency, balanced in accordance with AMCA Standard 204-05.

C. Motor for exhaust fan to be heavy duty type with permanently lubricated sealed bearings and furnished at the specified voltage, phase and enclosure.

D. Size and CFM’s for in line exhaust fans as shown or indicated on the drawings.

E. Control of fan shall be by on-off toggle switch. See drawings for location.

E. Exhaust fan shall be model SQN-D as manufactured by Loren Cook Co., Springfield, Mo. or other acceptable manufacturers:

1. Loren Cook.
2. Greenheck.
3. Penn.
4. Or approved equal.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which fans, grilles, registers, diffusers, louvers and ductwork shall be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 EQUIPMENT INSTALLATION

A. The following mechanical equipment shall be installed, wired with controls and placed in operating condition according to the manufacturer’s instructions:

1. Exhaust Fans.
5. Ductwork
6. Grilles, Registers, Diffusers, and Louvers.

3.03 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted.

B. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to the Authority.

3.04 ADJUSTMENT AND CLEANING

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean inside of housings.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

3.05 TESTING

A. Upon completion of installation and after building circuitry has been energized, test fans to demonstrate operability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance.

PART 4 MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of VENTILATION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of VENTILATION shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.02 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. Airex Manufacturing.
3. CALPICO, Inc.
4. GPT; an EnPro Industries company.
5. Metraflex Company (The).
6. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or Stainless steel as shown or selected by the Authority.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating or stainless steel, as shown or selected by the Authority, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6 (DN 150) Cast-iron wall sleeves..
    b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than [NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

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

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

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

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system.

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

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system.

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

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves, PVC-pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings, Molded-PE or -PP sleeves or Molded-PVC sleeves.
b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves, PVC-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves, PVC-pipe sleeves. As shown on the drawings or as selected by the Authority.
b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of SLEEVE AND SLEEVE-SEAL FOR HVAC PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SLEEVE AND SLEEVE-SEAL FOR HVAC PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.01 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION NO. 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

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

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type..
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
g. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
f. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of ESCUTCHEONS FOR HVAC PIPING PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of ESCUTCHEONS FOR HVAC PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.01 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 05 48
VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

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. Isolation pads.
2. Isolation mounts.
3. Freestanding spring isolators.
4. Elastomeric hangers.
5. Spring hangers.

1.03 DEFINITIONS

A. ICC-ES: ICC-Evaluation Service.

B. CBC: City of Chicago Building Code

1.04 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

2. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For professional engineer.

F. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following

1. Amber/Booth Company, Inc.
2. Mason Industries.
3. Vibration Eliminator Co., Inc.
4. Vibration Mountings & Controls, Inc.
5. Approved equal.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

F. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

G. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

c. Minimum Additional Travel: 50 percent of the required deflection at rated load.

d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base plates, and factory cut to sizes that match requirements of supported equipment.

a. Resilient Material: Oil- and water-resistant standard neoprene.

H. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

I. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.02 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test to 90 percent of rated proof load of device.
5. Measure isolator restraint clearance.
6. Measure isolator deflection.
7. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.04 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.01 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 07 00

MECHANICAL INSULATION

PART 1 GENERAL

1.01 SCOPE OF WORK:

A. The Contractor shall furnish all labor, material, equipment, and services necessary to furnish and install thermal duct insulation and equipment insulation at the location as directed and required by the Authority.

1.02 RELATED DOCUMENTS:

A. General provisions of Contract apply to this Section.

1.03 RELATED WORK:

A. Section 22 07 00, Pipe Insulation.

1.04 SUBMITTALS

A. The Contractor shall furnish product data, technical data, samples, installation instructions and shop drawings as required below:

1. Product Data: Provide product description, list of materials, and thicknesses for each type and application of insulation, cement, adhesive, sealant, tape, attachment device, jacket, cover and other accessory.

   a. Provide specifications and test data indicating thermal performance standards of insulating products.
   b. Provide data for each insulating product indicating thickness of material and related R value.

2. Provide product data, specifications, technical data and shop drawings for any equipment insulation indicating thickness, R values, size and profile of equipment to be insulated, location of protrusions, access requirements, method of attachment and seam closure method.
3. Samples: Submit two (2) samples of any representative size illustrating each insulation and accessory type. Provide samples of any jackets or covers in actual color and finish to be supplied.
4. Manufacturer's installation instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.
5. Manufacturer’s certificate of compliance and thermal efficiency.
6. Copy of manufacturer’s warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer of insulation shall have been producing the products successfully for a period of at least five years and be able to provide documentation that the products meet all specified requirements.

B. The material(s) required for the work will be furnished by the Contractor. All material(s) furnished by the Contractor shall be new and shall meet the standards and requirements specified by the applicable institutions and organizations (i.e. ASME, ASTM, NFPA, and EPA), and local building codes.

C. All installation of insulation shall follow the insulation manufacturer's recommended procedures and meet the standards and requirements specified by the applicable institutions, organizations, Federal, State, and Local building codes.

1.06 REFERENCE STANDARDS

A. American Society for Testing and Materials:

1. ASTM E 84, Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:

1. NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters' Laboratories:

1. UL 723 Fire and Smoke Hazard Classification.

1.07 SEQUENCING/SCHEDULING

A. The Contractor shall schedule and perform tasks required for furnishing and installing the thermal insulation and accessories in conformance with the requirements of the accepted project schedule.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver insulation products to the site in unbroken shipping cartons bearing a label indicating the contents and the appropriate ASTM, NFPA and UL flame and smoke hazard ratings as specified herein for the various insulation products.

B. Deliver and store insulation products protected from the weather. Store insulation on the site elevated off wet and otherwise contaminating surfaces.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 THERMAL INSULATING MATERIALS, GENERAL:

A. Rigid Thermal Insulation: Use rigid insulation manufactured of molded glass fiber with composite (insulation, jacket or facing, and sealing adhesive) fire and smoke hazard ratings meeting requirements of NFPA 90A Standards, tested per ASTM E 84, NFPA 255 and UL 723, not to exceed a "Flame Spread" rating of 25 and a "Smoke Developed" rating of 50 except as noted herein. Products or their shipping cartons shall bear a label indicating above requirements. Insulation shall have a maximum thermal conductivity of 0.23 BTUH per sq. ft. per degree F. per inch at 70 degrees F. mean temperature. The water vapor transmission rating shall be less than 0.2 perms per inch using a jacket of white kraft bonded to aluminum foil and reinforced with fiberglass yarn.

B. All exterior ductwork and/or equipment shall be insulated with cellular glass type insulation having integral self sealing jacket.

C. Fitting Insulation (Rigid): Insulate fittings and valve bodies with factory-premolded one-piece insulation. Insulation inserts of noncombustible glass fiber shall have a K factor of .27 at 75 degrees F. mean temperature.

2.02 DUCT AND EQUIPMENT INSULATION

A. Preformed rigid or soft insulation composed of calcium silicate, cellular glass, flexible elastomeric, mineral or glass-fiber blanket, mineral or glass-fiber board, phenolic, polyisocyanurate, polyolefin or polystyrene as submitted and approved by the Authority.

B. Acceptable Manufacturers of duct insulation (depending on material):

1. The Industrial Insulation Group.
2. Cell-U-Foam Corporation.
3. Pittsburg Corning Corporation.
4. Aeroflex USA, Inc.
5. Armacell LLC.
6. RBX Corporation.
7. CertainTeed Corporation.
8. Johns Manville.
9. Knauf Insulation.
10. Manson Insulation.
11. Owens Corning.
12. Fiberex Insulations, Inc.
13. Rock Wool Manufacturing Company.
14. Roxul Inc.
15. Thermafiber.
16. Kingspan Corporation.
17. Apache Products Company.
18. Dow Chemical Company.
19. Duna USA Inc.
20. Elliott Company.
21. Nomaco Inc.
22. Approved Equal.

2.03 INSULATING CEMENTS

A. Mineral Fiber certified to meet the requirements specified in the current edition of ASTM C 195.

- Thermal Conductivity: Average max. 1.0 BTU·in./h·ft^{2}·^{o}F at 500 ^{o}F mean temperature.
- Minimum compressive strength: 10 p.s.i. at 5 percent deformation.

B. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement certified to meet the requirements specified in the current edition of ASTM C 449.

- Apparent Thermal Conductivity: Average max. 1.2 BTU·in./h·ft^{2}· ^{o}F at 400 ^{o}F mean temperature.
- Minimum compressive strength: 100 p.s.i. at 5 percent deformation.

2.04 PREFORMED GLASS FIBER

A. Molded and jacketed inorganic glass fibers, bonded with a thermosetting resin, into products preformed via a molding process to yield rigid full-round cylindrical pipe insulation sections, certified to meet the requirements specified in the current edition of

ASTM C 547, for Type I insulation.

- Apparent Thermal Conductivity: Average max. 0.26 BTU·in./h·ft^{2}· ^{o}F at 75 ^{o}F mean temperature.
- Density: Average max. 10 lb/ft^{3}

B. Surface Burning Characteristics: All preformed glass fiber insulation shall have composite (insulation, jacket, tape seal, and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested in accordance with the current editions of ASTM E 84, NFPA 255 and UL 723, not exceeding

- Flame Spread 25
- Smoke Developed 50

C. Hot-Surface Performance: All preformed glass fiber insulation shall not flame, glow, smolder, crack, delaminate or warp after 96 hours exposure to the heated surface of a heating pipe when tested in accordance with the current edition of ASTM C 411.

D. Jacketing: The preformed glass fiber insulation shall be furnished with either a foil and paper jacket with end joint butt strips or an aluminum jacket. All jacketing shall conform to the requirements specified herein under Article 3.1.5-Jackets.

2.05 JACKETS

A. Foil and Paper Jacket- Laminated glass-fiber-reinforced, flame-retardant Kraft paper and aluminum foil having self-sealing lap conforming to the current edition of ASTM C 1136, Type I, and ASTM C 921, Type I or Type II.

- Water Vapor Permeance: 0.02 perms maximum, when tested in accordance with the current edition of ASTM E 96.
- Puncture Resistance: 50 beach units minimum, when tested in accordance with ASTM D 781-84.

B. Aluminum Jacket - Aluminum jacketing material shall be Alloy 3003, H14 temper roll stock, ready for shop or field fabrication to required sizes, in compliance with the current edition of ASTM B 209.

- Finish and Thickness: Smooth finish, 0.010 inch to 0.016 inch thick.
- Moisture Barrier: Factory applied 1-mil, heat bonded polyethylene and Kraft paper.
- Moisture Barrier: Factory applied 3-mil Dupont Surlyn, or approved equal.

C. Aluminum fitting jackets shall be factory preformed from the same material having the same finish, moisture barrier, and thickness as that specified for jackets.

D. All straight runs of pipe insulation are to be protected with Childers Corrolon or approved equal aluminum jacketing. The jacketing is to be manufactured from .016" type 3003 or 5005 aluminum. All jacketing shall have an integrally bonded polykraft moisture barrier over the entire surface in contact with the insulation. All jacketing shall be installed in accordance with manufacturer's latest published recommendations.

E. All 90 degree F and 45 degree F insulated elbows having a nominal iron pipe size of ½" to 12", inclusive, shall be protected with Childers Aluminum Ell-Jacs or approved equal manufactured from 1100 Aluminum alloy in .024" thickness. The Ell-Jacs shall be installed in accordance with manufacturer's latest published recommendations.

2.06 STANDARD PVC FITTING COVERS

A. Factory-fabricated fitting cover consisting of one-piece, pre-molded, PVC covers manufactured from 20-mil thick, high-impact, ultraviolet-resistant PVC.

- Shapes: 45- and 90-degree, short- and long-radius elbows, reducers, end caps, soil-pipe hubs, traps, mechanical joints, roof drains, and P-trap, in compliance with the current edition of ASTM C 585.

- Smooth high gloss surface that does not promote bacteria or fungi growth.

2.07 ATTACHMENTS, ADHESIVES AND SEALANT MATERIAL

A. Metal bands shall be 3/4 inch wide x 0.020 inch thick Type 304 stainless steel.

B. Wire tie material shall be one of the following: 14 gage nickel-copper alloy, 16 gage soft-annealed stainless steel, or 16 gage soft-annealed galvanized steel as indicated in the contract document.

C. Adhesives for the flexible elastomeric cellular insulation shall be solvent based, and suitable for the insulation furnished as recommended by the insulation manufacturer.

D. Adhesives for rigid preformed glass fiber insulation shall be non-flammable, solvent based and have a service temperature range of minus 20 ^{o}F to plus 180 ^{o}F.

E. Vapor Barrier Compound shall be a water-based fire-resistive composition exhibiting the following characteristics.

- Water Vapor Permeance: 0.08 perm maximum.
- Temperature Range: Minus 20 ^{o}F to plus 180 ^{o}F.

F. Weatherproof Sealant: Flexible-elastomer-based, vapor barrier sealant designed to seal metal joints.

- Water Vapor Permeance: 0.02 perm maximum.
- Temperature Range: Minus 50 ^{o}F to plus 250 ^{o}F.
  Color: Aluminum.

PART 3 EXECUTION

3.01 INSPECTION

A. Carefully inspect installed work of other Trades in connection with insulating work and verify such work shall be complete, including system or equipment testing, to such point where insulating work may begin.

B. Verify that ductwork and/or equipment has been tested and approved before applying insulation materials.

3.02 PREPARATION

A. Apply insulation on clean, dry surfaces only and without foreign materials. Perform cleaning required for removal of construction debris, spills, etc. prior to installation.

3.04 INSTALLATION

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

B. Install insulation continuous through structure penetration of surfaces being insulated. All duct insulation shall be continuous through walls, ceilings, floor openings or sleeves except where firestop or firesafing materials are required.

C. Insulation installed on ductwork or equipment operating below ambient temperatures shall have a continuous vapor barrier. Adequately seal hanger, support, and anchor penetrations of insulation. All joints, seams and fittings shall be sealed with approved materials.

D. Apply specified insulation adhesive, sealers and coatings at the manufacturer's specified minimum coverage per gallon.

3.05 PIPING INSULATION:

A. Apply insulation materials on ductwork and equipment in accordance with thicknesses recommended by manufacturer for local climatic conditions. Insulate fittings and valve bodies and in-line control devices, except gage and thermometer faces, setting or measuring scales integral with in-line devices and control handles.

B. Rigid Insulation Installation: Install on ductwork or equipment according to manufacturer's instructions, using specified adhesive to seal both longitudinal jacket laps and butt strips. Insulate in-line appurtenances with factory-premolded one-piece insulated covers as previously specified. Secure fitting cover by stapling first followed by a tape sealing using tape specified by the fitting cover manufacturer.

C. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining ductwork, and finish with glass mesh reinforced vapor barrier cement applied in two inch thick coats. Install the glass reinforcing mesh in the first coat while tacky and allow to dry before applying the second coat. Cover with aluminum jacket with seams located on bottom side of horizontal piping and facing building wall on vertical pipe. Secure cover with ½ inch wide aluminum draw brands on maximum 2 foot (610 mm) centers, or edges with aluminum sheet metal screws on maximum 4 inch (102 mm) centers. Caulk seams with flexible latex caulking.

D. For buried ducts, provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

E. Insulate ductwork and equipment less than 8 feet above finished floors in locations accessible to personnel contact so that temperatures of exposed surfaces do not exceed 180 degrees F (82 degrees C).

G. Carry vapor barriers down and seal to the cold surface at not more than 50 foot (15 meters) intervals on horizontal runs and at not more than 10 foot (3 meters) intervals on vertical runs.

H. Seal hangers on ducts carrying air of less than 70 degrees F (21 degrees C) to a point of 2 inches (51 mm) minimum above the top of the insulation where the insulation is penetrated.

I. Vapor barrier jackets may be all purpose jackets, foil-scrim-kraft jacket, minimum 3 mil plastic sheeting, or spray on plastic coatings.

J. Provide a factory or field applied fiberglass cloth jacket over all vapor barriers, except all

purpose jackets, on all piping exposed to view or specified to be painted.

K. Provide a factory or field applied fiberglass cloth jacket over all thermal insulation exposed to view or specified to be painted, except all purpose jackets. Size all insulation exposed to view in accordance with section painting.

L. Adhesives and fasteners used to secure jackets and covers on insulation shall be vermin, rodent and mildew resistant and have a smoke and flame spread rating equal to or greater than the insulation on which applied.

M. Apply insulation so that it does not interfere with the operation of control valves or servicing of equipment, valves or controls. Apply insulation so that access doors, covers, panels and access plates on equipment and piping can be removed, opened or operated without damage to the insulation. Insulation shall not cover nameplates, inspection stamps, rating plates, code stamps, and similar information attachments.

N. On high-temperature ducts, provide double layering of insulation. Stagger insulation joints when more than one layer of insulation is applied.

O. All ends of insulation materials shall be firmly butted and secured with appropriate butt strip materials.

P. When installing insulation cover seams, locate in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

3.06 CLEANUP

A. The Contractor shall ensure a general clean up is conducted at all work sites at the close of each workday. All waste material or rubbish (e.g. old insulation) must be disposed of in accordance with all applicable City and State regulations in effect for the work area, including disposal of waste in a licensed yard and/or refuse land fill.

B. Contractor shall not dispose of waste material or rubbish into the Authority's refuse containers or anywhere else on or about the Authority's property.

C. Contractor shall keep premises free from accumulation of waste material or rubbish as the work progresses. At completion of work, the Contractor shall remove all rubbish from the worksite and shall remove all tools, scaffolding and surplus materials, leaving the work area "broom clean". In case of dispute, the Authority may remove rubbish and charge such costs to the Contractor. Any damages caused by the Contractor, either directly or indirectly, shall be the sole responsibility of the Contractor.

3.07 DEFECTIVE MATERIALS OR WORKMANSHIP

A. All material and workmanship covered by this specification shall be subject to the inspection and approval of the Authority and shall be in conformance with this specification, all relevant codes and requirements and good practice. All materials used for this work shall be new, in original packaging and undamaged prior to installation.

B. Any defective material shall be immediately removed from the premises by the Contractor and replaced at no cost to the Authority. Any defective workmanship shall be promptly corrected to the satisfaction of the Authority and at no cost to the Authority.

Part 4 MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of MECHANICAL INSULATION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of MECHANICAL INSULATION shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. General requirements that apply to implementation of commissioning of HVAC systems, assemblies and components.

B. Related Sections:

   1. Division 23, HVAC Sections.

1.03 REFERENCES

A. General:

   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
   3. Refer to Division 01 Section “General Requirements” for the list of applicable regulatory requirements.
   4. Refer to Division 23 Section “Common Work Results for HVAC” for codes and standards, and other general requirements.

1.04 DESCRIPTION

A. The purpose of commission is the ensure the Authority that work has been completed as specified and that systems are functioning in the manner as described in Division 23 Section “Common Work Results for HVAC” and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a tool to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.

B. Commissioning will commence after preliminary punch list items are completed by Subcontractors.

C. The steps associated with commissioning are outlined below:

1. Step One – Installation Verification.
2. Step Two – System Start-Up.
3. Step Three – Functional Performance Testing.

D. Operational staff training is essential to the commissioning process and will run concurrently with steps one through three.

E. The Commissioning Team will include representatives of the Authority, Construction and Installing Subcontractors, Test and Balance Subcontractor and Construction Subcontractor's Commissioning Agent. Equipment manufacturer's representatives will be present for start-up as specified in the equipment specification sections and for equipment training.

1.05 SYSTEMS TO BE COMMISSIONED

A. Commissioning will be performed on the following systems:

1. Building Automation Systems.
2. Central Supply and Return Air Systems.
3. Air Terminals.
4. Chilled Water System.
5. Heating Hot Water System.
6. Compressed Air System.
7. High Sensitivity Smoke Detection (HSSD) System.
8. Air conditioning units including direct expansion systems (DX systems).

1.06 SUBMITTALS

A. Submit under provisions of Division 23 Section "Common Work Results for HVAC" and Division 01 Section "General Requirements."

B. Commissioning Plan as prepared by the prime Subcontractor or his Commissioning Agent.

C. Prime subcontractors or his Commissioning Agent shall provide Functional Performance Tests (FPT) procedures for the above listed systems. Prime subcontractors or his Commissioning Agent shall provide system narrative descriptions as part of the FPT procedures.

PART 2 – PRODUCTS

2.01 COMMISSIONING PLAN

A. The commissioning place shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

2.02 NARRATIVE DESCRIPTIONS

A. A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.03 FUNCTIONAL PERFORMANCE TESTS (FPT) PROCEDURES

A. The FPT procedures at the minimum shall consist of the following sections:

1. Narrative Description:

a. This section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.

2. Testing Prerequisites:

a. This section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT is prepared against are completed, tested and operational.

3. Installation Verification:

a. This section contains verification that the system installation is completed and is ready for commissioning.

4. Commencement of Functional Performance Testing:

a. This section records the date and time of the start of system commissioning.

5. System Condition Prior to Staring Performance Testing:

a. This section records the current set points and parameters of the system at the start of commissioning.

6. Functional Performance Test:

a. This section shall provide the following:

1) Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.
2) Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems

and interfaces between systems function in accordance with the contract documents and design intents.

3) All modes and sequences of control operations, interlocks, and conditional responses and specified responses to abnormal emergency conditions.

4) Failure Mode Analysis: Simulate failure of each component in order to test for proper system response to such failure.

7. End of Functional Performance Test:

   a. This section records the date and time of the end of system commissioning.

8. Field Notes:

   a. This section records notes or remarks during system commissioning.

9. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.
10. List problems discovered during Commissioning that were corrected.
11. List problems discovered during Commissioning that were not corrected.
12. List recommended party that should take action on these problems.

PART 3 – EXECUTION

3.01 GENERAL

A. The subcontractors shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Authority and Commissioning Agent.

B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by Subcontractors.

C. Subcontractors shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, set points, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.02 OPERATIONAL STAFF TRAINING

A. System narrative descriptions will be prepared by the Commission Agent and supported by flow diagrams, one line diagrams, and appropriate specification sections for major

systems to be commissioned. The Commission Agent will coordinate “system description” meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

B. The Subcontractor and associated manufacturer’s representatives shall provide required training to operational staff after the system description meetings have occurred. The Subcontractor training sessions shall provide a more detailed analogy of systems operation and maintenance.

3.03 INSTRUMENTATION

A. Instrumentation will be provided by the Subcontractor. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC Standards.

B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC Standards.

3.04 DOCUMENTATION

A. The installing Subcontractor shall be responsible for collection of pertinent data during system start-up and function performance testing. The Subcontractor shall submit to the Commissioning Agent documentation of tests performed prior to and after system start-up. Documentation shall also include start-up procedures as approved by Commissioning Team

B. Documentation is to be typewritten on 8-1/2 by 11 inches paper and inserted in a 2 inches to 3 inches thick three ring binder. Indicate the project name, number, volume number, and volume title on the end panel of each binder.

C. Provide a title sheet for each volume and list the following:

1. Volume Title and Section Name and Number requiring this submittal.
2. Project name, project number, and address.
3. Subcontractor name, address, and phone number.
4. Name, title, signature, and date of person making the submittal.
5. Name of Authority, a blank line for signature, and the date of person accepting the submittal.
6. Name, address, and phone number of Commission Agent; a blank line for signature; and date of person accepting the submittal.

D. Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order. Provide tabs for multiple submittals in a single binder.

3.05 STEP ONE – INSTALLATION VERIFICATION

A. General Commissioning Responsibilities:

1. Before system start-up begins, the Commission Team shall conduct a final installation verification audit. The Subcontractor shall be responsible for completion of work including change orders, and punch list items to the Authority's satisfaction. The audit shall include, but not be limited to checking of:

   a. Piping specialties including balance, control, and isolation valves.
   b. Ductwork specialty items including turning devices, balance, fire, smoke, control dampers, and access doors.
   c. Control sensor types and location.
   d. Identification of piping, valves, equipment, controls, etc.
   e. Major equipment, pumps, valves, starters, gauges, thermometers, etc.
   f. Documentation of prestart-up tests, performed, including manufacturer's factors tests.

2. If work is found to be incomplete, incorrect, or non-functional, the Subcontractor shall correct the deficiency before system start-up work proceeds.

3.06 STEP TWO – SYSTEM START-UP

A. General Commissioning Responsibilities:

1. A start-up plan shall be developed and submitted by the installing Subcontractor. Start-up plan to include the following:

   a. Flushing and cleaning of pipe.
   b. Filters, strainers, and screens.
   c. Valve/damper positions.
   d. Electrical tests.
   e. Pressure tests.
   f. Safeties.
   g. Chemical treatment.
   h. Manufacturer's tests.

2. The start-up plan will be reviewed and a prestart-up inspection performed by designated members of the Commissioning Team, The installing Subcontractor shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed. Designated members of the Commissioning Team shall witness system start-up and list system and equipment deficiencies noted during start-up. The Subcontractor shall take corrective action on system deficiencies noted and demonstrate to the Commissioning Team members suitable system operation.
3. Designated systems requiring test and balance work shall have this activity commence after systems have successfully completed start-up. System and

equipment deficiencies observed during this activity are to be noted and corrected.

3.07 STEP THREE – FUNCTIONAL PERFORMANCE TESTING

A. General Commissioning Responsibilities:

1. Functional Performance Testing begins after operation testing, adjusting, and balancing of the systems have been completed by the Subcontractors; and the System Description and Hands-on Training sessions have been completed.

2. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.

3. Attaining this object will be accomplished by developing individual systems testing protocols which, when implemented by the Subcontractor, will allow the Commissioning Team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.

4. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

Part 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of COMMISSIONING OF HVAC shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of COMMISSIONING OF HVAC shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 34 13

AXIAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Providing, installing and making operational including providing all required accessories, attachments, supports, wiring, controls and connections the following:

1. Tubeaxial fans.
2. Vaneaxial fans.
3. Mixed-flow fans.

B. Related Sections:

1. Section 03 30 00, Cast-in-Place Concrete.
2. Section 23 05 48, Vibration Controls for HVAC Piping and Equipment
3. Section 23 08 00, Commissioning of HVAC
4. Division 26 - Electrical

1.3 REFERENCES

A. General: The work to comply with or exceed the referenced standards and codes. Any work which cannot meet the referenced standards and codes is to be brought to the attention of the Authority for written approval before proceeding with the work.

B. Codes: The work to comply with the following codes:

1. City of Chicago Building Code.

C. Standards: The work to comply with the following standards:

1. American National Standard Institute (ANSI)
2. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):

a. ASHRAE 90A - Energy Efficiency and Conservation.

3. American Society of Mechanical Engineers (ASME):

a. ASME/ANSI Sec. 9 - Welding and Brazing Qualifications.

4. American Society of Testing and Materials (ASTM):

5. Electrical Components Standard: Provide components complying with NFPA 70”National Electric Code.”

    a. Listing and Labeling: Provide water heaters that are listed and labeled.

        1) The terms “listed” and “labeled” shall be as defined in the National Electric Code, Article 100.
        2) Listing and labeling agency Qualifications: A “Nationally recognized testing Laboratory” (NRTL) as defined in OSHA.

6. Underwriters Laboratories, Inc. (UL):
7. Miscellaneous Standards and Regulations:

    a. Environmental Protection Agency (EPA)
    b. Occupational Safety and Health Act (OSHA)
    c. Manufacturer's Standardization Society MSS

D. Conflicts: In all cases where conflicts exist in standards or codes, the more stringent requirement is to be followed. Where the Contract Documents are in excess of the referenced codes and standards, the Contract Documents are to be followed. All conflicts are to be brought to the attention of the Authority for written approval before proceeding with the work in question.

1.4 ACTION SUBMITTALS

A. Submit for Authority’s review product data, catalog cuts, shop drawings, construction details, material descriptions, dimensions of individual components, profiles, finishes, manufacturer’s literature indicating installation instructions and dimensions, accessories, performance information and warranties.

    1 Product data submitted to include specifications section and paragraph reference with intended use clearly indicated. A submittal must be made for review and approval for all items; even if already identified herein by manufacturer’s model number. .

B. Product Data: For each type of product.

    1. Include rated capacities, furnished specialties, and accessories for each fan.
    2. Certified fan performance curves with system operating conditions indicated.
    3. Certified fan sound-power ratings.
    4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
    5. Material thickness and finishes, including color charts.
    6. Dampers, including housings, linkages, and operators.
    7. Fan speed controllers.

C. Shop Drawings:

    1. Include plans, elevations, sections, and attachment details.
    2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    3. Include diagrams for power, signal, and control wiring.
    4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Provide certified performance curves, rated capacities, electrical requirements and wiring diagrams, standards listing , operating characteristics, furnished specialties and accessories, product certificates, testing agency certificates and labels, source quality-control reports, field quality control reports.

C. Test and Inspection Reports: Furnish within five (5) days of each test or inspection of any fixture or, equipment installation. Include all relevant information concerning the test or inspection, as provided in the format specified, including Contractor's Material and Test Certificates.

D. The Contractor to furnish operating instructions and maintenance recommendations and requirements in accordance with the requirements of Division One Section, Project Closeout.

E. Manufacturer List: Contractor to forward to the Authority for preliminary review, a complete list of manufacturers of all material and equipment proposed to be incorporated into the work. The review of the list by the Authority is to be considered tentative and is further subject to submission and final review of shop drawings, catalog cuts, etc.

F. Warranties: Submit copies of warranties for the fans, controls and other major components.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For axial fans and controls to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. General: All materials are to be clearly stamped or tagged as required by the referenced standards. Any materials or workmanship which in the opinion of the Authority does not use the referenced standards and codes shall be discarded and replaced at the Contractor's expense.

B. Authority's Review: No portion of any work to commence until review of shop drawings and other submittals for that portion of the work has been completed and returned to the Contractor marked “Approved”. All work to be in accordance with and constructed from documents bearing the Authority's stamp of review.

C. Manufacturer Qualifications: Subject to conformance with the requirements of the Contract Documents, the Contractor to furnish materials, fixtures, and equipment manufactured by a company specializing in manufacturing the products specified in this section with a minimum of five (5) years documented experience.

D. Installer Qualifications: Subject to conformance with the requirements of the Contract Documents, fans to be installed by a company specializing in performing the work of the Section with a minimum of five (5) years documented experience.

E. Regulatory Requirements: City of Chicago Code.

F. Welding: Qualifying welding procedures, welders and operators in accordance with ASME B31.9, as applicable, for shop and project site welding of pipe work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

G. Code Ratings, labels or other data which are die-stamped or otherwise affixed to the surface of the equipment shall be in visible location.

H. Electrical Components: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and UL approved.

I. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

J. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

K. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

L. UL Standards: Comply with applicable UL requirements for electrical and motor operated equipment.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store products in manufacturer's original shipping containers. Do not stack containers or store in such a manner that may cause damage.

B. Provide temporary protective covering on all equipment, fixtures, fans and controls and maintain in place during shipping, delivery, storage, installation and until substantial completion.

C. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

D. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

1.9 SCHEDULING

A. The Contractor is to schedule and perform tasks required for furnishing and installing the fixtures, fans, controls and equipment in conformance with the requirements of the accepted project schedule.

B. Coordinate the installation of sleeves for wall and floor penetrations, anchors and carriers.

C. Schedule fixture, fan, controls, wiring, connections and accessories rough-in with installation of other building components.

D. Coordinate sizes and locations of supports with actual fixtures, and other equipment provided.

E. Coordinate sizes and locations of concrete bases with actual equipment provided.

F. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. All fixtures, fans, controls, equipment, and accessories to be warrantied by the manufacturer and installer for a minimum period of one (1) year after the date of substantial completion unless a longer warranty is noted otherwise. If any item or installation is found defective, the item or installation must be repaired or replaced at no cost to the Authority and upon the discretion of the Authority.

1.11 MAINTENANCE MATERIAL

A. Provide for the Authority's attic stock the following extra or replacement items:

B. 1. Belts: Two sets for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
2. Operating Limits: Classify according to AMCA 99.

B. Unusual Service Conditions:

1. High humidity.
2. Bus and train wash locations with corrosive conditions.
3. Areas exposed to road salt.

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. Capacities and Characteristics:

1. Airflow: As shown on the drawings or as selected by the Authority.
2. External Static Pressure: As shown on the drawings or as selected by the Authority.
3. Fan Diameter: As shown on the drawings or as selected by the Authority.
4. Brake Horsepower: As shown on the drawings or as selected by the Authority.

5. Drive Type: As shown on the drawings or as selected by the Authority.
6. Fan Rpm: As shown on the drawings or as selected by the Authority.
7. Motor:

    a. Motor Enclosure: Open, drip-proof; Totally enclosed, fan cooled; Totally enclosed, air over; Open, externally ventilated; Totally enclosed, non-ventilated or Severe duty; as shown on the drawings or as selected by the Authority.
    b. Enclosure Materials: Cast iron, Cast aluminum or Rolled steel; as shown on the drawings or as selected by the Authority.
    c. Motor Bearings: As shown on the drawings or as selected by the Authority.
    d. Efficiency: Premium efficient.
    e. NEMA Design: As shown on the drawings or as selected by the Authority.
    f. Service Factor: As shown on the drawings or as selected by the Authority.
    g. Electrical Characteristics:

        1) Motor Size: As shown on the drawings or as selected by the Authority.
        2) Motor Rpm: As shown on the drawings or as selected by the Authority.
        3) Volts: 120, 208, 230, 460; As shown on the drawings or as selected by the Authority.
        4) Phase: As shown on the drawings or as selected by the Authority.
        5) Hertz: 60 or as shown on the drawings or as selected by the Authority.
        6) Full-Load Amperes: As shown on the drawings or as selected by the Authority.
        7) Minimum Circuit Ampacity: As shown on the drawings or as selected by the Authority.
        8) Maximum Overcurrent Protection: As shown on the drawings or as selected by the Authority.

E. Vibration Isolators: Spring or Restrained spring; as shown on the drawings or as selected by the Authority; isolators having a static deflection.

F. Spark-Resistance Class: A, B or C; as shown on the drawings or as selected by the Authority.

G. Project Altitude: Base fan-performance ratings on actual project site elevations.

H. Operating Limits: Classify according to AMCA 99.

2.2 TUBEAXIAL FANS

A. Description: Fan wheel and housing, factory-mounted motor with belt or direct drive, an inlet cone section, and accessories; as shown on the drawings or as selected by the Authority.

B. Housings: Steel, Galvanized steel, Aluminum or Stainless steel with flanged inlet and outlet connections; as shown on the drawings or as selected by the Authority.

C. Wheel Assemblies: Cast or extruded aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Wheel Assemblies: Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless-steel shaft.

E. Wheel Assemblies: Cast aluminum, machined and fitted to shaft.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size: 1.3, 1.4 or 1.5; as shown on the drawings or as selected by the Authority.
3. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
4. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
6. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
7. Belt Guards: Fabricate of galvanized steel for motors mounted on outside of fan cabinet.
8. Motor Mount: Adjustable base.
9. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L10 of 50,000 hours or as shown on the drawings or as selected by the Authority.
    b. Roller-Bearing Rating Life: ABMA 11, L10 of 50,000 hours or as shown on the drawings or as selected by the Authority.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan inlet and outlet (or as shown on the drawings or as selected by the Authority); allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: Horizontal ceiling or Vertical mounting clips welded to fan housing, as shown on the drawings or as selected by the Authority; of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
9. Outlet Screen: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
10. Backdraft Dampers: Butterfly style, for bolting to the discharge of fan or outlet cone, of same material as housing.
11. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to 300 degrees F.
12. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
13. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation of same material as housing.
14. Inlet Bell: Curved inlet for when fan is not attached to duct, [of same material as housing] [aluminum].
15. Inlet Cone: Round-to-round transition of same material as housing.
16. Outlet Cone: Round-to-round transition, of same material as housing.
17. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.

18. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing]. Extend lubrication lines to outside of casing and terminate with grease fittings.

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Thermoplastic vinyl, Epoxy, Zinc, Synthetic resin, Phenolic, Color-match enamel, Polytetrafluoroethylene, Vinyl ester, Hot-dip galvanized, Powder-baked enamel; as shown on the drawings or as selected by the Authority.

a. Apply to finished housings.
b. Apply to fan wheels.

I. Project Altitude: Base fan-performance ratings on actual Project site elevations.

J. AMCA Compliance: Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

2.3 VANEAXIAL FANS

A. Description: Fan wheel and housing, straightening vane section, factory-mounted motor with belt drive or direct drive, an inlet cone section, and accessories.

1. Variable-Pitch Fans: Internally mounted electric or electronic (as shown on the drawings or as selected by the Authority) actuator, externally-mounted positive positioner, and mechanical-blade-pitch indicator.

B. Housings: Steel, Galvanized steel, Aluminum or Stainless steel; as shown on the drawings or as selected by the Authority.

1. Inlet and Outlet Connections: Flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
3. Sound-Trap Housing: Housing incorporating perforated steel inner liner, 2 inch fiberglass duct liner sandwiched between the inner and outer shell, and steel bands sealing the insulated cavity.

C. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Wheel Assemblies: Fiberglass-reinforced plastic cured under pressure with airfoil-shaped blades keyed to stainless-steel shaft.

E. Wheel Assemblies: Cast-aluminum hub assembly, machined and fitted with threaded bearing wells to receive blade-bearing assemblies with replaceable, cast-aluminum blades; factory mounted and balanced.

F. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.3, 1.4 or 1.5; as shown on the drawings or as selected by the Authority.
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of galvanized steel for motors mounted on outside of fan cabinet.
7. Motor Mount: Adjustable base.
8. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours or as shown on the drawings or as selected by the Authority.
    b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours or as shown on the drawings or as selected by the Authority.
    c. Extend lubrication lines to outside of casing and terminate with grease fittings.

G. Accessories:

1. Companion Flanges: Rolled flanges of same material as housing.
2. Inspection Door: Bolted door allowing limited access to internal parts of fan, of same material as housing.
3. Propeller Access Section Door: Short duct section bolted to fan inlet and outlet; as shown on the drawings or as selected by the Authority; allowing access to internal parts of fan for inspection and cleaning, of same material as housing.
4. Swingout Construction: Assembly allowing entire fan section to swing out from duct for cleaning and servicing, of same material as housing.
5. Mounting Clips: Horizontal ceiling or Vertical mounting clips (as shown on the drawings or as selected by the Authority) welded to fan housing, of same material as housing.
6. Horizontal Support: Pair of supports bolted to fan housing, of same material as housing.
7. Vertical Support: Short duct section with welded brackets bolted to fan housing, of same material as housing.
8. Inlet Screen: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
9. Outlet Screen: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
10. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section, of same material as housing.
11. Stall Alarm Probe: Sensing probe capable of detecting fan operation in stall and signaling control devices. Control devices and sequence of operation are specified in other specification sections.
12. Flow Measurement Port: Pressure measurement taps installed in the inlet of fan to detect and signal airflow readings to temperature-control systems. Control devices and sequence of operation are specified in other specification sections.
13. Shaft Seal: Elastomeric seal and Teflon wear plate, suitable for up to 300 degrees F.
14. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
15. Inlet Vanes: Adjustable; with peripheral control linkage operated from outside of airstream, bronze sleeve bearings on each end of vane support, and provision for manual or automatic operation, of same material as housing.
16. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
17. Inlet Cone: Round-to-round transition, of same material as housing.
18. Outlet Cone: Round-to-round transition, of same material as housing.

19. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
20. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing. Extend lubrication lines to outside of casing and terminate with grease fittings.

H. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Thermoplastic vinyl, Epoxy, Zinc, Synthetic resin, Phenolic, Color-match enamel, Polytetrafluoroethylene, Vinyl ester, Hot-dip galvanized or Powder-baked enamel; as shown on the drawings or as selected by the Authority.

    a. Apply to finished housings.
    b. Apply to fan wheels.

2.4 MIXED-FLOW FANS

A. Description: Fan wheel and housing, straightening vane section (if applicable),factory-mounted motor with belt drive and accessories.

B. Housings: Steel, Galvanized steel or Aluminum; as shown on the drawings or as selected by the Authority.

1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
3. Mixed-Flow Outlet Connection: One or Two (as shown on the drawings or as selected by the Authority) flanged discharge(s) perpendicular to fan inlet.

C. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.

D. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: 1.3, 1.4 or 1.5; as shown on the drawings or as selected by the Authority.
2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
6. Belt Guards: Fabricate of galvanized steel for motors mounted on outside of fan cabinet.
7. Motor Mount: Adjustable base.
8. Shaft Bearings: Radial, self-aligning bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours or as shown on the drawings or as selected by the Authority.

b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours or as shown on the drawings or as selected by the Authority.
c. Extend lubrication lines to outside of casing and terminate with grease fittings.

E. Accessories:

1. Mounting Clips: Horizontal ceiling or Vertical mounting clips (as shown on the drawings or as selected by the Authority) welded to fan housing, of me material as housing.
2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section, of same material as housing.
4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
6. Inlet Cones: Round-to-round transition, of same material as housing.
7. Outlet Cones: Round-to-round transition, of same material as housing.
8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
9. Direct-Driven Units: Encase motor in housing outside of airstream, factory wired to disconnect switch located on outside of fan housing.

F. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Thermoplastic vinyl, Epoxy, Zinc, Synthetic resin, Phenolic, Color-match enamel, Polytetrafluoroethylene, Vinyl ester, Hot-dip galvanized or Powder-baked enamel; as shown on the drawings or as selected by the Authority.

a. Apply to finished housings.
b. Apply to fan wheels.

2.5 DUCT SILENCERS

A. Description: Tubular [with center cone] silencers consisting of a shell with fill material.

B. Housings: Steel, Galvanized steel, Aluminum or Stainless steel; as shown on the drawings or as selected by the Authority; with flanged inlet and outlet connections matching fan or cone sizes.

1. Inner Shell: Steel, Galvanized steel, Aluminum or Stainless steel.
2. Liner: Duct liner.

C. Factory Finishes:

1. Sheet Metal Parts: Prime coat before final assembly.
2. Exterior Surfaces: Baked-enamel finish coat after assembly.
3. Coatings: Thermoplastic vinyl, Epoxy, Zinc, Synthetic resin, Phenolic, Color-match enamel, Polytetrafluoroethylene, Vinyl ester, Hot-dip galvanized or Powder-baked enamel; as shown on the drawings or as selected by the Authority; applied to finished housings.

D. Capacities and Characteristics:

1. Airflow: as shown on the drawings or as selected by the Authority; cfm.
2. Static Pressure Drop: as shown on the drawings or as selected by the Authority, inches.
3. Diameter: as shown on the drawings or as selected by the Authority, inches.

4. Sound Attenuation (Insertion Loss): As shown on the drawings or as selected by the Authority.

5. Vibration Isolators: Spring or Restrained spring isolators (as shown on the drawings or as selected by the Authority) having a static deflection of 1 inch.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

C. Fans, controls, fixtures and equipment will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and re-inspecting requirements and for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide and install all fans, controls, conduit, wiring, equipment, fixtures, supports, accessories and connections as shown on the Contract Drawings, as required by the referenced standards and codes, as recommended by the manufacturer, and as specified for the HVAC systems.

B. All work to be installed in accordance with reviewed Shop Drawings. Install all fixtures and equipment straight and direct as possible, plumb and true.

C. Installation of work of this section to be coordinated with other work. The Contractor shall carefully check the architectural, mechanical, structural, electrical and civil drawings for conflicts and interferences with his/her work.

3.2 EXAMINATION

A. Verify all dimensions by field measurements. Verify all conditions in the field. Verify that all supports, conduit, electrical wiring and connections to be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Examine roughing-in of supports and conduit to verify actual locations of connections before fixture, equipment and control installation.

C. Examine building structure, substrates and supports for suitable conditions where fans and equipment will be installed.

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

3.3 INSTALLATION

A. Install axial fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install fans on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration Controls for HVAC."

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

G. Contractor to furnish the Authority with a spreadsheet of all equipment assemblies installed under this contract. The Authority has the option to then create asset tags as necessary. Contractor to assist in access to the equipment, providing clean surface areas and installing the asset tags.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of fans, supports, controls, equipment and electrical conduit, wiring and connections.

B. Ground equipment according to Section 26 19 00 "Grounding."

C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 ADJUSTING

A. Remove protective coverings or blocking before operating.

B. Inspect and adjust operation of fans and controls for proper operation. Tighten any loose connections or installations.

C. Fans should not be excessively noisy or wobbly and operate smoothly without vibration.

D. Fans and equipment that do not operate properly to be repaired or replaced at no cost to the Authority and as approved by the Authority.

E. Lubricate bearings.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency approved by the Authority 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 with the assistance of a factory-authorized service representative:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove paint splatters and other spots, dirt, and debris from fans, controls and other equipment. Inspect and repair damaged finishes to match original finish.

B. Clean fans, fixtures, equipment, controls, trim and fittings with manufacturers' recommended cleaning methods and materials. Protect metal and other furnishes against damage from strong cleaning solutions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Authority's maintenance personnel to adjust, operate, and maintain centrifugal fans.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of AXIAL HVAC FANS shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of AXIAL HVAC FANS shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 81 29

VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, concealed, ceiling-mounted units for ducting.
2. Indoor, exposed, wall-mounted units.
3. Indoor, suspended, ceiling-mounted units.
4. Outdoor, air-source, heat-pump units.
5. System controls.
6. System refrigerant and oil.
7. System condensate drain piping.
8. System refrigerant piping.
9. Metal hangers and supports.
10. Piping and tubing insulation.
11. System control cable and raceways.

1.3 DEFINITIONS

A. Retain terms that remain after this Section has been edited for a project.

B. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

C. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

D. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

E. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to manage and control refrigerant between indoor units to provide simultaneous heating and cooling zones. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, changeover box, flow selector unit, mode change unit, and other such terms.

F. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

G. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

H. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

I. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

J. VRF: Variable refrigerant flow.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.

1. Include a Sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.

D. Delegated-Design Submittals:

1. Retain any of five subparagraphs below if corresponding delegated-design requirement is included in "Delegated Design" Paragraph in "Performance Requirements" Article.
2. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.
3. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
4. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
5. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
   a. Sprinklers.
   b. Service access panels.
   c. <Insert item>.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

   a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. One set(s) for each unit with replaceable filters.
b. One set(s) for each unit type and unique size of washable filters.

2. Indoor Units: One for each unique size and type installed.
3. Controllers for Indoor Units: One for each unique controller type installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
3. Demonstrated past experience on five projects of similar complexity, scope, and value.

a. Each person assigned to Project shall have demonstrated past experience.

4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
5. Service and maintenance staff assigned to support Project during warranty period.
6. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
7. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

a. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.

b. Demonstrated past experience on five projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.

b. Faulty operation.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: 10 year(s) from date of Substantial Completion.

b. For Parts, Including Controls: 10 year(s) from date of Substantial Completion.

c. For Labor: 10 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following manufacturers are to be used for this project:

1. Daikin
2. Carrier
3. Trane

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Retain any of six subparagraphs below to suit Project.
2. Indoor and outdoor units, including accessories.
3. Controls and software.
4. HRCUs.
5. Refrigerant isolation valves.
6. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.
2. System(s) operation, heat pump as indicated on Drawings.

3. Each system with one refrigerant circuit shared by all indoor units connected to system.

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. AHRI Compliance: System and equipment performance certified according to AHRI 1230.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer or specialist to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide system refrigerant calculations.

a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.

b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.

3. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.

b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.

c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

4. System Controls:

a. Network arrangement.

b. Network interface with other building systems.

c. Product selection.

d. Sizing.

B. Service Access:

1. Provide and document service access requirements.

2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.

3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.

4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.

5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.

6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.

2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

E. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Not less than 60 percent.

2. Not more than 130 percent.

3. Range acceptable to manufacturer.

F.System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

H. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

a. Design equipment and supports to withstand wind loads of governing code
b. Design equipment and supports to withstand snow and ice loads of governing code.
c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

I. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

J. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Galvanized or painted steel.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.

4. Mounting: Manufacturer-designed provisions for field installation.

5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

3. Coil Tubes: Copper, of diameter and thickness required by performance.

4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Unit Internal Tubing: Copper tubing with brazed joints.

6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

7. Field Piping Connections: Manufacturer's standard.

8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.
b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

5. Vibration Control: Integral isolation to dampen vibration transmission.

F.Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.

G. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.

2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

H. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. "Factory-Installed Sensors" Subparagraph below indicates requirements that may not be available on some products from some manufacturers. Consult manufacturers for availability.

4. Factory-Installed Sensors:

   a. Unit inlet air temperature.
   b. Coil entering refrigerant temperature.
   c. Coil leaving refrigerant temperature.

5. Features and Functions:

   a. Self-diagnostics.
   b. Time delay.
   c. Auto-restart.
   d. External static pressure control.
   e. Auto operation mode.
   f. Manual operation mode.
   g. Filter service notification.
   h. Power consumption display.
   i. Drain assembly high water level safety shutdown and notification.
   j. Run test switch.

6. Communication: Network communication with other indoor and outdoor units.

7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.

2. Field Connection: Single point connection to power unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Mounting: Manufacturer-designed provisions for field installation.

4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

3. Coil Tubes: Copper, of diameter and thickness required by performance.

4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Unit Internal Tubing: Copper tubing with brazed joints.

6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

7. Field Piping Connections: Manufacturer's standard.

8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Gravity.

a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.
b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.

2. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Grille Assembly: Manufacturer's standard discharge grille mounted in top or front face of unit cabinet.

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

I. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Communication: Network communication with other indoor units and outdoor unit(s).

4. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

5. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.6 INDOOR, RECESSED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Mounting: Manufacturer-designed provisions for field installation.

4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

3. Coil Tubes: Copper, of diameter and thickness required by performance.

4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Internal Tubing: Copper tubing with brazed joints.

6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

7. Field Piping Connections: Manufacturer's standard.

8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.
b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.

2. Efficiency: ASHRAE 52.2, MERV 7.

3. Media:

a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
b. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control to satisfy unit control sequence of operation indicated on Drawings.

2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

H. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Communication: Network communication with other indoor units and outdoor unit(s).

4. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

5. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.7 INDOOR, SUSPENDED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Mounting: Manufacturer-designed provisions for field installation.

4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

3. Coil Tubes: Copper, of diameter and thickness required by performance.

4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Internal Tubing: Copper tubing with brazed joints.

6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

7. Field Piping Connections: Manufacturer's standard.

8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Gravity.

a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.

b. Single or multiple fans connected to a common motor shaft and driven by a single motor.

c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.

d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.

2. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in front of unit cabinet.

1. Discharge Pattern: One-way throw.

2. Retain one of two subparagraphs below to provide discharge-air grille assembly with additional features. Features indicated may not be available from all manufacturers on all products. Consult manufacturers for availability.

3. Discharge Pattern Adjustment: Field-adjustable limits for range of pattern.

4. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

H. Return-Air Grille Assembly: Manufacturer's standard.

I. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

J. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Factory-Installed Sensors: Unit inlet air temperature and Coil leaving refrigerant temperature.

4. Features and Functions: Self-diagnostics, time delay, auto-restart filter service notification, run test switch.

5. Communication: Network communication with other indoor units and outdoor unit(s).

6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

K. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.8 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.

2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.

a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.

3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.

2. Protection: Integral protection against the following:

a. High refrigerant pressure.

b. Low oil level.

c. High oil temperature.

d. Thermal and overload.

e. Voltage fluctuations.

f. Phase failure and phase reversal.

g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

4. Vibration Control: Integral isolation to dampen vibration transmission.

5. Oil management system to ensure safe and proper lubrication over entire operating range.

6. Crankcase heaters with integral control to maintain safe operating temperature.

7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

a. Casing: Aluminum, galvanized, or stainless steel.

b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.

c. Tubes: Copper, of diameter and thickness required by performance.

2. Aluminum Microchannel Coils:

a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

b. Single- or multiple-pass arrangement.

c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Coating: Corrosion resistant.

4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

a. Direct-drive arrangement.

b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.

c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.

3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.

4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.

6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Factory-Installed Sensors:

a. Refrigerant suction temperature.

b. Refrigerant discharge temperature.

c. Outdoor air temperature.

d. Refrigerant high pressure.

e. Refrigerant low pressure.

f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, power consumption display, run test switch.

5. Communication: Network communication with indoor units and other outdoor unit(s).

6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.

2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

3. Field Piping Connections: Manufacturer's standard.

4. Factory Charge: Dehydrated air or nitrogen.

5. Testing: Factory pressure tested and verified to be without leaks.

2.9 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units and outdoor units shall include integral controls and connect through a manufacturer-selected control network.

2. Network Communication Protocol: open control communication between interconnected units.

3. Retain "Integration with Building Automation System" Subparagraph below if controls for VRF HVAC system are required to communicate with other building automation system. Only ASHRAE 135 is indicated. Consult manufacturers if integration in other system protocols is required.

4. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.

c. Integration shall include control, monitoring and change of value notifications.

5. Operator Interface:

a. Operators shall interface with system and unit controls through the following:

1) Operator interfaces integral to controllers.
2) Owner-furnished PC connected to central controller(s).
3) Web interface through web browser software.
4) Integration with Building Automation System.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.

2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Retain any of 16 subparagraphs below to include features and functions for software installed on PC. Some requirements may not be available from some manufacturers. Consult manufacturers for availability. If Project has multiple controller types, each with different features and functions, revise to suit requirements for each different type and indicate application of each type on Drawings.

2. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.

3. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.

4. Plan views shall show building plans with location of indoor units and identification superimposed on plans.

5. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

6. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.

7. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

8. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

9. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

10. Displays service notifications and error codes.

11. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.

12. Monitors and displays cumulative operating time of indoor units.

13. Able to disable and enable operation of individual controllers for indoor units.

14. Information displayed on individual controllers shall also be available for display.

15. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

   a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

   b. Sets schedule for daily, weekly, and annual events.

   c. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

7. Service diagnostics tool.

8. Able to disable and enable operation of individual controllers for indoor units.

9. Information displayed on individual controllers shall also be available for display through central controller.

10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.

12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.

2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

3. Temperature Units: Fahrenheit.

4. On/Off: Turns indoor unit on or off.

5. Hold: Hold operation settings until hold is released.

6. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.

7. Temperature Display: 1-degree increments.

8. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between.

9. Relative Humidity Display: 1 percent increments.

10. Fan Speed Setting: Select between available options furnished with the unit.

11. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.

12. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

13. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

14. Occupancy detection.

15. Service Notification Display: "Filter".

16. Service Run Tests: Limit use by service personnel to troubleshoot operation.

17. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.

18. User and Service Passwords: Capable of preventing adjustments by unauthorized users.

19. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

20. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

E. Wireless Controllers for Indoor Units:

1. Wireless Communication:

a. Controller communicates to remote-mounted receiver that is wired to indoor unit(s).

1) Include receivers with wireless controllers as required to complete installation.
2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.

b. One wireless controller shall be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.

2. Controller Battery Life: Three years.

3. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

4. Temperature Units: Fahrenheit.

5. On/Off: Turns indoor unit on or off.

6. Hold: Hold operation settings until hold is released.

7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.

8. Temperature Display: 1-degree increments.

9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between.

10. Relative Humidity Display: 1 percent increments.

11. Fan Speed Setting: Select between available options furnished with the unit.

12. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.

13. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

14. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

15. Occupancy detection.

16. Service Notification Display: "Filter" .

17. Service Run Tests: Limit use by service personnel to troubleshoot operation.

18. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.

19. User and Service Passwords: Capable of preventing adjustments by unauthorized users.

20. Setting stored in non-volatile memory to ensure that settings are not lost if power is lost. Battery for date and time only.

2.10 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

2. ASHRAE 34 refrigerant classification.

3. [R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.11 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L or Type DWV according to ASTM B306.

2. Wrought-Copper Fittings: ASME B16.22.

3. Wrought-Copper Unions: ASME B16.22.

4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.

D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.

2.12 SYSTEM HYDRONIC PIPING

A. Comply with requirements in Section 232113 "Hydronic Piping" for system piping requirements.

2.13 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 232300 "Refrigerant Piping" for system piping requirements.

B. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.

2. Wrought-Copper Fittings: ASME B16.22.

3. Brazing Filler Metals: AWS A5.8/A5.8M.

C. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.

2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.

3. Standard one-piece length for connecting to indoor units.

4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.

5. Factory Charge: Dehydrated air or nitrogen.

D. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

E. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.

2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.

3. Valve Connections: Flare or sweat depending on size.

2.14 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.15 FASTENER SYSTEMS

A. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.

B. Powder-Actuated Fasteners: Threaded, zinc-coated steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: stainless steel.

2. Outdoor Applications: Stainless steel.

2.16 MISCELLANEOUS SUPPORT MATERIALS

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

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.17 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

B. Condensate Drain Piping and Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.
b. Indoors: 1 inch (25 mm) thick.
c. Outdoors: 1 inch (25 mm) thick.

2. Field-Applied Jacket:

a. Concealed: None required.

b. Indoors, Exposed to View: PVC, 20 mils (0.5 mm) thick.

c. Outdoors, Exposed to View: stainless steel, smooth, 0.020 inch (0.51 mm) thick.

C. Refrigerant Tubing Insulation and Jacket Requirements:

1. Flexible Elastomeric Insulation:

a. Closed-cell, sponge- or expanded-rubber materials, complying with ASTM C534, Type I for tubular materials.

b. Indoors: 1 inch (25 mm).

c. Outdoors: 1 inch (25 mm) thick.

2. Field-Applied Jacket:

a. Concealed: None required.

b. Indoors, Exposed to View: PVC, 20 mils (0.5 mm) thick.

c. Outdoors, Exposed to View: stainless steel, smooth, 0.020 inch (0.51 mm) thick.

D. Flexible Elastomeric Insulation Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

F. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.

2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

4. Color: Aluminum.

2.18 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

a. Flame Travel Distance: 60 inches (1520 mm) or less.

b. Peak Optical Smoke Density: 0.5 or less.

c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

b. PVC insulation.

c. Braided or foil shielded.

d. PVC jacket.

e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

    a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

    b. PVC insulation.

    c. Braided or foil shielded.

    d. PVC jacket.

    e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

    f. Flame Resistance: Comply with NFPA 262.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.

    a. Paired, one pair or two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.

    b. PVC insulation.

    c. Unshielded.

    d. PVC jacket.

    e. Flame Resistance: Comply with UL 1685.

2. Plenum-Rated Cable: NFPA 70, Type CMP.

    a. Paired, one pair or two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.

    b. Fluorinated ethylene propylene insulation.

    c. Unshielded.

    d. Fluorinated ethylene propylene jacket.

    e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

    f. Flame Resistance: NFPA 262.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6a cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.

2. Conductors: 100-ohm, 23 AWG solid copper.

3. Shielding: Shielded twisted pairs (FTP).

4. Cable Rating: By application.

5. Jacket: Gray thermoplastic.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.19 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.

2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb (11.3 N-m).
c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Spray.

3. Thickness: 1 mil (0.025 mm).

4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.20 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Retain first paragraph below for units requiring ductwork.

E. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

F. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

G. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

H. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.

2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch (13 mm).

H. hardware for proper attachment to supported equipment.

I. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Grouting: Place grout under equipment supports and make bearing surface smooth.

D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Indicate piping locations and arrangements on Drawings if such were used in sizing and other design considerations.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

C. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping and tubing to permit valve servicing.

G. Install piping and tubing at indicated slopes.

H. Install piping and tubing free of sags.

I. Install fittings for changes in direction and branch connections.

J. Install piping and tubing to allow application of insulation.

K. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

L. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

M. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.

2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.

3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.

5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.

2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet (1.5 m). Minimum rod size, 1/4 inch (6.4 mm).

3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps to entrain oil in vertical runs.

4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.

2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.

3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Retain first paragraph below for projects in areas that require seismic restraints.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

F. Fastener System Installation:

1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel.

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Piping and Tubing Insulation:

1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

2. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

N. Horizontal-Piping Hangers and Supports: Install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu if individual clevis hangers.

5. Pipe stands for horizontal pipes located outdoors.

6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

O. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. Sizes through NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).

2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).

3. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).

4. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).

5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).

6. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).

7. NPS 3 (DN 80) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

P. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

Q. Support vertical runs at roof, at each floor, and at midpoint intervals between floors, not to exceed 10 feet (3 m).

R. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

S. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

T. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

U. Hanger-Rod Attachments: Install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

V. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

1. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

   a. Light (MSS Type 31): 750 lb (340 kg).
   b. Medium (MSS Type 32): 1500 lb (680 kg).

2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
3. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
4. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.10 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch (13 mm) high.

2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by [1-1/2 inches (38 mm)] [2-1/8 inches (53 mm)] deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.

3. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.11 SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.12 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

a. Within equipment and associated control enclosures.
b. In accessible ceiling spaces where open cable installation method may be used.
c. In gypsum board partitions where cable may be enclosed within wall cavity.

1. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.

5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.

11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.

12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

13. Provide strain relief.

14. Keep runs short. Allow extra length for connecting to terminals.

15. Do not bend cables in a radius less than 10 times the cable OD.

16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist balanced twisted-pair cables more than 1/2 inch (13 mm) at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.

2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.13 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.14 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.15 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.16 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

   a. First Visit: Kick-off meeting.

   b. Second Visit: At approximately 50 percent completion of system(s).

   c. Third Visit: At approximately 100 percent completion of system(s).

   d. Fourth Visit: Final inspection before system startup.

3. Kick-off Meeting:

   a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.

   b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.

   c. Meeting shall cover the following as a minimum requirement:

      1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
      2) Manufacturer's installation requirements specific to systems being installed.
      3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
      4) Required field activities related installation of VRF HVAC system.
      5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.

   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.

   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

   d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.

   e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.

2) Date(s) and time frames while on-site.

3) Names and contact information of people meeting with while on-site.

4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.

b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.

d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Controller type and model controlling unit.

13) Controller location.

14) Temperature settings and readings within an acceptable range.

15) Humidity settings and readings within an acceptable range.

16) Condensate removal acceptable.

17) Fan settings and readings within an acceptable range.

18) Unit airflow direction within an acceptable range.

19) If applicable, fan external static pressure setting.

20) Filter type and condition acceptable.

21) Noise level within an acceptable range.

22) Refrigerant piping properly connected and insulated.

23) Condensate drain piping properly connected and insulated.

24) If applicable, ductwork properly connected.

25) If applicable, external interlocks properly connected.

26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Condensate removal acceptable.

13) Noise level within an acceptable range.

14) Refrigerant piping properly connected and insulated.

15) Condensate drain piping properly connected and insulated.

16) Remarks.

f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Controller type and model controlling unit.

13) Controller location.

14) Temperature settings and readings within an acceptable range.

15) Humidity settings and readings within an acceptable range.

16) Condensate removal acceptable.

17) Fan settings and readings within an acceptable range.

18) Fan external static pressure setting.

19) Filter type and condition acceptable.

20) Noise level within an acceptable range.

21) Refrigerant piping properly connected and insulated.

22) Condensate drain piping properly connected and insulated.

23) Automatic dampers properly installed and operating.

24) Ductwork properly connected.

25) If applicable, external interlocks properly connected.

26) Remarks.

g. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Controller type and model controlling unit.

13) Controller location.

14) Temperature settings and readings within an acceptable range.

15) Humidity readings.

16) Condensate removal acceptable.

17) Fan settings and readings within an acceptable range.

18) Fan external static pressure setting.

19) Filter type and condition acceptable.

20) Noise level within an acceptable range.

21) Automatic dampers properly installed and operating.

22) Ductwork properly connected.

23) If applicable, external interlocks properly connected.

24) Remarks.

h. Inspection reports for hydronic units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Controller type and model controlling unit.

13) Controller location.

14) Temperature settings and readings within an acceptable range.

15) Condensate removal acceptable.

16) Noise level within an acceptable range.

17) Refrigerant piping properly connected and insulated.

18) Hydronic piping properly connected and insulated.

19) Proof of water flow checked for proper operation.

20) Condensate drain piping properly connected and insulated.

21) If applicable, external interlocks properly connected.

22) Remarks.

i. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

j. Installer shall correct observed deficiencies found by the inspection.

k. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

l. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.

m. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig (4137 kPa), using dry nitrogen.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 12 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.

4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.

b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.

c. Detailed description of extent of tubing tested.

d. Date and time at start of test.

e. Test pressure at start of test.

f. Outdoor temperature at start of test.

g. Name of person ending test, company name, phone number, and e-mail address.

h. Date and time at end of test.

i. Test pressure at end of test.

j. Outdoor temperature at end of test.

k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.

4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.

b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.

c. Detailed description of extent of tubing tested.

d. Date and time at start of test.

e. Test pressure at start of test.

f. Outdoor temperature at start of test.

g. Name of person ending test, company name, phone number, and e-mail address.

h. Date and time at end of test.

i. Test pressure at end of test.

j. Outdoor temperature at end of test.

k. Remarks:

5. Submit test reports for Project record.

6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.

2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.

3. System refrigerant charging shall be witnessed by system manufacturer's representative.

4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.17 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.

2. Complete startup service of each separate system.

3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).

2. Check each indoor unit's response to demand for cooling and heating.

3. Check each indoor unit's response to changes in airflow settings.

4. Check each indoor unit and outdoor unit for proper condensate removal.

5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.

2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.

3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters shall be included in the information submitted.

3.18 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Retain "Occupancy Adjustments" Paragraph below to provide additional on-site assistance. Consult Owner to determine if additional occupancy adjustments is needed.

E. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.19 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.20 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 83 13

ELECTRIC HEAT TRACING SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies the furnishing and installing of electric heat trace systems for protecting water pipes and drains from freezing.

B. The Contractor shall furnish and install complete and functional heat trace systems including wiring; controls; thermostats; all electrical connections and any conduit, cable, boxes, outlets and other equipment and accessories required.

C. Related work specified elsewhere:

1. Section 22 07 00, Pipe Insulation.

1.02 SUBMITTALS

A. The Contractor shall prepare and submit, before fabrication and assembly of the heat trace system equipment, the following:

1. Shop drawings showing the layout of each pipe line to be protected, equipment drawings showing the details of the wiring, thermostat, controls, connections, warning lights and alarms and control panels.
3. Calculation data showing the electrical load data for each system.
4. Product data, catalog cuts and specifications describing the electrical and physical characteristics of each item including the thermostat, controls warning lights and alarms and control panels.
5. Installation instructions for the system.

B. The Contractor shall submit, for record and distribution, prior to shipment of the equipment, five copies of Operation and Maintenance manuals for the heat trace system.

1. Operation and Maintenance manuals shall include descriptive bulletins and operation leaflets for the thermostats, controls and warning lights and alarms.

a. Each Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

PART 2 PRODUCTS

2.01 GENERAL

A. The Contractor shall furnish all necessary labor and tools, materials, and equipment and shall properly construct and connect the electric heat trace system in accordance with the manufacturer’s directions and recommendations.

B. The electric heat trace cable shall be either be covered with a protective nickel braid or

covered with a tinned copper braid and a corrosion protective outer fluoropolymer jacket.

C. The Contractor shall coordinate the design and installation of the heat trace system with the pipe insulation system.

D. The design, selection and size of the heat trace cable shall be in accordance with correct heat transfer calculations as recommended by the equipment manufactures design guide.

E. The system shall be controlled and monitored from a single control panel. The system shall be controlled from a thermostat with provisions for a manual override from a Hand-Off-Auto switch.

F. Monitoring and alarm circuits shall be provided that monitor each heat trace circuit for current and continuity of the heat trace cable, and the entire system for low temperature failure.

G. The electric heat trace cable, control panel, and accessories shall have UL, FM, or CSA system listing.

2.02 MATERIALS

A. The Contractor shall furnish and install the electric heat trace system which shall include but not be limited to the electric heat trace cable, tape or banding, thermostats, control panel and warning lights and alarm.

B. The electric heat trace system for freeze protection shall be controlled from a common ambient sensing thermostat set to activate the system at 40 degrees, and a parallel backup thermostat set at 40 degrees F. An alarm shall be provided to indicate the failure of either thermostat or lack of power.

C. The control panel shall provide for the necessary controls and contactors plus an additional 25 percent spare space. The contactors shall be electrically operated, electrically held, 30 ampere, 600 Volt, 3 pole, with a 120 Volt control coil. The contactors shall be as manufactured by Allen Bradley or Square D.

D. LED pilot lights shall be provided to indicate control power available, system on, off, and circuit on and failure alarms for each heat trace circuit.

E. The system and all components shall be approved by the Authority.

F. The cable shall be industrial type, rated 8 watts per foot (W/ft), at 120 volts, at a temperature of 50 degrees F. and a temperature identification number (T-rating) of T6 (185 degrees F. exposure). Values shall be established per Institute of Electrical and Electronics Engineers, Incorporated (IEEE) Standard 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.

G. The heating cable shall be self-regulating. The cable heat output shall decrease with raising ambient temperature without employment of an auxiliary electrical regulatory device.

H. The heating cable shall be composed of two parallel 16 AWG (or larger) stranded, nickel-plated copper bus wires, embedded in a polymeric conductive (heat generative) core (web). The wires and core shall be enclosed within a tinned copper, braided shield, suitable for use as an electrical fault grounding conductor. All cable components shall be jacketed with a tough, abrasion and moisture resistant thermoplastic (e.g. polyolefin), inert with aqueous and cleaning chemicals. The overjacket shall provide corrosion protection

for the cable. A polyolefin or fluoropolymer overjacket is an acceptable alternate.

I. The cable shall have, monitor wires and a tinned copper braid, with a fluoropolymer jacket for mechanical and corrosion protection. The cable is suitable for direct placement on metallic and polyvinyl chloride (PVC) piping. The heat trace circuits shall be designed to operate on 20 ampere circuits.

J. The heating cable shall be unaffected by exposure to non-hazardous, unshielded indoor and outdoor environmental conditions. The cable service life shall not be diminished by exposure to ultraviolet radiation and random fluctuating temperatures within the range of -30 degrees to 150 degrees F.

K. The cable shall have a minimum expected service life of 10 years in applications of continuous operation. A minimum of 90% of the nominal rated power shall be exhibited following 1000 hours of continuous operation, in accordance with Underwriters Laboratories, Incorporated (UL) Standard 746B, Polymeric Materials – Long Term Property Evaluations.

L. Heating cable shall be UL approved. Cable shall have original manufacturer's labeling.

M. The heat trace system shall be as manufactured by Delta-Therm, Chemelex, Bylin or approved equal.

PART 3 EXECUTION

3.01 PREPARATION

A. Heat tracing shall be installed on clean surfaces free of dirt, debris, protrusions, oil, grease and moisture. Remove existing insulation, if any, as required for proper installation of the heat trace cable. Remove existing heat trace system or components as required for installation of the new system or components.

B. Locations for installation of the control panel, thermostat and warning light and alarm shall be approved by the Authority.

3.02 INSTALLATION

A. The heat trace cable shall be installed in such a manner as to maintain the best possible contact with the traced pipe, valves, flanges and other in-line equipment. The heat tracing cable shall be secured to the pipe as recommended by the heat trace system manufactures installation instructions.

B. In order to allow for maintenance access to valves, strainers, and other in-line equipment where additional heat tracing is required, a loose loop of heating cable of the length required shall be left at the item to be traced. The loop shall be spiraled around the item and secured as recommended by the heat tracing system manufacture's installation instructions.

C. All junction boxes, splices, and terminations requiring maintenance shall be mounted to be accessible without disturbing the insulation and jacket.

D. The location of the ambient sensing thermostats shall be selected to obtain a representative temperature, be accessible for maintenance, and protected from tampering.

E. The installation and final adjustments to the electrical heat tracing system shall be supervised and field tested by a qualified factory trained equipment manufactures service

engineer.

F. After field testing has been completed the installed heat trace system shall be covered with insulation and a jacket as specified in pipe insulation section of this Specification.

G. All pipe electrically heat traced and insulated shall have a plastic label applied to the insulation every 25 feet. The plastic label shall read "Electric Heat Trace Circuit Number, Panel Number.

H. Unless otherwise approved, cable of 1000 feet in length and shorter shall be furnished in one piece. Cable of greater lengths shall be furnished in increments of this length or longer.

3.03 ELECTRICAL CONNECTIONS

A. Final electrical connections between the heat trace system and the power source and the energizing of the system will be performed by the Authority's electrical department unless directed and approved otherwise.

3.04 RE-INSULATION

A. Re-insulate or insulate over the new heat trace cable after installation. See insulation specification. Type of insulation must be approved to be used with the heat trace cable to avoid fire and other hazards. Insulate according to manufacturer's directions. Take precautions to not damage the heat trace cable.

3.05 OPERATION AND MAINTENANCE MANUAL

A. Upon completion, Contractor shall test system for proper operation and set controls.

B. The equipment manufacturer and installer shall provide adequate training for the Authority's Personnel in the proper operation and maintenance of the equipment.

C. The installer shall provide as built drawings indicating the location of heat tracing and location of connections, controls, thermostats and warning lights and alarms. The manufacturer shall provide final and complete operation and maintenance manuals for all components of the heat trace system.

PART 4 MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRIC HEAT TRACING SYSTEM shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of ELECTRIC HEAT TRACING SYSTEM shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 23 83 33

RADIANT HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Electric radiant heaters.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, specification sheets, UL approval certificate, specialties, and accessories for each product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Include rough opening dimensions and other opening requirements for recessed and semi-recessed units. Detail equipment assemblies and attachment. 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. Operation and Maintenance Data: For electric radiant heaters to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. All electric heaters to be U.L. approved.

1.5 COORDINATION

A. Coordinate layout and installation of radiant heaters and components with other construction.

PART 2 - PRODUCTS

2.1 ELECTRIC RADIANT HEATERS

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. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox Inc.; a division of Emerson Electric Company.
3. Fostoria Industries, Inc.; a division of TPI Corporation.
4. Markel Products; a division of TPI Corporation.
5. Omega Engineering, Inc.
6. QMark Electric Heating; a division of Marley Engineered Products.
7. Approved equal.

B. Units to be UL approved.

C. Enclosures: Painted steel housing with anodized-aluminum reflector.

1. Finish: Baked-enamel finish in manufacturer's standard paint color as selected by Architect.

D. Unit Controls:

1. Line-voltage thermostat.

E. Capacities and Characteristics:

1. Enclosure Length:
2. Mounting Height:
3. Heating Capacity:

2.2 FAN-FORCED ELECTRIC WALL HEATER

A. Electric semi-recessed wall mounted thermostat controlled with fan and built-in fan delay switch to energize fan motor after elements are heated and shuts off fan motor when residual heat has been dissipated after heat shuts off.

1. Fan motor to have lifetime lubricated bearings. Fan 100 CFM.
2. Heater to have a power disconnect switch and be equipped with a thermal overheat protection in the event of overheating.
3. Heater to have an integral built-in thermostat; adjustable at front cover.

B. Enclosure: Semi-recessed housing to be 20 gauge minimum galvanized metal. Front cover and grill to have a neutral gray baked enamel finish.

C. Heating elements to be steel finned metal sheath.

D. The wall mounted electric heater for this project shall be Q Mark CWH 3000 series, or another manufacturer’s model submitted to the Authority for approval as an equal.

1. Provide a heater to provide 3000 watts, of 240 volts, single phase, 12.5 amps.

2.3 ELECTRIC BASEBOARD HEATER

A. Enclosure: Shall be fabricated of 16 gauge cold-rolled steel with a built-in wireway with factory installed wiring rated up to 45 amps. The front panel to be removed to provide access to the element area and terminal boxes. Enclosures to have an extruded aluminum grille. Heater to have top discharge outlets and bottom inlet outlets.

1. Finish of enclosure and accessories to be phosphatized and painted by a baked enamel painting process. Accessories include end caps and blank sections. The Authority to select the color from the manufacturer's standards.

B. Heating elements: Constructed of nickel chromium heating element wire, embedded in magnesium oxide, and enclosed in a metal sheath. Aluminum fins shall be pressure bonded to the sheath.

1. An automatic reset thermal overheat protector shall run the length of the heater turning the unit off in the event an overheating situation should occur. The protector shall automatically reset after the unit has cooled down.

C. Heater Control: Each heater unit shall have its own built-in controls and thermostats as provided with unit by the manufacturer of the heater.

1. Thermostat and Disconnect Switch to be in-line. Thermostat to be single pale, adjustable through the grill with a range of 60-120 degrees F. Disconnect switch to be energized through the grill. Control combination to be rated 20 amps at 120-277 VAC.

D. The electric baseboard heater for this project shall be Berko CSL series or another manufacturer's model submitted to the Authority for approval as an equal.

1. Provide, as shown on the drawings the following heaters:

a. 5' length, 2500 watts total, 240 V., single phase, 10.4 amps.
b. 4' length, 2250 watts total, 240 V., single phase, 9.4 amps.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiant heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for electrical connections to verify actual locations before radiant heating unit installation.

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

3.2 INSTALLATION

A. Install radiant heating and cooling units level and plumb.

B. Verify that size of opening for semi-recessed wall heater is of proper size and depth for proper installation of the heater. Follow manufacturer's directions and installation drawings.

C. Install wall heaters and baseboard heaters at locations indicated on the drawings. Verify sizes and conditions in the field. Install wall heater at height from floor recommended by manufacturer.

D. Secure heaters to wall as recommended by manufacturer, using approved fasteners required to secure heaters to the specific substrate.

3.3 CONNECTIONS

A. Ground electric units according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:

1. Operate electric heating elements through each stage to verify proper operation and electrical connections.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.

B. Remove and replace malfunctioning units and retest as specified above.

C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The work of RADIANT HEATING UNITS shall not be measured for payment.

4.2 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of RADIANT HEATING UNITS shall be included in the contract lump sum price as shown in the Schedule of Prices for MECHANICAL WORK.

4.3 PAY ITEM ACCOUNT NUMBER

A. Mechanical work: 230000.

END OF SECTION

SECTION 26 01 00

ELECTRICAL GENERAL PROVISIONS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. The specifications for the project basic electrical requirements.
2. The Contractor to provide items, articles, materials, operations and methods required by the Drawings and Specifications including labor, equipment, supplies and incidentals necessary for completion of the Work under this Contract.
3. Any incidental accessories necessary to make the work complete and ready for operation, even though not specified or shown on the Drawings to be furnished and installed without additional expense to the Contract.
4. Should there be any discrepancies or a question of intent, the Contractor to refer the matter to the Commissioner for decision before ordering any equipment, materials or before starting any related work.
5. The Contractor to furnish, erect, install, connect, clean, adjust, test and condition all manufactured articles, materials and equipment, and place in service in accordance with the equipment manufacturer's directions and specifications except as otherwise specified herein.

1.03 RELATED WORK

A. The general provisions specified to be furnished and installed herein have related work in various other sections, including but not limited to:

B. Related Sections:

1. Division 23 “Heating, Ventilating and Air Conditioning (HVAC)”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261900 “Grounding”
10. Section 261950 “Identification”
11. Section 260573 “Short-Circuit/Coordination and Arc Flash Study”
12. Section 262116 “Electrical Utility Service”
13. Section 263353 “Uninterruptible Power Supply”

14. Section 264000 “Service Equipment”
15. Section 264600 “Dry Type Transformers”
16. Section 264700 “Panelboards”
17. Section 264900 “Generator Tap Box”
18. Section 265010 “Lighting Fixtures”
19. Section 265560 “Light Emitting Diode”
20. Section 266000 “Concrete for Electrical Work
21. Section 267500 “Cabinet and Terminal Strips”
22. Section 267700 “Infrared Heating”
23. Section 269500 “Electrical Testing”

1.04 ACTION SUBMITTALS

A. As soon as practical and within thirty days after award of contract and before any material or equipment is purchased, the Contractor to submit to the Commissioner for approval one electronic DVD and one electric PDF copy of all shop drawings to be incorporated in the work.

B. Shop drawings to include manufacturers' names, catalog numbers, cuts, diagrams and other such descriptive data as may be required to identify and approve the equipment.

C. Extended time for submitting special shop drawing may be requested; however, an extension of time approved does not relieve this Contractor of the responsibility of executing the work in accordance with the Contract.

D. Any listed materials, fixtures, apparatus, or equipment that are not in accordance with the Specification requirements can and will be rejected for use in this installation and construction.

E. Any materials, fixtures, apparatus or equipment installed without stamped or written approval to be removed by the Contractor and replaced with specified equipment at the direction of the Commissioner and without recourse for additional compensation.

F. Substitutions to listed acceptable manufacturers equipment and material will not be accepted until the Contractor has complied with the Specification Division One.

1.05 INFORMATION SUBMITTALS

A. Pre-Installation Submittals of the following types are required for the listed categories.

1. Shop Drawings are required for the following.

    a. Equipment details for switchboard, panelboards, transformers, etc.
    b. Special systems for fire alarm, public address, security, etc.
    c. Lighting fixtures.

2. Catalog Cuts are to cover common materials and supplies such as conduit, wire, devices, manufacturer’s standard lighting fixtures, etc.
3. Installation drawings are to cover equipment, materials supplies where installation is not adequately detailed on the Contract Documents. Provide the electrical room conduit and equipment layout to be provided.
4. The equipment manufacturers wiring diagrams are to show terminal blocks for external wiring.

5. The equipment manufacturers internal point to point and external wiring diagrams between cubicles, panels and components within the equipment line up are to be provided.
6. Complete rating data for all equipment to be provided.
7. Instruction books, operation and maintenance manuals with spare parts manuals are to be provided.

B. Post construction submittals are required for the following types of documents.

1. Shop drawing installation drawings are to be updated to "Record Document" status.
2. Record Documents are to indicate the actual "as installed" status of all equipment, controls and materials incorporated into the facility.
3. Test data to be provided for all equipment and wiring as required by various sections of these Specifications.
4. Instruction books, operations and maintenance manuals, spare parts lists are to be provided for all equipment and special systems.

    a. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, shop drawings, equipment lists, descriptions, parts lists, etc. to instruct operating and maintenance personnel unfamiliar with such equipment.

C. Installation Drawings:

1. In addition to the preparation and submittal of Shop Drawings for manufactured electrical equipment and materials, the Contractor is to prepare and maintain in current status, a complete set of detailed, completely circuited, and dimensioned electrical construction drawings for all electrical work included under this Contract. These drawings to be made at the Contractor's expense and to be made on mylars.
2. The installation drawings to be made under the direction and supervision of the Contractor to show all electrical work inclusive of conduit, wiring, electrical equipment and devices, lighting fixture locations and elevations, points where conduit enters or leaves structural slabs and walls, junction boxes, conduit supports and inserts. Symbol representation for home run circuits will not be acceptable.
3. The Contractor to provide a separate set of installation drawings for the lighting system; a separate set of installation drawings for the power and control; and a separate set of installation drawings for the special systems.
4. The complete electrical distribution system from source or sources up to and including each branch circuit panelboard to be shown and dimensioned exactly as installed, with all feeders located on the Drawings. Major equipment, lighting controls and apparatus are to be shown to scale and properly located; conduit home runs are not acceptable.
5. The installation drawings are to include floor plans and reflected ceiling plans with electrical layouts drawn at a scale (or scales) as required with a minimum scale of 1/8 inch equal 1 foot, 0 inches. It is intended that installation drawings of each trade be the same scale(s) in order to permit respective plans to be superimposed upon all others of each trade.
6. In addition to the floor plans, the layouts of all congested areas such as mechanical and/or electrical equipment rooms, and all functionally critical areas are to be drawn at a minimum scale of 1/4 inch equals 1 foot, 0 inches, and with all details of construction shown. The Commissioner may request additional installation drawings if in their opinion they are required to properly coordinate the project.
7. The installation drawings are to include schedules for all panelboards. Schedules are to depict the bus arrangement of the panelboard, the size of all circuit breakers, the connected load on each breaker, and a description of the load and it's location.
8. All installation drawings are to be of the same size and with the same border lines and title blocks as the Contract Drawings, with the Contractor's name added.

9. The Contractor is to be responsible for the coordination of electrical work with the work of all other trades and to, in preparing the installation drawings, continually check the work of all other trades (inclusive of that indicated by shop drawings) in order to avoid possible installation conflicts arising. It is understood that the work shown on the installation drawings has been so coordinated. In the event of conflicts or interferences that cannot be resolved in the field, the Contractor is to request a written clarification from the Commissioner.
10. The installation drawings are to indicate the electrical installation exactly as constructed and therefore to be periodically revised to reflect all changes inclusive of those required by the Commissioner, those which are or have been found necessary in the field, those which may be suggested by the Contractor and approved by the Commissioner, etc.
11. Conduits are to be shown on the installation drawings as installed. Conduit home runs are not acceptable.
12. Revisions are to be performed when considered necessary by the Commissioner or the Contractor in order to facilitate proper coordination but are to in no event be performed at interim periods exceeding 30 days between each such revision.
13. The initial copy of all installation drawings are to be submitted to the Commissioner for review. These submittals are to be considered as shop drawings and are subject. to the shop drawing approval process. Subsequent revised copies are to be issued to the Commissioner as requested. It to be clearly understood that these installation drawings are for installation coordination purposes only and cannot in any way alter the requirements of the Contract. Therefore, the Drawings, Specifications, and authorized revisions thereto, are to remain the only determinants of the Contract requirements.
14. Upon completion, the initial installation drawings, and all revised installation drawings thereafter, it is to be dated and certified by the Contractor as having been fully coordinated. It is then to be understood that the work shown thereupon is ready for construction.
15. No electrical work is to begin until these installation drawings (and each revision thereof) are so drawn, and thereafter finally accepted by the Commissioner.
16. All installation drawings are to be made in accordance with an approved schedule, prepared by the Contractor, and arranged to coincide with actual construction in such a manner as to allow the latter work to proceed without delay.
17. If, in the opinion of the Commissioner, the installation drawings are in acceptable condition after each has been finally revised and accepted, the Contractor may submit same as the field record drawings called for elsewhere in the Specifications.
18. The Contractor is to include wiring diagrams and schematic diagrams. Each schematic diagrams are to be "JIC" ladder type. Wire numbers are to be shown on all schematic and wiring drawings.
19. The minimum drafting letter size is to be 1/8 inch in height, block style.

D. The Contractor is to submit test reports as described under this Contract.

E. See specific Specification Sections for additional submittal requirements.

1.06 QUALITY ASSURANCE

A. Materials and installation to conform to the applicable Codes and Standards.

B. After all equipment, devices and raceways are installed and wires and cables are in place and connected to devices and equipment, the Contractor to test the system for continuity, proper phase rotation, short circuit, improper grounds, and other defects. If any defective conditions are present, the Contractor to make all necessary corrections and retest for compliance.

C. Each major component of equipment to have the manufacturer's name, address, model number and rating on the manufacturer's nameplate securely affixed in a conspicuous place.

1. The nameplate of a distributing agent is not acceptable.
2. Code ratings, labels or other data, including any that are die-stamped into the surface of the equipment, to be in a visible location.

1.07 DELIVERY, STORAGE AND HANDLING

A. Equipment and materials to be delivered to the site and stored in original containers, suitably sheltered from the elements and mechanical injury, but readily accessible for inspection until installed.

1. Items subject to moisture damage to be stored in dry heated spaces.
2. Manufacturer's directions to be followed in the delivery, handling, storage, protection, installation and operation of all equipment and materials.

B. The Contractor to determine, from examination of the Drawings, whether any special temporary openings in the building will be required for the admission of apparatus furnished under this section, and notify the Commissioner accordingly. In the event of failure to give sufficient notice in time to arrange for these openings during construction, the Contractor to assume all costs of providing such openings thereafter.

C. The Contractor to coordinate with the Commissioner the movement of heavy machinery, equipment and heavy parts thereof brought into or onto the building or premises.

D. Conduit openings to be kept closed by means of plugs or caps to prevent the entrance of foreign matter.

E. The Contractor to cover all fixtures, equipment and apparatus as required to protect them against dirt, water, chemical, solar, or mechanical damage. The Contractor to also provide any supplementary heating and cooling required to prevent moisture and thermal damage.

F. Equipment to be inherently safe and moving parts are to be covered with guards.

G. Equipment in storage having moving parts, which may be damaged or distorted by being idle, to be rotated or exercised periodically and all lubricants to be properly maintained.

1.08 CODES AND STANDARDS

A. Materials and installation to comply with codes, laws and ordinances of Federal, State, and Local governing bodies having jurisdiction.

B. In every installation where regulations of electric utility and telephone companies apply, conformance with their regulations to be mandatory and any costs incurred to be included in the Contract.

C. In case of differences between building codes, State and Federal laws, local ordinances and utility companies regulations and the Contract Documents, the most stringent to govern.

D. All equipment and materials purchased for this Project to conform to any acts, laws, rules and regulations of the following organizations:

1. City of Chicago Electrical Code (CEC) to take jurisdictional precedence over all other authoritative bodies.
2. National Electrical Safety Code (NESC-ANSI C2).
3. American National Standards Institute (ANSI).
4. National Fire Protection Association (NFPA).
5. Institute of Electrical and Electronics Engineers (IEEE).
6. Insulated Cable Engineers Association (ICEA).
7. National Electrical Manufacturers Association (NEMA).
8. Illuminating Engineering Society (IES).
9. Underwriters Laboratories Inc. (UL).
10. Canadian Standards Association (CSA).
11. Occupational Safety and Health Administration (OSHA).

E. Should Work be performed which does not comply with the requirements of the applicable building codes, State and Federal laws, local ordinances, industry standards and utility company regulations, changes for compliance to be done at no additional cost to the City of Chicago.

F. The Contractor to secure and pay for all required permits, governmental fees, taxes and licenses necessary for the proper execution and completion of the Electrical Work.

G. The Contractor to submit to governmental agencies and utility companies any shop drawings for equipment, which require their approval.

H. The Contractor to notify the Commissioner of any proposed materials or apparatus believed to be inadequate, unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction.

1.09 DRAWINGS

A. The Drawings are diagrammatic and are intended to convey the scope of work and indicate the general arrangement and/or sizes of conduit, equipment, fixtures and other work included in the Contract.

B. The location of items required by the Drawings or Specifications where not definitely fixed by dimensions on the Drawings are approximate only. The exact locations necessary to secure the best conditions and results are to be determined at the site and are to be subject to the approval of the Commissioner.

C. The Contractor to coordinate the location of the lighting fixtures and intercommunication speakers with the location of the mechanical equipment.

D. The Contractor to lay out the work, check drawings of other trades to verify spaces in which work to be installed and maintain maximum headroom and space conditions at all points.

1. Where headroom or space conditions appear inadequate, the Contractor is to notify the Commissioner before proceeding with installation.
2. Any minor changes in the locations of equipment, fixtures, lighting fixtures conduits, outlets, devices, etc., from those locations as shown on the Drawings is to be made without extra cost to the Contract. A minor change in location to be considered is to be within 10'-0" of the location as may be scaled from the Drawings for all interior work and within 25'-0" for all exterior work.

1.10 EXECUTION, CORRELATION AND INTENT OF DOCUMENTS

A. In the event that conflicts, if any, cannot be settled rapidly and amicably between the affected trades, with the Work proceeding in a workmanlike manner, then the Commissioner to decide which Work is to be relocated. The Commissioner's judgment to be final and binding on the Contractor.

B. No measurements of a Drawing by scale to be used as a definite dimension to work by.

1.11 INSTRUCTIONS AND ADJUSTMENTS

A. At the conclusion of the Work and before final contract payment is made, the Contractor to demonstrate and explain to the Commissioner the function, operation and maintenance of all equipment and systems installed.

B. The primary adjustments of the system(s) to be accomplished by the Commissioner to the complete satisfaction of the Commissioner at the time of completion of the installation.

1.12 GUARANTEE

A. The Contractor to be responsible for all Work in this Specification. The Contractor to make good, repair, or replace at his own costs and expense as may be necessary, any defect which in the opinion of the Commissioner is due to imperfections in material, design or workmanship or if defect shows itself to be defective within one year after acceptance by the Commissioner.

B. The Contractor to be responsible for protecting all equipment and systems against harmful exposures to, or accumulations of dust and moisture, flooding, corrosion or other forms of damage and to clean and restore damaged finishes as may be required to place installations in a "Like New" condition before acceptance by the Commissioner.

C. All manufacturers' equipment guarantees or warranties to be included in the Maintenance Manuals.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment to be new and to be UL or CSA labeled where applicable and to bear the manufacturer's name, model number and other identification markings.

B. Materials and equipment to be the standard product of a manufacturer regularly engaged in the production of the required type of material or equipment for at least five years (unless specifically exempted by the Commissioner and to be the manufacturer's latest design with published properties that meet the specification requirements.

C. Equipment and materials of the same general type to be of the same manufacturer throughout the project to provide uniform appearance, operation and maintenance.

D. Equipment and materials to be without blemish or defect and to not be used for temporary light or power purposes, including lamps, without the Commissioner's written authorization.

2.02 ENCLOSURES FOR ELECTRICAL EQUIPMENT/FITTINGS

A. Enclosures for Electrical Equipment to be governed by the area classification described below or unless otherwise noted on the Drawing.

B. NEMA Type 1A may be used in dry indoor environmental with full time filtered air supplies.

C. NEMA Type 12 to be used in indoor dry and non-chemical environment.

D. NEMA Type 13 oil tight devices to be used for all control panels.

E. NEMA Type 4X stainless steel to be used in exterior, interior wet areas, and corrosive environment where chemicals are stored or mixed with liquids or as indicated on the Contract Drawings.

F. NEMA Type 7/9 hazardous, to be used in all hazardous areas.

G. Specific site requirements may necessitate the use of different enclosure ratings.

2.03 MOTOR VOLTAGE OPERATION

A. Unless otherwise noted, all AC motors to be operated on the following voltages:

1. Motors under 1/2 horsepower to be 115 volts AC, single phase, 60 hertz.
2. Motors 1/2 horsepower and larger to be 208 volts AC, 3 phase, 60 hertz.

B. AC motor type, enclosure type, and other design requirements to be as specified in these Specifications.

PART 3 - EXECUTION

3.01 INSTALLATION OF WORK

A. The Contractor to perform all Work with trained mechanics of the particular trade involved in a neat and workmanlike manner as approved by the Commissioner.

B. The Contractor to perform all Work in cooperation with other trades and schedule to allow speedy and efficient completion of the Project.

C. The Contractor to furnish other trades with advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit trades affected to install their work properly and without delay.

D. Where there is evidence that the work of one trade will interfere with the work of other trades, all trades to assist in working out space conditions to make satisfactory adjustments and to be prepared to submit and revise coordinated shop drawings and installation drawings.

E. With the approval of the Commissioner and without additional cost to the Contract, the Contractor to make minor modifications in the Work as required by structural interferences, by interferences with work of other trades or for proper execution of the Work.

F. Minor changes in the locations of outlets, fixtures and equipment to be made at the direction of the Commissioner prior to rough-in and to be at no additional cost to the Contract.

G. The equipment to be installed with ample space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring to be provided without moving other equipment which is to be installed or which is in place.

H. Locations of electrical outlets, lighting panels, cabinets, equipment, etc. are approximate and exact locations to be determined by the Contractor at the Project site.

I. The Contractor to refer to the Contract Documents for details and reflected ceiling drawings.

J. The Contractor to protect the materials and work of other trades from damage during installation of the work provided under this Contract.

3.02 EQUPIMENT NOISE LIMITATION

A. Noise levels of electrical devices and equipment to be within acceptable limits as established by NEMA or other valid noise rating agencies. Noise levels to be subject to the Commissioner's acceptance which will be based on practical and reasonable considerations, of occupancy requirements.

B. The Contractor to check and tighten the fastenings of sheet metal plates, covers, doors, and trims to prevent vibration and chatter under normal conditions of use.

C. When located elsewhere than in high-noise-level equipment rooms, the enclosures or solenoid-operated switching devices and other noise-producing devices are to have anti- vibration mountings and non-combustible sound-absorbing linings.

D. Transformers, reactors, dimmers, lamp ballasts, and solenoids are to be designed and rated for "quiet" design.

E. The Contractor to remove and replace any individual electrical item or device that is found to produce a sound energy output exceeding that of other identical devices installed at the Project.

3.03 TRANSMISSION OF VIBRATION

A. Electrical equipment, conduit, and fittings are not to be mounted to or supported by elements subject to vibration except by methods specified here in and/or shown on the Drawings.

B. Where flexible conduit lengths are utilized as a means of isolating equipment and conduit systems vibration, care to be exercised to assure continuity of ground throughout. Flexible conduit lengths to be a maximum of 18 inches in areas where same are permitted.

3.04 PROTECTION

A. The Contractor to protect conduit and wireway openings against the entrance of foreign matter by means of plugs or caps.

B. The Contractor to cover fixtures, materials, equipment and devices furnished or installed under this Contract or otherwise protect against damage, before, during, and after installation.

C. Fixtures, materials, equipment, or devices damaged prior to final acceptance of the Work to be restored to their original condition or replaced.

D. Equipment to be inherently safe and moving parts to be covered with guards.

3.05 INSTALLATION OF WORK FOR OTHER SECTIONS

A. The Contractor to coordinate all electrical work and to complete all wiring, conduit, material and electrical equipment as required for equipment installed under other divisions of these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRICAL GENERAL PROVISIONS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of ELECTRICAL GENERAL PROVISIONS must be included in the Contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 01 12

ELECTRICAL FRAME AND LID, 30”, 24” FRAME AND LID
ELECTRICAL FRAME AND LID, 36”, 24” FRAME AND LID

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Article 202.03 (Removal and Disposal of Surplus, Unstable, Unsuitable, and Organic Materials) of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

B. Division 1000, Materials, section 1041, 1001, 1020, of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

1.02 SUMMARY

A. This item is for supplying and installing an electrical handhole 30" in diameter with a 24" frame and lid or a handhole 36" in diameter with a 24" frame and lid in a parkway or sidewalk.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The frame and lid must meet the requirements of Material Specification 1458. The handhole must meet the requirements of Material Specification 1528. A 24" frame and lid must also meet the requirements of Standard Drawing 872. Bricks must meet the requirements of Article 1041 of the Standard Specifications. All other materials used must meet the appropriate material requirements of the Standard Specifications.

PART 3 EXECUTION

3.01 INSTALLATION

A. The handhole will be a precast concrete structure, or, if conditions merit, a cast in place concrete structure, complete with cast iron frame and cover, and conforming in detail with either Drawing Number 867 or Drawing Number 866, except that the number of conduit openings must be as shown on the construction plans.

B. Each handhole must be installed at the location specified on the plans or at the location identified by the Resident Engineer.

C. The area where the handhole is to be placed must be properly excavated. All disposable material must be properly disposed of per Section 202.03 of the Standard Specifications. Each handhole must be set or constructed on a foundation of loose stone not less than eight inches (8") deep. The 36" handhole for pavement installation must have a floor as shown in Drawing Number 871. The frame casting must be accurately set on a full bed of mortar to the finished elevation so that no subsequent adjustment will be necessary. It is desirable not to use a neck for the frame.

However, if approved by the Resident Engineer, mortar and brick, or mortar and concrete rings, may be used to adjust to the proper grade. Adjustment rings, bricks, and frames must be set in a full mortar bed. Use of partial bricks will not be allowed. Bricks must be laid in full header courses only. Mortar must be mixed in a proportion of one (1) part of cement to three (3) parts sand by volume of dry materials. After entering laterals have been installed in place in the handhole, the openings in the wall must be plugged in an approved manner flush with the inner surface. If backfill is required, screenings must be used and properly compacted. Parkway must be restored to the proper grade. Pavement must be properly restored to the correct grade. Patching of the pavement must be done with high early strength concrete meeting the requirements of Articles 1001 and 1020 of the Standard Specifications. Sidewalks must be restored to the proper grade using a 5 inch thickness of concrete. The inside of the handhole must be clean of all debris.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRICAL FRAME AND LID, 30”, 24” FRAME AND LID or ELECTRICAL FRAME AND LID, 36”, 24” FRAME AND LID shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ELECTRICAL FRAME AND LID, 30”, 24” FRAME AND LID or ELECTRICAL FRAME AND LID, 36”, 24” FRAME AND LID included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1458, 1528

END OF SECTION

SECTION 26 01 17

ELECTRICAL FRAME AND LID, 24”
ELECTRICAL FRAME AND LID, 30”

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Division 1000, Materials, section 1041, 1001, 1020, of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

1.02 SUMMARY

A. This item will consist of adjusting or replacing an existing or new 24 inch or 30 inch frame and lid for an existing manhole or handhole to the new or existing grade. The existing manhole or handhole may be in the street, in the sidewalk, or in the parkway.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The 24 inch frame and lid must be as shown in Standard Drawing 872. The 30 inch frame and lid must be as shown in Standard Drawings 874 and 10927. All frames and lids must conform to Material Specification 1458. Bricks must meet the requirements of Article 1041 of the Standard Specifications. rigid Concrete will be Portland cement concrete, SI Class, meeting the requirements of Article 1020 of the Standard Specifications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pavement, sidewalk, and dirt must be removed to the extent necessary to adjust the frame. Material must be disposed of according to the requirements of Section 202.03 of the Standard Specifications. Mortar and brick, or mortar and concrete rings, must be used to adjust to the proper grade. With the approval of the Resident Engineer, the contractor may use precast adjusting rings. Adjustment rings, bricks, and frames are to be set in a full mortar bed. Mortar must be mixed in a proportion of one (1) part cement to three (3) parts sand by volume of dry mix. The interior of the adjustment must be smooth. Use of partial bricks will not be allowed. Bricks must be laid in full header courses only. In no instance will the neck of the manhole or handhole exceed two (2) feet in depth.

B. The pavement, sidewalk, or parkway must be restored to the proper grade after adjustment. Patching of pavement around a structure must be with high early strength concrete meeting the requirements of Articles 1001 and 1020 of the Standard Specifications. The bituminous concrete layer must be properly restored. Sidewalk must be replaced to the nearest full slab, or expansion joint, and must be a minimum of 5 inches in thickness. Parkways must be properly backfilled and topped with appropriate soil material.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRICAL FRAME AND LID, 24” or ELECTRICAL FRAME AND LID, 30” shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of CONCRETE ELECTRICAL FRAME AND LID, 24” or ELECTRICAL FRAME AND LID, 30” included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1458, 1528

END OF SECTION

SECTION 26 01 20

DRILL EXISTING MANHOLE OR HANDHOLE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings number 814 of the City of Chicago Department of Transportation Division of Electrical Operations.

1.02 SUMMARY

A. This Section specifies requirements for drilling existing manhole or handhole. The work under this Section shall consist of drilling a hole in an existing handhole or manhole for the installation of a new conduit. This item must meet the requirements of Article 879 of the Standard Specifications.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. The size of the hole must be as close as possible to the size of the conduit to be installed. The conduit must be installed in the drilled hole with a bushing before the hole is grouted. The conduit will be covered by a separate item. The space between the conduit and the handhole or manhole wall must be caulked with a waterproof grout. Drawing 814 provides additional information.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DRILL EXISTING MANHOLE OR HANDHOLE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DRILL EXISTING MANHOLE OR HANDHOLE shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 01 23

CLEAN EXISTING MANHOLE OR HANDHOLE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements for clean existing manhole or handhole. The work will consist of furnishing all labor, materials, tools and equipment necessary to clean a manhole or handhole. Work must include the removal and disposal of all foreign debris and liquids from the manhole or handhole. Manholes or handholes to be cleaned will be identified on the plans or by the Resident Engineer.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.01 CLEANING

A. The inside dimension of the handhole will normally be 30 to 36 inches in diameter and three feet in depth. The inside dimension of the manhole will normally be 3'x4'x4' or 4'x6'x6'. Handholes and manholes of other dimensions may be encountered. Cleaning will include opening the lid and placing the lid back in place after cleaning. The cables must not be damaged or disturbed during the cleaning process. All debris removed from the hole must be properly disposed of in an approved manner and not be left in the public way or dumped into the City sewer system. Guidelines outlined in Section 202.03 of the Standard Specifications should be followed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CLEAN EXISTING MANHOLE OR HANDHOLE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of CLEAN EXISTING MANHOLE OR HANDHOLE shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 01 30

CONDUIT ATTACHED TO STRUCTURE, 1 ½" DIA., PVC COATED, GALVANIZED STEEL

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing lateral of CONDUIT ATTACHED TO STRUCTURE, 1 ½" DIA., PVC COATED, GALVANIZED STEEL

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid steel conduit and PVC coated steel conduit must conform to the requirements of Material Specification 1462. Polyvinyl chloride (PVC) conduit must conform to the requirements of Material Specification 1533 and to the requirements of the National Electrical Manufacturers Association Standard, Publication Number TC2 for EPC-40, or EPC-80. Conduit color will be determined by the Resident Engineer.

B. Coilable non-metallic conduit must be a high density polyethylene meeting the requirements of Material Specification 1533 and ASTM-D1248, Type III, Grade PE34, Category 5, and Class C. The duct must meet the requirements of Section 1088.01(c) of the Standard Specifications. The average outside diameter of the 1.25 inch duct must be 1.66 inches, with a minimum wall thickness of .15 inches for the Schedule 40 conduit, and a wall thickness of .20 for the Schedule 80 conduit. Conduit color will be as determined by the Resident Engineer.

C. Aluminum conduit will be rigid wall conduit with a minimum wall thickness of 0.099". The conduit will be extruded from 6063 aluminum alloy and tempered to T-1. Aluminum conduit must meet the requirements of UL-6 and ANSI C80.5.

PART 3 EXECUTION

3.01 DEFINITION OF LATERALS

A. A lateral will mean a conduit raceway extending from one sub surface location to another sub surface location, and in every case intended to encase electric circuit cable under paved surfaces, or in unpaved parkway, street or alley, where specifically designated

3.02 LOCATIONS

A. Laterals must be installed at the locations shown on the construction plans. Laterals must be installed in the shortest practicable line between points of termination, or under adverse conditions, as directed by the Resident Engineer. Laterals not shown on the drawing, but necessary to be installed will be paid for at the unit price bid for laterals as additional units of construction.

3.03 INSTALLATION REQUIREMENTS

A. Galvanized rigid steel conduit may be installed in a trench, pushed underground, or attached to a structure. PVC conduit will normally be installed in a trench or attached to a structure. Coilable conduit will be installed in a trench for short distances only. The normal installation method for coilable conduit is directional boring. The Contractor must exercise care in installing the conduit to ensure that it is smooth, free from sharp bends or kinks, and has the minimum practicable number of bends. Crushed or deformed conduit will not be accepted. All conduit and fittings must have the burrs and rough places smoothed, and all conduit runs must be cleaned and swabbed before installation of electric cables. If cable is not to be installed immediately after cleaning of the conduit, a light weight pulling line such as 1/8" polyethylene line must be placed in the conduit and will remain in the conduit for future work. The excavation for pushing conduit must be located at least two feet (2') from the edge of pavement. All underground conduits must have a minimum cover of thirty inches (30") below grade. If conduit cannot be installed with a minimum cover of thirty inches (30"), the conduit must be encased in concrete for protection. The method of encasement and protection must be approved by the engineer. Concrete encasement will be paid for as a separate pay item.

B. When multiple laterals in a common trench are required, no more than three (3) three inch (3") or smaller conduit laterals can be laid on a single, horizontal level. Four or more conduit laterals must be installed on two (2) levels in accordance with instructions of the Resident Engineer.

C. Conduit laterals attached to a structure must be flush to the structure where possible. Clamps or hangers must be used at a maximum interval of five feet (5') to hold the conduit rigidly in place. Fittings must be supplied and installed that are compatible with the conduit in use. Expansion couplings must be used at locations where the conduit crosses expansion joints in the structure.

D. Conduit laterals installed under vaulted walks must be securely attached to the retaining wall by means of galvanized clamps and clamp backs held in place by anchor bolts. Laterals will be fastened as close to the underside of the sidewalk as possible, and securing clamps installed every five feet (5'). Laterals must be continuous through party walls.

E. Threaded fittings and bends of the same material as conduit must be furnished and installed as required. Threadless couplings may be used only for splicing existing conduit. All conduit splices, where required, will be considered incidental to this pay item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CONDUIT ATTACHED TO STRUCTURE, 1 ½” DIA., PVC COATED, GALVANIZED STEEL shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of CONDUIT ATTACHED TO STRUCTURE, 1 ½” DIA., PVC COATED, GALVANIZED STEEL included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1462, 1533

END OF SECTION

SECTION 26 01 32

PVC CONDUIT IN TRENCH 2” (SCHEDULE #40)

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing lateral of PVC CONDUIT IN TRENCH 2” (SCHEDULE #40)

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid steel conduit and PVC coated steel conduit must conform to the requirements of Material Specification 1462. Polyvinyl chloride (PVC) conduit must conform to the requirements of Material Specification 1533 and to the requirements of the National Electrical Manufacturers Association Standard, Publication Number TC2 for EPC-40, or EPC-80. Conduit color will be determined by the Resident Engineer.

B. Coilable non-metallic conduit must be a high density polyethylene meeting the requirements of Material Specification 1533 and ASTM-D1248, Type III, Grade PE34, Category 5, and Class C. The duct must meet the requirements of Section 1088.01(c) of the Standard Specifications. The average outside diameter of the 1.25 inch duct must be 1.66 inches, with a minimum wall thickness of .15 inches for the Schedule 40 conduit, and a wall thickness of .20 for the Schedule 80 conduit. Conduit color will be as determined by the Resident Engineer.

C. Aluminum conduit will be rigid wall conduit with a minimum wall thickness of 0.099”. The conduit will be extruded from 6063 aluminum alloy and tempered to T-1. Aluminum conduit must meet the requirements of UL-6 and ANSI C80.5.

PART 3 EXECUTION

3.01 DEFINITION OF LATERALS

A. A lateral will mean a conduit raceway extending from one sub surface location to another sub surface location, and in every case intended to encase electric circuit cable under paved surfaces, or in unpaved parkway, street or alley, where specifically designated

3.02 LOCATIONS

A. Laterals must be installed at the locations shown on the construction plans. Laterals must be installed in the shortest practicable line between points of termination, or under adverse conditions, as directed by the Resident Engineer. Laterals not shown on the drawing, but necessary to be installed will be paid for at the unit price bid for laterals as additional units of construction.

3.03 INSTALLATION REQUIREMENTS

A. Galvanized rigid steel conduit may be installed in a trench, pushed underground, or attached to a structure. PVC conduit will normally be installed in a trench or attached to a structure. Coilable conduit will be installed in a trench for short distances only. The normal installation method for coilable conduit is directional boring. The Contractor must exercise care in installing the conduit to ensure that it is smooth, free from sharp bends or kinks, and has the minimum practicable number of bends. Crushed or deformed conduit will not be accepted. All conduit and fittings must have the burrs and rough places smoothed, and all conduit runs must be cleaned and swabbed before installation of electric cables. If cable is not to be installed immediately after cleaning of the conduit, a light weight pulling line such as 1/8" polyethylene line must be placed in the conduit and will remain in the conduit for future work. The excavation for pushing conduit must be located at least two feet (2') from the edge of pavement. All underground conduits must have a minimum cover of thirty inches (30") below grade. If conduit cannot be installed with a minimum cover of thirty inches (30"), the conduit must be encased in concrete for protection. The method of encasement and protection must be approved by the engineer. Concrete encasement will be paid for as a separate pay item.

B. When multiple laterals in a common trench are required, no more than three (3) three inch (3") or smaller conduit laterals can be laid on a single, horizontal level. Four or more conduit laterals must be installed on two (2) levels in accordance with instructions of the Resident Engineer.

C. Conduit laterals attached to a structure must be flush to the structure where possible. Clamps or hangers must be used at a maximum interval of five feet (5') to hold the conduit rigidly in place. Fittings must be supplied and installed that are compatible with the conduit in use. Expansion couplings must be used at locations where the conduit crosses expansion joints in the structure.

D. Conduit laterals installed under vaulted walks must be securely attached to the retaining wall by means of galvanized clamps and clamp backs held in place by anchor bolts. Laterals will be fastened as close to the underside of the sidewalk as possible, and securing clamps installed every five feet (5'). Laterals must be continuous through party walls.

E. Threaded fittings and bends of the same material as conduit must be furnished and installed as required. Threadless couplings may be used only for splicing existing conduit. All conduit splices, where required, will be considered incidental to this pay item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PVC CONDUIT IN TRENCH 2” (SCHEDULE #40) shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of PVC CONDUIT IN TRENCH 2” (SCHEDULE #40) be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1462, 1533

END OF SECTION

SECTION 26 01 33

PVC CONDUIT IN TRENCH 3” (SCHEDULE #40)

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing lateral of PVC CONDUIT IN TRENCH 3” (SCHEDULE #40)

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid steel conduit and PVC coated steel conduit must conform to the requirements of Material Specification 1462. Polyvinyl chloride (PVC) conduit must conform to the requirements of Material Specification 1533 and to the requirements of the National Electrical Manufacturers Association Standard, Publication Number TC2 for EPC-40, or EPC-80. Conduit color will be determined by the Resident Engineer.

B. Coilable non-metallic conduit must be a high density polyethylene meeting the requirements of Material Specification 1533 and ASTM-D1248, Type III, Grade PE34, Category 5, and Class C. The duct must meet the requirements of Section 1088.01(c) of the Standard Specifications. The average outside diameter of the 1.25 inch duct must be 1.66 inches, with a minimum wall thickness of .15 inches for the Schedule 40 conduit, and a wall thickness of .20 for the Schedule 80 conduit. Conduit color will be as determined by the Resident Engineer.

C. Aluminum conduit will be rigid wall conduit with a minimum wall thickness of 0.099”. The conduit will be extruded from 6063 aluminum alloy and tempered to T-1. Aluminum conduit must meet the requirements of UL-6 and ANSI C80.5.

PART 3 EXECUTION

3.01 DEFINITION OF LATERALS

A. A lateral will mean a conduit raceway extending from one sub surface location to another sub surface location, and in every case intended to encase electric circuit cable under paved surfaces, or in unpaved parkway, street or alley, where specifically designated

3.02 LOCATIONS

A. Laterals must be installed at the locations shown on the construction plans. Laterals must be installed in the shortest practicable line between points of termination, or under adverse conditions, as directed by the Resident Engineer. Laterals not shown on the drawing, but necessary to be installed will be paid for at the unit price bid for laterals as additional units of construction.

3.03 INSTALLATION REQUIREMENTS

A. Galvanized rigid steel conduit may be installed in a trench, pushed underground, or attached to a structure. PVC conduit will normally be installed in a trench or attached to a structure. Coilable conduit will be installed in a trench for short distances only. The normal installation method for coilable conduit is directional boring. The Contractor must exercise care in installing the conduit to ensure that it is smooth, free from sharp bends or kinks, and has the minimum practicable number of bends. Crushed or deformed conduit will not be accepted. All conduit and fittings must have the burrs and rough places smoothed, and all conduit runs must be cleaned and swabbed before installation of electric cables. If cable is not to be installed immediately after cleaning of the conduit, a light weight pulling line such as 1/8" polyethylene line must be placed in the conduit and will remain in the conduit for future work. The excavation for pushing conduit must be located at least two feet (2') from the edge of pavement. All underground conduits must have a minimum cover of thirty inches (30") below grade. If conduit cannot be installed with a minimum cover of thirty inches (30"), the conduit must be encased in concrete for protection. The method of encasement and protection must be approved by the engineer. Concrete encasement will be paid for as a separate pay item.

B. When multiple laterals in a common trench are required, no more than three (3) three inch (3") or smaller conduit laterals can be laid on a single, horizontal level. Four or more conduit laterals must be installed on two (2) levels in accordance with instructions of the Resident Engineer.

C. Conduit laterals attached to a structure must be flush to the structure where possible. Clamps or hangers must be used at a maximum interval of five feet (5') to hold the conduit rigidly in place. Fittings must be supplied and installed that are compatible with the conduit in use. Expansion couplings must be used at locations where the conduit crosses expansion joints in the structure.

D. Conduit laterals installed under vaulted walks must be securely attached to the retaining wall by means of galvanized clamps and clamp backs held in place by anchor bolts. Laterals will be fastened as close to the underside of the sidewalk as possible, and securing clamps installed every five feet (5'). Laterals must be continuous through party walls.

E. Threaded fittings and bends of the same material as conduit must be furnished and installed as required. Threadless couplings may be used only for splicing existing conduit. All conduit splices, where required, will be considered incidental to this pay item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PVC CONDUIT IN TRENCH 3” (SCHEDULE #40) shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of PVC CONDUIT IN TRENCH 3” (SCHEDULE #40) be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1462, 1533

END OF SECTION

SECTION 26 01 37

PVC CONDUIT IN TRENCH 3” (SCHEDULE #80)

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing lateral of PVC CONDUIT IN TRENCH 3” (SCHEDULE #80)

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid steel conduit and PVC coated steel conduit must conform to the requirements of Material Specification 1462. Polyvinyl chloride (PVC) conduit must conform to the requirements of Material Specification 1533 and to the requirements of the National Electrical Manufacturers Association Standard, Publication Number TC2 for EPC-40, or EPC-80. Conduit color will be determined by the Resident Engineer.

B. Coilable non-metallic conduit must be a high density polyethylene meeting the requirements of Material Specification 1533 and ASTM-D1248, Type III, Grade PE34, Category 5, and Class C. The duct must meet the requirements of Section 1088.01(c) of the Standard Specifications. The average outside diameter of the 1.25 inch duct must be 1.66 inches, with a minimum wall thickness of .15 inches for the Schedule 40 conduit, and a wall thickness of .20 for the Schedule 80 conduit. Conduit color will be as determined by the Resident Engineer.

C. Aluminum conduit will be rigid wall conduit with a minimum wall thickness of 0.099”. The conduit will be extruded from 6063 aluminum alloy and tempered to T-1. Aluminum conduit must meet the requirements of UL-6 and ANSI C80.5.

PART 3 EXECUTION

3.01 DEFINITION OF LATERALS

A. A lateral will mean a conduit raceway extending from one sub surface location to another sub surface location, and in every case intended to encase electric circuit cable under paved surfaces, or in unpaved parkway, street or alley, where specifically designated

3.02 LOCATIONS

A. Laterals must be installed at the locations shown on the construction plans. Laterals must be installed in the shortest practicable line between points of termination, or under adverse conditions, as directed by the Resident Engineer. Laterals not shown on the drawing, but necessary to be installed will be paid for at the unit price bid for laterals as additional units of construction.

3.03 INSTALLATION REQUIREMENTS

A. Galvanized rigid steel conduit may be installed in a trench, pushed underground, or attached to a structure. PVC conduit will normally be installed in a trench or attached to a structure. Coilable conduit will be installed in a trench for short distances only. The normal installation method for coilable conduit is directional boring. The Contractor must exercise care in installing the conduit to ensure that it is smooth, free from sharp bends or kinks, and has the minimum practicable number of bends. Crushed or deformed conduit will not be accepted. All conduit and fittings must have the burrs and rough places smoothed, and all conduit runs must be cleaned and swabbed before installation of electric cables. If cable is not to be installed immediately after cleaning of the conduit, a light weight pulling line such as 1/8" polyethylene line must be placed in the conduit and will remain in the conduit for future work. The excavation for pushing conduit must be located at least two feet (2') from the edge of pavement. All underground conduits must have a minimum cover of thirty inches (30") below grade. If conduit cannot be installed with a minimum cover of thirty inches (30"), the conduit must be encased in concrete for protection. The method of encasement and protection must be approved by the engineer. Concrete encasement will be paid for as a separate pay item.

B. When multiple laterals in a common trench are required, no more than three (3) three inch (3") or smaller conduit laterals can be laid on a single, horizontal level. Four or more conduit laterals must be installed on two (2) levels in accordance with instructions of the Resident Engineer.

C. Conduit laterals attached to a structure must be flush to the structure where possible. Clamps or hangers must be used at a maximum interval of five feet (5') to hold the conduit rigidly in place. Fittings must be supplied and installed that are compatible with the conduit in use. Expansion couplings must be used at locations where the conduit crosses expansion joints in the structure.

D. Conduit laterals installed under vaulted walks must be securely attached to the retaining wall by means of galvanized clamps and clamp backs held in place by anchor bolts. Laterals will be fastened as close to the underside of the sidewalk as possible, and securing clamps installed every five feet (5'). Laterals must be continuous through party walls.

E. Threaded fittings and bends of the same material as conduit must be furnished and installed as required. Threadless couplings may be used only for splicing existing conduit. All conduit splices, where required, will be considered incidental to this pay item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PVC CONDUIT IN TRENCH 3” (SCHEDULE #80) shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of PVC CONDUIT IN TRENCH 3” (SCHEDULE #80) be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1462, 1533

END OF SECTION

SECTION 26 01 38

PVC CONDUIT IN TRENCH 4” (SCHEDULE #80)

PART 1 GENERAL

1.01 SUMMARY

A. This work consists of furnishing and installing lateral of PVC CONDUIT IN TRENCH 4” (SCHEDULE #80)

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid steel conduit and PVC coated steel conduit must conform to the requirements of Material Specification 1462. Polyvinyl chloride (PVC) conduit must conform to the requirements of Material Specification 1533 and to the requirements of the National Electrical Manufacturers Association Standard, Publication Number TC2 for EPC-40, or EPC-80. Conduit color will be determined by the Resident Engineer.

B. Coilable non-metallic conduit must be a high density polyethylene meeting the requirements of Material Specification 1533 and ASTM-D1248, Type III, Grade PE34, Category 5, and Class C. The duct must meet the requirements of Section 1088.01(c) of the Standard Specifications. The average outside diameter of the 1.25 inch duct must be 1.66 inches, with a minimum wall thickness of .15 inches for the Schedule 40 conduit, and a wall thickness of .20 for the Schedule 80 conduit. Conduit color will be as determined by the Resident Engineer.

C. Aluminum conduit will be rigid wall conduit with a minimum wall thickness of 0.099”. The conduit will be extruded from 6063 aluminum alloy and tempered to T-1. Aluminum conduit must meet the requirements of UL-6 and ANSI C80.5.

PART 3 EXECUTION

3.01 DEFINITION OF LATERALS

A. A lateral will mean a conduit raceway extending from one sub surface location to another sub surface location, and in every case intended to encase electric circuit cable under paved surfaces, or in unpaved parkway, street or alley, where specifically designated

3.02 LOCATIONS

A. Laterals must be installed at the locations shown on the construction plans. Laterals must be installed in the shortest practicable line between points of termination, or under adverse conditions, as directed by the Resident Engineer. Laterals not shown on the drawing, but necessary to be installed will be paid for at the unit price bid for laterals as additional units of construction.

3.03 INSTALLATION REQUIREMENTS

A. Galvanized rigid steel conduit may be installed in a trench, pushed underground, or attached to a structure. PVC conduit will normally be installed in a trench or attached to a structure. Coilable conduit will be installed in a trench for short distances only. The normal installation method for coilable conduit is directional boring. The Contractor must exercise care in installing the conduit to ensure that it is smooth, free from sharp bends or kinks, and has the minimum practicable number of bends. Crushed or deformed conduit will not be accepted. All conduit and fittings must have the burrs and rough places smoothed, and all conduit runs must be cleaned and swabbed before installation of electric cables. If cable is not to be installed immediately after cleaning of the conduit, a light weight pulling line such as 1/8" polyethylene line must be placed in the conduit and will remain in the conduit for future work. The excavation for pushing conduit must be located at least two feet (2') from the edge of pavement. All underground conduits must have a minimum cover of thirty inches (30") below grade. If conduit cannot be installed with a minimum cover of thirty inches (30"), the conduit must be encased in concrete for protection. The method of encasement and protection must be approved by the engineer. Concrete encasement will be paid for as a separate pay item.

B. When multiple laterals in a common trench are required, no more than three (3) three inch (3") or smaller conduit laterals can be laid on a single, horizontal level. Four or more conduit laterals must be installed on two (2) levels in accordance with instructions of the Resident Engineer.

C. Conduit laterals attached to a structure must be flush to the structure where possible. Clamps or hangers must be used at a maximum interval of five feet (5') to hold the conduit rigidly in place. Fittings must be supplied and installed that are compatible with the conduit in use. Expansion couplings must be used at locations where the conduit crosses expansion joints in the structure.

D. Conduit laterals installed under vaulted walks must be securely attached to the retaining wall by means of galvanized clamps and clamp backs held in place by anchor bolts. Laterals will be fastened as close to the underside of the sidewalk as possible, and securing clamps installed every five feet (5'). Laterals must be continuous through party walls.

E. Threaded fittings and bends of the same material as conduit must be furnished and installed as required. Threadless couplings may be used only for splicing existing conduit. All conduit splices, where required, will be considered incidental to this pay item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PVC CONDUIT IN TRENCH 4” (SCHEDULE #80) shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of PVC CONDUIT IN TRENCH 4” (SCHEDULE #80) be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1462, 1533

END OF SECTION

SECTION 26 01 44

ROD AND CLEAN DUCT IN EXISTING CONDUIT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements for rod and clean duct in existing conduit system. work will consist of inserting a duct rod or electrical fish rod or tape of sufficient length and rigidity into an electrical conduit opening in one electrical manhole or handhole, and pushing the said rod through the conduit to emerge at the next or subsequent manhole in the conduit system at the location shown on the plans. The duct rod may be inserted and removed by any standard construction method which causes no damage to the conduit system. The size of the conduit may vary from two inch (2") to four inch (4"), but there will be no differentiation in cost for the size of the conduit.

B. The conduit system which is to be rodded and cleaned may exist with various amounts of standing water in the manholes. The contractor must pump the water or sufficient water from the manholes to drain the conduit and to afford compatible working conditions for the installation of the duct rods and/or cables. The pumping of the manholes will be incidental to the work of rodding and cleaning of the conduit. Any manhole which, in the opinion of the Resident Engineer contains excessive debris, dirt or other materials to the extent that conduit rodding and cleaning is not feasible, will be cleaned at the Engineer's order and payment approved as a separate pay item, and not a part of this specification.

C. Any manhole which, in the opinion of the Resident Engineer contains excessive debris, dirt or other materials to the extent that conduit rodding and cleaning is not feasible, will be cleaned at the Engineer's order and payment approved as a separate pay item, and not a part of this specification.

D. Prior to removal, of the duct rod, a duct cleaning attachment such as a properly sized wire brush or cleaning mandrel must be attached to the duct rod, which by removal of the duct rod will be pulled through the conduit to remove sand, grit, or other light obstructions from the duct to provide a clean, clear passage for the installation of cable. Whenever the installation of cables is not performed as an adjunct to or immediately following the cleaning of the duct, a light weight pulling line such as a 1/8" polyethylene line or conduit measuring tape must be placed and will remain in the conduit to facilitate future work. When great difficulty of either inserting the duct rod or removal of the cleaning mandrel is encountered, the duct may require further cleaning by use of a compressed air gun, or a low pressure water hose. In the case of a broken duct line, the conduit must be excavated and repaired. The existence and location of breaks in the duct line may be determined by rodding, but the excavation and repair work required will not be a part of this pay item.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ROD AND CLEAN DUCT IN EXISTING CONDUIT SYSTEM shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ROD AND CLEAN DUCT IN EXISTING CONDUIT SYSTEM shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 01 45A

CONCRETE FOUNDATION FOR TYPE “SUPER P” BASE MOUNTED TRAFFIC SIGNAL CONTROLLER

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Division this item will be performed in accordance with Division 800 of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

1.02 SUMMARY

A. This work consists of installing a foundation for a “Super P” cabinet, as shown on City of Chicago Drawing Number 888A

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Galvanized rigid Concrete will be Portland cement concrete, SI Class, meeting the requirements of Article 1020 of the Standard Specifications. Ground rods will meet the requirements of Material Specification 1465. Conduit will be PVC meeting the requirements of Material Specification 1533. Anchor rods will meet the applicable requirements of Material Specification 1467.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. The Contractor will install a concrete foundation for a base mounted traffic signal controller cabinet, as shown on CiDivision of Electrical Operations Drawing Number 888A for a “Super P” cabinet. Work under this item will be performed in accordance with Article 800 of the Standard Specifications.

B. The foundation will have a minimum depth of at least forty inches (40") below grade and must have large radius conduit elbows in quantity, size and type shown. The elbow ends above ground will be capped with standard conduit bushings. The ground rod will be installed adjacent to the foundation, and will be driven straight down with the top to be no higher than 30 inches below finished grade. The Contractor will furnish anchor bolts, hardware, conduit elbows, and all other material shown on the foundation construction drawing.

C. All excavation and restoration of parkway will be considered as part of this item. If the foundation is in sidewalk, an expansion joint will be required between the sidewalk and the foundation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CONCRETE FOUNDATION FOR TYPE “SUPER P” BASE MOUNTED TRAFFIC SIGNAL CONTROLLER shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of CONCRETE FOUNDATION FOR TYPE “SUPER P” BASE MOUNTED TRAFFIC SIGNAL CONTROLLER included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1465, 1467, 1533

END OF SECTION

SECTION 26 01 51

CONCRETE FOUNDATION, 24” DIAMETER, 1 ¼” ANCHOR RODS, 15” BOLT CIRCLE, 7 FEET

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. This item will be performed in accordance with Division 1000 of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

B. Specifications 1465, 1467, 1533, and drawing 811, 818, 11825, and 837 of the City of Chicago Department of Transportation Division of Electrical Operations.

1.02 SUMMARY

A. This foundation will be a poured in place concrete structure used for structurally supporting street light poles or traffic signal poles.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete must be Portland cement concrete meeting the requirements of Article 1020 of the Standard Specifications for SI Class concrete. Reinforcement bars must meet the requirements of Section 1006.10 of the Standard Specifications. Anchor rods must meet the requirements of Material Specification 1467 and the ground rod must meet the requirements of Material Specification 1465. Conduit elbows must be PVC conduit meeting the requirements of Material Specification 1533.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Every foundation will be installed at the location designated and in the manner herein specified or in special cases as specifically directed. The contractor will locate foundations as per plan or as directed by the Resident Engineer. A hole must be augered for placement of the concrete form.

B. Top surface of these foundations in parkway will be at an elevation of two inches (2") above grade or as required by the Engineer. Care must be taken to install a level foundation and to ensure adequate anchor rod projections for double nut installation. The foundations must be centered back from the face of the curb in accordance with dimensions shown on the construction plans. Foundation raceways must consist of large radius conduit elbow(s) in quantity, size and type as specified on the corresponding standard drawing or in the construction plans. Any number of elbows in excess of the number shown on the standard drawing must be paid for under a separate pay item. The elbow ends above ground will be capped with standard conduit bushings. The Contractor must furnish anchor rods, a ground rod, hardware, conduit elbow(s) and all other

material shown on applicable foundation construction drawings. Depth of foundation will be as shown on the appropriate drawing. The foundation top must be chamfered 3/4 of an inch. When the foundation is installed in a sidewalk, the foundation must be installed level, with the height of the foundation as close to the height of the sidewalk as possible, or as directed by the Engineer. A proper expansion joint will be installed between the sidewalk and the foundation.

C. Anchor rods must be set in accordance with applicable construction plans so that when poles are mounted on the foundations, the street lighting mast arm will be properly oriented as indicated on the construction plans. The anchor rods will be set by means of a metal template which shall be submitted for approval before any foundation work is begun. The template must hold the rods vertical, and in proper position. Anchor rods must conform in all respects to the appropriate City drawing

4 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CONCRETE FOUNDATION, 24” DIAMETER, 1 ¼” ANCHOR RODS, 15” BOLT CIRCLE, 7 FEET, shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of CONCRETE FOUNDATION, 24” DIAMETER, 1 ¼” ANCHOR RODS, 15” BOLT CIRCLE, 7 FEET, included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1465, 1467, 1533

END OF SECTION

SECTION 26 02 38

CIRCUIT BREAKER, 1 POLE, 70 AMPERE, 600 VOLT IN STREET LIGHT CONTROLLER

PART 1 GENERAL

1.01 SUMMARY

A. This item will consist of furnishing and installing a single pole or double pole thermal magnetic circuit breaker in an existing arterial street light controller at the designated location creating a controlled power source to supply a proposed traffic signal controller or other electrical device or circuit.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The material of the circuit breaker must meet the requirements of Specification 1428.

PART 3 EXECUTION

3.01 INSTALLATION

A. The circuit breaker must be mounted on a 3/8" thick phenolic linen base bakelite panel 3" x 8" which will be attached on the inside of the lower left hand side of the controller cabinet with 4 1/4" 20x7/8" brass screws in holes which will be drilled and tapped into the side of the cabinet for this purpose. The ends of any screws protruding through the side of cabinet wall must be filed or ground off flush with the face of the cabinet. The bakelite panel shall be set out from the wall of the controller cabinet using four 1/4" bakelite spacer washers, one at each mounting screw position.

B. The line side terminal of the circuit breaker must be connected to one of the line side terminals of the main circuit breaker with a 1/C #4 600V 90 degree C. insulated copper cable trained around the cabinet in a neat and workman like manner. This cable will be a part of the installation of the circuit breaker and will not be a separate pay item. The installation and connection of the load side cables servicing the traffic signal controller will be a part of the installation of service cable and not a part of the installation of the circuit breaker.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CIRCUIT BREAKER, 1 POLE, 70 AMPERE, 600 VOLT IN STREET LIGHT CONTROLLER shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of CIRCUIT BREAKER, 1 POLE, 70 AMPERE, 600 VOLT IN STREET LIGHT CONTROLLER be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1428

END OF SECTION

SECTION 26 03 00

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Work required for this Section includes providing all labor, material, apparatus, equipment and services necessary to disconnect and remove electrical items which are affected by or rendered obsolete by demolition work.

B. Major items with all related appurtenances, which are rendered obsolete and require removal in the areas being demolished, include but are not limited to, the following:

1 Abandoned underground.
2 Existing wayside communication cables upon installation and complete testing of new temporary wayside communication cables.
3 Temporary power and lighting cable and conduit from source to point of use.
4 Temporary wayside communication cables upon installation and complete testing of new wayside communication cables.

C. All material, equipment, damaged items, conduit and wire rendered obsolete shall be removed from the premises and properly disposed of off-site by the Contractor.

D. Items being removed which are salvageable and serviceable (such as lighting fixtures, wiring devices, signal and telecommunication devices) shall remain the property of the Authority and to be stored by the Contractor in locations on site where directed by the Commissioner and Authority. Items of doubtful classification shall be reviewed with the Commissioner's representative prior to disposal of same to determine their disposition. Care shall be exercised in the removal of these items to avoid damage.

E. Relocation and/or modifications to certain existing equipment may be required to retain services to existing adjacent systems or equipment which are to remain. Such relocation and/or modification costs to be included in the Base Bid and no additional compensation will be allowed.

F. Include providing new conduit, wiring, boxes, outlets, fittings, etc. as may be required for such relocation and retention of services.

1.03 RELATED WORK

A. ELECTRICAL DEMOLITION specified to be furnished and installed herein have related work in various other sections including, but not limited to:

1. Section 260100 "General Provisions"

2. Section 260500 “Raceways and Boxes”
3. Section 261000 “Basic Electrical Materials and Methods”
4. Section 261230 “Wires, Cables, Splices, Terminations”
5. Section 261410 “Wiring Devices”
6. Section 261700 “Local Control”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 SPECIAL CONDITIONS

A. Visit the Project Site and thoroughly investigate existing conditions. Carefully evaluate all existing Electrical Work which is to be removed, altered or modified, and include all these costs in the Bid. Determine existing installation Work which is to remain to serve areas outside the limits of demolition Work and include all costs of relocation Work which may be required to retain these services. No additional costs are allowed for failure to include all labor and material that is required for demolition, relocation or modification to the existing electrical installation. If any potential problems are envisioned during the site visit which could affect the Work to be done, they shall be brought to the immediate attention of the Commissioner.

B. Electrical demolition to be done according to the schedule established for general demolition work to eliminate any conflicts, interferences or delays.

C. Exercise care in demolition work so as not to damage or interrupt existing services which may pass through the areas of demolition and serve areas outside the demolition work areas which are to remain.

PART 4 MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of ELECTRICAL DEMOLITION will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of ELECTRICAL DEMOLITION must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 03 03

SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 3-SECTION, BRACKET MOUNTED
SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 5-SECTION, BRACKET MOUNTED

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Material Specifications 1475, 1493, 1495 and drawing number 834, 835, 741, 740, and 12268a of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This item will consist of furnishing and installing a traffic signal head or combination of heads on a street light pole, a traffic signal pole, or a traffic signal post as shown on the plans, as specified herein, or as directed by the Engineer. Specific installations and configurations are shown on Drawing Numbers 834 and 835, entitled "Standard Traffic Signal Mounting Details".

B. The type of installation will be as indicated on the plans. The number of signal faces, the number of signal sections in each signal face, any dual indication sections, and the method of mounting will be as indicated in the plans and in the standard drawings.

C. The type of installation will be as indicated on the plans. The number of signal faces, the number of signal sections in each signal face, any dual indication sections, and the method of mounting will be as indicated in the plans and in the standard drawings.

D. During construction and until the installation is placed in operation, all signal faces must be hooded. The hooding material must be securely fastened so it will not be disturbed by normal inclement weather or wind.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The traffic signal must meet the requirements of Material Specification 1493 for LED signals. The mounting brackets must meet the requirements of Material Specification 1495

PART 3 EXECUTION

3.01 CONSTRUCTION METHOD

A. The signals must be mounted using pole mounting brackets banded to the pole with two strips of 3/4" stainless steel banding single wrapped, one at the top and one at the bottom of the brackets, each secured with a stainless steel banding clip. The banding and clips will be coated with a baked-on black finish. The mounting configuration connecting the signals to the mounting bracket must consist polycarbonate brackets specifically made for mounting signal heads to the side of

poles, to create the designated structure. When the signals are to be mounted on a square pole or flat surface, the bracket used will be bolted to the flat pole or surface using 3/8" drive studs where permissible or using a 3/8" studs in a tapped hole.

B. The bottom mounting bracket must be accurately located to cover a hole 1" in diameter for the cable entrance drilled into the pole at a height calculated to position the bottom signal face at a standard height of 10 feet, or a height indicated on the plans. The hole must be reamed or filed to remove all sharp edges or burrs which might damage cable during installation, or through vibration when the signals are in operation.

C. The Contractor must provide and install a length of 8/C #16 AWG flexible electric cord, of sufficient length to extend without strain or stress from the terminal strip in the signal head to the terminal strip in the junction box mounted on the pole. The number of conductors in the cord, and the color coding of the conductors, must be sufficient to match the requirements of the signal head being installed, and must be so connected in accordance with Material Specification 1494. Both ends of the cable must be carefully stripped of six inches (6") of jacket and one inch (1") of insulation, and each conductor properly tinned. The service cord from the signal head must enter the pole through the bottom mounting bracket and enter the long sweep elbow to terminate by attachment to the terminal strip in accordance with the terminal strip connector schematic, Bureau of Electricity Drawing Number 12268A

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 3-SECTION, BRACKET MOUNTED or SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 5-SECTION, BRACKET MOUNTED shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 3-SECTION, BRACKET MOUNTED or SIGNAL HEAD, POLYCARBONATE, LED, 1-FACE, 5-SECTION, BRACKET MOUNTED be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1475, 1493, 1495

END OF SECTION

SECTION 26 03 15

PEDESTRIAN SIGNAL HEAD, POLYCARBONATE, 1-FACE, LED, COUNTDOWN, BRACKET MOUNTED

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Material Specifications 1494, 1495, 1475, 1545 and drawing number 834, 835, 741, 740, and 12268a of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This item will consist of furnishing and installing a pedestrian signal on a street light pole, a traffic signal pole or a traffic signal post as shown on the plans, as specified herein, or as directed by the Engineer. The signal may be installed as a single unit on a pole or in combination with other pedestrian signals or with traffic signals of various types and sizes. Specific installations and configurations are shown on Drawing Numbers 834 and 835 entitled "Standard Traffic Signal Mounting Details".

B. The method of mounting will be indicated on the plans, or as directed by the engineer. Each signal face must be pointed in the direction of the marked cross walk area for the pedestrians it is intended to control

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The pedestrian signal head material must be consistent with the requirements of Bureau of Electricity Material Specification 1494. The countdown pedestrian signal must meet the requirements of Material Specification 1545. All housing units must be made of polycarbonate. The light source must be LED. Mounting hardware must meet the requirements of Material Specification 1495. Cable must meet the requirements of Material Specification 1475.

PART 3 EXECUTION

3.01 CONSTRUCTION METHOD

A. The signal must be mounted using pole mounting brackets banded to the pole with two strips of 3/4" stainless steel banding, single wrapped, one at the top and one at the bottom of the bracket, each secured with a stainless steel banding clip. The banding and clips must have a baked-on black finish. The mounting configuration connecting the signals to the mounting bracket must consist of polycarbonate brackets specifically made for mounting signal heads to the side of poles, to create the designated structure.

B. The bottom mounting bracket must be accurately located to cover a hole 1" in diameter for the cable entrance drilled into the pole at a height calculated to position the bottom signal face at a standard height of 10 feet, or a height indicated on the plans. The hole must be reamed or filed to

remove all sharp edges or burrs which might damage cable during installation, or through vibration when the signals are in operation.

C. When the pedestrian signal is attached below a traffic signal head, the separate opening for cable may be omitted to eliminate additional weakening of the pole and the pedestrian signal cord will be installed using the same opening as the traffic signal cord.

D. The Contractor must provide and install a length of 8/C #16 AWG flexible electric cord, of sufficient length to extend without strain or stress from the terminal strip in the signal head to the terminal strip in the junction box mounted on the pole. The number of conductors in the cord, and the color coding of the conductors, must be sufficient to match the requirements of the signal head being installed, and must be so connected in accordance with Material Specification 1494. Both ends of the cable must be carefully stripped of six inches (6") of jacket and one inch (1") of insulation, and each conductor properly tinned. The service cord from the signal head must enter the pole through the bottom mounting bracket and enter the long sweep elbow to terminate by attachment to the terminal strip in accordance with the terminal strip connector schematic, Bureau of Electricity Drawing Number 12268A

E. During construction and until the installation is placed in operation, all signal faces must be hooded. The hooding material must be securely fastened so it will not be disturbed by inclement weather or wind.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PEDESTRIAN SIGNAL HEAD, POLYCARBONATE, 1-FACE, LED, COUNTDOWN, BRACKET MOUNTED shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of PEDESTRIAN SIGNAL HEAD, POLYCARBONATE, 1-FACE, LED, COUNTDOWN, BRACKET MOUNTED be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1475, 1494, 1495, 1545

END OF SECTION

SECTION 26 03 15A

ACCESSIBLE PEDESTRIAN SIGNAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Material Specifications 1618 and 1619 of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This work shall consist of furnishing and installing an accessible pedestrian signal (APS) to be mounted on a traffic signal pole or post.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The APS must meet the requirements of Material Specification 1618. Cable for the APS must meet the requirements of Material Specification 1619.

PART 3 EXECUTION

3.01 INSTALLATION

A. The location of the APS shall be as shown on the plans or as directed by the Engineer and shall meet the requirements of the MUTCD Chapter 4, Sections 4E.08 to 4E.10.

B. The power supply shall be installed in the associated WALK/DONT WALK signal head compartment and be securely attached. The input wires to the power supply must be terminated to the correct terminals in the signal head. The output wires of the power supply shall be connected to the APS cable with quick disconnect plugs. The APS cable shall be properly terminated at the APS

C. The APS cable is the four conductor cable that will connect the power supply to the APS. The cable length will vary depending upon the relative location of the APS to its associated WALK/DONT WALK signal head. Care must be taken to insure the correct wires are connected to the correct terminals. In all cases, the white wire will be the neutral and the green wire will be the ground. The cable should have sufficient slack so that there is no tension in the cable and there is enough extra cable to make or break connections easily. If the cable goes through a manhole/handhole, it must be trained along the sides.

D. The APS shall be located as indicated on the plans. A three-quarters-inch (3/4”) to one inch (1”) diameter hole must be drilled into the pole at the proper height for the cable entrance. The size of the hole will be as directed by the Engineer. The hole must be reamed or filed to remove all sharp edges or burrs which might damage the cable. A weatherproof flexible caulking must be applied

between the hole in the pole and the APS housing to protect the cable. The APS bracket shall be attached to the pole with 3/4" steel banding or with two stainless steel screws. The APS shall be attached to the bracket with two stainless steel screws. The height of the push-button shall be 42" above the sidewalk grade where the pedestrian will be located when at the APS, according to ADA requirements. The front face of the APS shall be parallel to the associated crosswalk. The tactile arrow shall be positioned to point toward the crosswalk.

E. The APS shall be programmed following the manufacturer's instructions. The sound levels and any vocal messages must be programmed as indicated on the plans or as directed by the Engineer.

F. A sign shall be mounted to the back-plate of the APS. The sign size and message shall be as indicated on the plans or as directed by the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ACCESSIBLE PEDESTRIAN SIGNAL shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ACCESSIBLE PEDESTRIAN SIGNAL be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1618, 1619

END OF SECTION

SECTION 26 03 16

JUNCTION BOX, STAINLESS STEEL, ATTACHED TO STRUCTURE 12”X12”X6”

PART 1 GENERAL

1.01 RELATED DOCUMENT

A. Specification Division 800, Materials, section 813 of the Illinois Department of Transportation Standard Specification for Road and Bridge Construction.

1.02 SUMMARY

A. This work shall consist of furnishing and installing junction box or pull box of the type and size specified, as shown on the Plans and as direct by the Commissioner. Work under this item shall be performed in accordance with Section 813 Standard Specifications and as specified herein.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The Materials shall be according to the following Bureau of Electricity (BOE) Specifications and Articles of Standard Specifications Section 1000-Materials:

Item…… Article/Section
Requirement a. Stainless Steel Junction Box …… 1088.04

PART 3 EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Exposed junction boxes on structure shall be installed on one- foot stainless struts, or as noted on plans. The exact orientation shall be as shown on the plans or as directed by the Engineer. Care shall be taken to assure proper orientation of mounting lugs.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of JUNCTION BOX, STAINLESS STEEL, ATTACHED TO STRUCTURE 12”X12”X6” shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of JUNCTION BOX, STAINLESS STEEL, ATTACHED TO STRUCTURE 12”X12”X6” included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1407

END OF SECTION

SECTION 26 03 50

ELECTRICAL CABLE IN CONDUIT NO. 14 19/C

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Material Specifications 1537 of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This work will consist of furnishing and installing electric cable for traffic signals of the type, size and number of conductors as specified on the plans. The cable will be rated 600 volts and comply with the following requirements.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 TRAFFIC SIGNAL CABLE

A. The cable must meet all requirements of Material Specification 1537 of the Bureau of Electricity, City of Chicago

PART 3 EXECUTION

3.01 INSTALLATION

A. All cable must be installed in conduit, as indicated on the plans, with care to prevent damage to the insulation or cable. Suitable devices must be used in pulling the cable, and only approved lubricants should be used. All cables installed in conduit will be from the power source to the traffic signal controller cabinet, from the traffic controller cabinet to the traffic signal junction box, or from junction box to junction box. For cable terminating in a traffic signal controller cabinet or traffic signal junction box the following procedures must be followed:

1. Controllers
   a. Remove thirty six inches (36") of neoprene jacket.
   b. Wrap vinyl electrical tape on two inches (2") of the neoprene jacket and two inches (2") on the exposed conductors.
   c. Remove one inch (1") of insulation and scrape copper conductor.
   d. Train cables neatly along the base and back of cabinet.
   e. Connect conductors to proper terminal lugs.

2. Traffic Signal Junction Box
   a. Remove twenty four inches (24") of neoprene jacket.
   b. Wrap vinyl electrical tape on two inches (2") of neoprene jacket and two inches (2") on the exposed conductors.
   c. Remove one inch (1") of insulation and scrape copper conductor.

d. Train cables neatly along the side and back of the box.
e. Connect all conductors to terminal strip.

3.02 CABLE SLACK

A. The length of cable slack that must be provided will be in accordance with the following schedule:

Location	Length of Slack Cable (feet)
Base of Controller	7
Detector, Junction Box	1
Base of Traffic Signal Post or Traffic Signal Pole	4
City Handhole	6
City Manhole	12
ComEd Manhole	25

B. Cable slack in manholes/handholes must be trained and racked in the holes. If racks are non-existent, racks must be provided, and considered incidental and a part of this pay item.

C. No cable splices will be allowed for traffic signal cable, with the exception of 7 conductor interconnect cable. These splices must be indicated on the plans.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRICAL CABLE IN CONDUIT NO. 14 19/C shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ELECTRICAL CABLE IN CONDUIT NO. 14 19/C be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1534

END OF SECTION

SECTION 26 03 53

REMOVE EXISTING TRAFFIC SIGNAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This work will consist of removing all the existing traffic signal equipment at the intersections listed on the plans.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.01 REMOVAL

A. The items to be removed will include traffic signal arms, traffic signal poles, traffic signal heads, traffic signal controllers, and all associated equipment and cable.

B. The traffic signal items, except for traffic signal cable, are to remain the property of the City of Chicago. The Contractor must deliver the obsolete traffic signal equipment to the City of Chicago Yard at 4101 South Cicero Avenue, Chicago, Illinois. Twenty-four hour advance notice is necessary before delivery. The traffic signal cable must be removed and become the property of the Contractor and must be disposed of by him, outside the right of way, at his sole expense.

C. The Contractor must provide three (3) copies of a list of equipment that is to remain the property of the City, including model and serial numbers where applicable. He must also provide a copy of the contract plan, or special provisions, showing the quantities and type of equipment. The Contractor will be responsible for the condition of the traffic control equipment from the time of removal until its acceptance by a receipt drawn by the City indicating that the items have been returned.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of REMOVE EXISTING TRAFFIC SIGNAL EQUIPMENT shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of REMOVE EXISTING TRAFFIC SIGNAL EQUIPMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 03 62

TRAFFIC SIGNAL HARNESS CABLE, #16, 8/C

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Specifications 1475 of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This item will consist of furnishing and installing cable in traffic signal poles to connect traffic signals or illuminated signs to a junction box on the pole.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The cable must meet all requirements of Material Specification 1475 of the Bureau of Electricity, City of Chicago

PART 3 EXECUTION

3.01 INSTALLATION

A. The contractor must install the cable from the required signal or sign terminal strip through the pole and mast arm to the terminal strip in the junction box. The contractor must properly terminate the cable at the terminal strips as directed by the Engineer. Sufficient cable will be provided so as not to unduly strain the cable during installation, and to provide sufficient cable for easy termination.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of TRAFFIC SIGNAL HARNESS CABLE, #16, 8/C shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of TRAFFIC SIGNAL HARNESS CABLE, #16, 8/C be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 03 76

ATC CONTROLLER, TRAFFIC, 16 LOAD BAY, WITH UPS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Specification 1560 of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This work will consist of furnishing and installing an Advanced Transportation Controller (ATC) with a battery powered back-up system and associated equipment in a cabinet onto a foundation and making all necessary connections.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The material must meet the requirements of Material Specification 1560, “Advanced Transportation Controller and Cabinet with Universal Power Supply”. The cabinet will be a Super P cabinet 16 load bays. Each load bay must include a load switch. A battery powered uninterruptible power supply (UPS) system must be included. Communications interface equipment, if required, will be included under a separate item.

PART 3 EXECUTION

3.01 PROCUREMENT

A. The contractor must provide Request for Inspection of Material forms for traffic signal controllers and cabinets as requested for specific projects. The Division of Electrical Operations will review and comment on the submitted material. The Division of Electrical Operations will approve the purchase of the material from a supplier. Final material approval will be made in accordance with Chicago Department of Transportation specifications. The Contractor must provide proof of purchase to the Resident Engineer within seven (7) days following approval by the Division of Electrical Operations. Payment will be withheld in accordance with the terms and conditions of this contract, until such time that the Commissioner determines the requirements are met.

B. The controllers and cabinets are to be delivered to the Division of Electrical Operations within ninety (90) days of purchase. If the controllers and cabinets are not delivered, payment will be withheld until such time that the controllers and cabinets are delivered.

C. The Division of Electrical Operations will notify the Contractor when the material has been inspected and approved. If a railroad interconnect is involved, a representative from the Illinois Commerce Commission will also need to review and inspect the controller at the Division’s facilities. Within forty-eight (48) hours of notification, the Contractor must pick-up the controllers

and cabinets from the Division. The controllers and cabinets will be stored at a facility, approved by the Commissioner, at the contractor's expense.

3.02 INSTALLATION

A. The controller will be programmed to provide the sequencing and timing of operation as shown on the plans. The controller must be enclosed in a housing and installed in a completely wired cabinet. The model and serial numbers of the controller must be affixed on the front of the controller housing and be readily visible.

B. The cabinet must be set onto a pad foundation designed specifically for the cabinet, and affixed with bolts provided with the foundation. Electric cables inside the cabinet must be neatly trained along the base and back of the cabinet. Each conductor used must be connected individually to the proper terminal, and the spare conductors must be insulated and bound into a neat bundle. Each cable must be marked with suitable identification and recorded on a copy of the plans for the intersection and submitted to the Engineer. Signal indications for each direction must be wired to a separate circuit whether or not the signal plans call for a split movement. The absolute zero for time coordination will be set in the field by City personnel after obtaining the appropriate City time-tone reference.

C. When properly installed, all signals will be connected and controlled by the controller, and the sequencing and timing of the signals will be as set forth in the plans.

D. All conduit entrances into the cabinet must be sealed with a pliable waterproof material to restrict moisture entrance into the cabinet.

E. Division of Electrical Operations and Division of Safety personnel from the Chicago Department of Transportation must be present during the cutover to the new control equipment. If a railroad interconnect is part of the signal project, a representative from the Illinois Commerce Commission must be invited to be present for the cutover.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ATC CONTROLLER, TRAFFIC, 16 LOAD BAY, WITH UPS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ATC CONTROLLER, TRAFFIC, 16 LOAD BAY, WITH UPS included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

4.04 MATERIAL SPECIFICATION

A. 1560

END OF SECTION

SECTION 26 03 86

MAINTENANCE OF EXISTING TRAFFIC SIGNAL INSTALLATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Specification Division 800, Materials, section 800, 801, and 850 of the Illinois Department of Transportation Standard Specification for Road and Bridge Construction.

B. Specification Division 1000, Materials, section 1085 of the Illinois Department of Transportation Standard Specification for Road and Bridge Construction.

1.02 SUMMARY

A. This work will consist of maintaining an existing traffic signal installation that has been designated to remain in operation during construction of the new traffic signals. If during the course of construction it becomes necessary to use temporary aerial cable to keep the intersection functioning, this work will be performed at no additional cost. However, the need for temporary traffic signals and controllers will be paid for under separate items, as shown on the plans or as directed by the Engineer.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.01 MAINTENANCE PROCEDURES

A. Before taking over maintenance of the existing traffic signal installation, the Contractor must arrange to make an inspection with the Engineer to determine if any corrective action needs to be done, and to mutually agree on a date for transferring maintenance. The contractor should normally begin maintaining the existing traffic signals as soon as he begins any work at the site.

B. The contractor will be responsible for maintaining the traffic signal installation in proper operating condition. The contractor must perform the maintenance procedures as outlined in Section 802.07 of the Standard Specifications.

C. The traffic controller must be maintained as outlined in Section 850.03 of the Standard Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of MAINTENANCE OF EXISTING TRAFFIC SIGNAL INSTALLATION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of MAINTENANCE OF EXISTING TRAFFIC SIGNAL INSTALLATION shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 00

RACKING CABLES IN EXISTING MANHOLE OR HANDHOLE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements for racking cables in existing manhole or handhole. The work will consist of furnishing all labor, materials, tools and equipment necessary to install a cable rack system on interior surfaces of handholes, heavy duty handholes, or manholes, per the standard drawings. Work will include placing cable on cable rack system within the manhole or handhole.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of RACKING CABLES IN EXISTING MANHOLE OR HANDHOLE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of RACKING CABLES IN EXISTING MANHOLE OR HANDHOLE shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 01

ELECTRICAL CABLE IN CONDUIT, 1/C, #2

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Specifications 1534 of the City of Chicago Department of Transportation Division of Electrical Operations

1.02 SUMMARY

A. This work consists of furnishing and installing ELECTRICAL CABLE IN CONDUIT, 1/C, #2

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The cable must meet all requirements of Material Specification 1534 of the Bureau of Electricity, City of Chicago

PART 3 EXECUTION

3.01 CONSTRUCTION METHOD

A. All cables must be installed with care to prevent damage to the cable. Any defects found in the cable must be reported to the resident engineer. Damaged cable must be replaced

B. The cable must be pulled into the conduit with a minimum of dragging on the ground or pavement. This will be accomplished by means of reels mounted on jacks or other suitable devices located for unreeling cable directly into duct. Lubricants must be used to facilitate installation if deemed necessary by the contractor.

C. Bends in the cable will conform to the recommended minimum radii as outlined in the National Electric Code.

D. Cable passing through manholes must be trained and racked around the sides of the manhole into a permanent position. If racks are non-existent or in poor condition, the contractor must install racks. The material must be approved by the resident engineer. Any material and labor involved in training and racking the cable will be considered incidental to the cost of this pay item.

E. Where cable runs continue from manhole to manhole without tapping within a light pole, they will be continuous without splices unless authorized by the resident engineer.

F. All wire or cable in the distribution panels and control cabinets must be properly trained and have sufficient slack provided for any rearrangement of equipment or future additions. There must be at least two feet of slack in a street light pole base or street light controller base. A handhole must

have at least five feet of slack and a manhole at least ten feet of slack.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELECTRICAL CABLE IN CONDUIT, 1/C, #2 shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ELECTRICAL CABLE IN CONDUIT, 1/C, #2 be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 02

TEMPORARY TRAFFIC SIGNAL INSTALLATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Division 800, Electrical, section 801, 850, and 890 of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

B. Specification Division 1000, Electrical, section 1086 of the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

1.02 SUMMARY

A. This work will consist of furnishing, installing and removing temporary aerial wiring on existing poles or poles mounted on concrete blocks to maintain continuous traffic signal operation while other intersection work is completed and installing signal timings as directed by CDOT/OEMC or Engineer for temporary condition. This work will also include any required temporary traffic signal equipment, temporary fiber interconnect, temporary relocation and wiring of traffic signal heads or pedestrian signal heads to adjacent poles to maintain visibility and continuous traffic signal operation during construction on intersections along Lake Street and State Street.

1.03 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. The Contractor must provide a Manufacturer’s written certification that the material complies with these specifications. Division 800, Sections 801, 850, 890 and 1086 of the Standard Specifications, CDOT Division of Electrical Operations Standards and the City of Chicago Electrical Code, except as herein modified.

PART 3 EXECUTION

3.01 INSTALLATION

A. The contractor must ensure at least two primary signal heads are visible at all times. The contractor must submit temporary traffic signal head location plan to the Engineer for approval before installing. The Contractor must select an aerial wiring scheme based on the specific requirements of each intersection. Contractor must ensure temporary cable connection is in place before intercepting existing conduits. The Contractor may use multi conductor self-supporting cable or cable requiring messenger wire of sufficient voltage and rating to handle the intersection electrical requirements as approved by the Commissioner and the CDOT Division of Electrical Operations. The Contractor must submit a sketch of the proposed wiring scheme and signal timing plan (wire location, type of cable) and signal timing plans to the Commissioner and the CDOT Division of Electrical Operations and CDOT traffic for approval prior to installation.

B. Any cables or wires utilized for this work below an elevation of 10 feet above the sidewalk must be protected from access and view by split duct or PVC conduit and must be properly secured to existing pole(s) through banding or other method as approved by the Commissioner and the CDOT Division of Electrical Operations. All split ducts must be securely tied with cable ties or other approved method at intervals of not more than three (3) feet. Drilling or notching of poles, cabinets or junction boxes is expressly prohibited. When directed by the Commissioner, Contractor must provide a temporary base for the existing traffic signal controller during the temporary traffic signal installation. The temporary location of the traffic signal controller must be approved by the Commissioner. Entry into poles at the pole tops is permissible. Entry into junction boxes by removing the top cover plate is also permissible provided that the plate and all screws shall be re installed at the end of the project. Entry of poles through the pole cap, removal and replacement of the top plate of the junction box, installation of split duct or PVC conduit below 10 feet will all be incidental to TEMPORARY TRAFFIC SIGNAL INSTALLATION.

C. Temporary wiring, temporary interconnect fiber or the temporary relocation of traffic signal and pedestrian heads will be connected to the existing or temporary controller and cabinet. After intersection operation is transferred to the new signal controller and equipment, the temporary aerial wiring, temporary interconnect fiber and any relocated traffic or pedestrian signal heads must be removed. Removed temporary wiring and interconnect fiber will remain the property of the Contractor. Removal of said wiring, interconnect fiber and any relocated traffic or pedestrian signal heads will be incidental to TEMPORARY TRAFFIC SIGNAL INSTALLATION.

D. The Contractor must maintain the existing traffic signal system at each intersection in this Contract. The maintenance must commence at the time during construction, when the Contractor in the course of his Work begins construction at the intersection. Maintenance must continue in force until the expiration of the time allotted for the project, or until the new signals are accepted by the sponsoring agency, whichever comes first. If signal installation is not completed and accepted within time allotted for the project, signals must be maintained by the Contractor at no additional cost to the sponsoring agency. A properly operating traffic signal system must be maintained by the Contractor at each intersection in the Contract until such date as the new traffic signal system will be accepted for operation and maintenance by the sponsoring agency at the direction of the Commissioner. Maintaining existing traffic signal system shall be incidental to TEMPORARY TRAFFIC SIGNAL INSTALLATION and shall not be paid for separately.

3.02 MAINTENANCE PROCEDURE

A. The Contractor must perform the following maintenance program:

1. Patrol and inspect the signal installation at least once each week for proper alignment of signal heads, lamp outages, and general operation of the traffic signals.

2. Provide immediate corrective action to replace burned out lamps or damaged sockets with new lamps or sockets of approved qualities. At the time of replacement, the reflector and lens must be cleaned.

3. Respond to emergency calls within two hours after notification and provide immediate corrective action. The Contractor must maintain in stock a sufficient amount of material and equipment to provide temporary and permanent repairs. Any damage to the signal installation from any cause whatsoever must be repaired or replaced by the Contractor at his own expense. The Contractor may institute action to recover damages from a responsible third party.

4. The Contractor must install STOP signs (Standard No. R1-1-3636) on all approaches to the intersection as a temporary means of regulating traffic during the time of repair.

5. The Contractor must provide the Commissioner the names and telephone numbers of two men who will be available 24 hours a day, 7 days a week, to perform any necessary work on the signal installation.

6. If at any time, the Contractor fails to perform any Work deemed necessary by the Commissioner to keep the traffic signals in proper operating condition, or if the Commissioner finds it impossible to contact the designated men to perform any Work, the Department reserves the right to have other Electrical Contractors perform the needed Work. The cost of such Work will be deducted from the amount due the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of TEMPORARY TRAFFIC SIGNAL INSTALLATION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of TEMPORARY TRAFFIC SIGNAL INSTALLATION shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 03

ORNAMENTAL POST

PART 1 GENERAL

1.01 SUMMARY

A. **Ornamental Traffic Signal Post:** This item will consist of furnishing and installing an ornamental traffic signal post, for supporting a traffic signal, upon a concrete foundation, at the location shown on the plans, as specified herein, or as directed by the Engineer.

B. **Ornamental Push Button Signal Post:** This item will consist of furnishing and installing a steel post, for supporting a push button for pedestrian traffic, in a concrete sidewalk, at the location shown on the plans, or as directed by the Engineer.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

D. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications of Structural Supports for Highway Signs, Luminaires and Traffic Signals.

E. American Institute of Steel Construction (AISC), Manual of Steel Construction, Allowable Stress Design.

F. American Welding Society (AWS): D1.1, Structural Welding Code, Steel.

1.03 SYSTEM DESCRIPTION

A. **Manufacture:** Each component shall be of current manufacture from a firm regularly engaged in design and manufacturing of such components. Provide only components which can be properly maintained and serviced without requiring long periods of interrupted service because of lack of available parts. Manufacturer shall certify to the City of Chicago that the accepted luminaire and pole components are proper and adequate for the intended application, and that such components are or shall become manufacturer's stock items with replacement parts readily available for a minimum of 10 years.

B. **Match Existing:** Contractor shall use an existing ornamental traffic signal pole located in the southeast or the southwest corner of State and Lake Street intersection as a model to assist in matching the casting and molding details, tapers and sizes, and to ensure installation compatibility. Contractor shall disassemble and transport an existing ornamental traffic signal pole to the pole manufacturer's factory for the purpose of matching new poles to existing ornamental traffic signal poles. Coordinate removal of the model ornamental traffic signal pole assembly with the City of Chicago Division of Electrical Operations.

1.04 SUBMITTALS

A. **Coordinated Submittals:** Furnish submittals of component parts and prepare coordination details and erection diagrams for traffic signal pole assemblies. Show in the submittals that traffic signal pole assemblies have received prior approval of the Contractor and the manufacturer or fabricator of each principal component.

B. **Shop Drawings**: Furnish shop drawings for the fabrication and installation of the Work. Prepare layouts in plan at not less than 1” = 1'-0” [1:100]. Prepare details at not less than 6” = 1'-0” [1:4] minimum scale. Show typical details of the conditions for every member, joint, anchorage and support in the system.

C. **Samples:** One complete ornamental traffic signal post and one complete ornamental push-button signal post of the manufacture intended to be furnished must be submitted within fifteen (15) business days upon receipt of a request from the Chief Procurement Officer.

D. **Product Data:** Furnish a material list with technical data documenting the primary function, quality, and performance of each system to be used in the Work, e.g., the UL ratings, photometric performance, and other such primary characteristics as required by the Drawings and Specifications.

E. **Supplementary Product Literature:** Furnish manufacturer's literature describing the general properties of each product to be used in the Work.

1.05 QUALITY ASSURANCE

A. **Contractor's Quality Assurance Responsibilities**: Contractor is solely responsible for quality control of the Work.

B. **Mock-Up:** Provide a factory mock-up of the approved designed components for the traffic signal pole. Utilize the same materials and installation methods in the mock-up as intended for the final Work. Schedule the mock-up so that it may be examined, and any necessary adjustments made, prior to commencing fabrication of the Work. Replace unsatisfactory items as directed. When accepted, mock-up shall serve as the standard for materials, workmanship, and appearance for such Work throughout the project.

C. **Regulatory Requirements:** Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package ornamental traffic signal poles in single or multiple-unit bundles suitable to protect against damage from shipment, storage and handling. Comply with the provisions of Articles 11.(a) and 11.(b) of the BOE Specification, except that the requirement for “twelve (12) pole” bundles shall not apply.

B. Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

1.07 WARRANTY

A. **Ornamental Traffic Signal Pole Warranty:** Furnish written warranties in form stipulated by Commissioner, signed by the Contractor and Manufacturer, agreeing to repair or replace Work which has failed as a result of defects in materials or workmanship. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Commissioner.

B. **Factory Finish Warranty**: Furnish manufacturer's 5 year written warranty, warranting that the factory applied finishes will not develop excessive fading or excessive nonuniformity of color or shade, and will not crack, peel, pit, corrode, or otherwise fail as a result of defects in materials or workmanship within the following defined limits. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the

Commissioner.

1. “Excessive Fading”: A change in appearance which is perceptible and objectionable as determined by the Commissioner when visually compared with the original color range standards.
2. “Excessive Non-Uniformity”: Non-uniform fading to the extent that adjacent components have a color difference greater than the original acceptable range of color.
3. “Will Not Pit or Otherwise Corrode”: No pitting or other type of corrosion discernible from a distance of 10' [3 m], resulting from the natural elements in the atmosphere at the project site.

1.08 MAINTENANCE

A. **Maintenance and Operating Manuals:** Furnish complete manuals describing the materials, devices and procedures to be followed in operating, cleaning and maintaining the Work. Include manufacturers' brochures and parts lists describing the actual materials used in the Work, including major components. Assemble manuals for component parts into single binders identified for each assembly.

B. **Tools:** Furnish manufacturer's recommended number of each tool required to service and maintain ornamental traffic signal poles.

PART 2 PRODUCTS

2.01 ORNAMENTAL TRAFFIC SIGNAL POST

A. **Manufacturer and Type:** The height and the foundation of the ornamental traffic signal post will be as indicated on the traffic control signal plans.

1. **Ornamental Traffic Signal Post:** Tapered 16-flute steel pole, minimum No. 7 Gauge. Cast-iron base. Provision for mounting and connection of traffic signals and street signage.

Union Metal Corp.;	Canton, OH; (833) 919-7653
Holophane Co.;	Granville, OH; (866) 759-1577
Spring City Electrical Mfg. Co.;	Spring City, PA; (610) 948-4000
Robinson Iron;	Alexander City, AL; (256) 329-8486
Allen Robbins Arch. Metals Inc.;	Talladega, AL; (256) 761-2609
Historic Arts & Castings;	West Jordan, UT; (801) 280-2400

B. **Ornamental Traffic Signal Poles:** Fabricate in accordance with provisions of Articles 4.(c) and 4.(f) of the BOE Specification. Provide poles of hot rolled commercial quality steel, one continuous length with no butt joints, not less than ASTM A595, Grade C, 60,000 psi yield strength. Hot-dip galvanize each pole after fabrication in accordance with requirements of ASTM A123. Cold-roll the shaft over a hardened steel mandrel using hydraulic pressure to provide a high quality tube with no visible welds. Single rolled flutes, or round poles with separate fluted sheathing will not be acceptable. Welds shall meet requirements of AWS D1.1.

1. Base plate shall conform to ASTM A36, with 1.75” thickness and 17.5” squared base plate. Base plate shall fit around the base of the shaft and be attached by means of continuous fillet welds, each 1/4” minimum size.
2. Provide gasketed handhole in base of pole.
3. At Contractor's option, fabricate poles of ASTM A48, Class 30B cast iron without hot-dip galvanizing, subject to prior acceptance by Commissioner.
4. Submit technical data verifying that the pole material meets the physical and chemical requirements of an ASTM standard grade structural alloy.
5. Pole and base shall fit the anchor rods provided by the proposed foundation.

C. **Base:** Ornamental bases custom fabricated of heavy wall cast iron, ASTM A48, Class 30B, sand casting, fine and tight, free of irregularities, with 2 access doors located in the base, 1 door to

coincide with the hand hole in the steel pole and 1 door at the opposite side.

D. **Assembly:** Pre-assemble components at pole manufacturer's shop to the greatest extent possible, so as to minimize field splicing and assembly of units at the project site. Disassemble units only to the extent necessary to comply with shipping limitations. Mark units clearly for re-assembly and proper installation.

E. **Factory Finish Painting:** Finish all metal surfaces of the poles with a polyester powder coating system in accordance with the provisions of Articles 8.(a) through 8.(h) of the BOE Specification.

1. Color and Sheen: Provide to match Commissioner's finish sample.
2. Touch-Up Coating: Furnish suitable paint for field application during pole installation to touch-up of scratches or other minor blemishes in the finish.

2.02 ORNAMENTAL PEDESTRIAN PUSH BUTTON SIGNAL POST

A. **Manufacture and Type:** The manufacturer will replicate and downscale the ornamental traffic signal post to a height of 5’ and a diameter of 6” for the ornamental pedestrian push button signal post. This post shall be designed to be attached to a 5" deep sidewalk with an 1/2" thick, 8” diameter base plate. The base plate will be made of a high strength low alloy steel meeting the requirements of ASTM A595, Grade A. The base material will consist of a 3.5” length of threaded coupling circumferentially welded to a base plate. Post and base plate shall be attached to the sidewalk with 5.5” long, 1/2” diameter stainless steel wedge concrete anchors with 9" bolt circle. The push button shall be mounted 42" above sidewalk grade. The post assembly shall be grounded with a 6 AWG copper wire.

B. **Factory Finish Painting:** Finish all metal surfaces utilizing the same coating system and finish color to match the traffic signal posts.

2.03 SOURCE QUALITY CONTROL

A. **Pole Test:** Comply with the provisions of Articles 9.(a) through 9.(c) of the BOE Specification, except that the requirements of “Table A” shall not apply.

1. Test Load, Deflection and Set: 3600 lb. test load, 12” maximum deflection, and 1” maximum set.

B. **Inspection:** Comply with provisions of Article 12. of the BOE Specification.

PART 3 EXECUTION

3.01 EXAMINATION

A. **Verification of Conditions:** Examine the areas to receive the Work and the conditions under which the Work would be performed. Contractor shall remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. **Ornamental Traffic Signal Poles:** The post and base must be mounted on the foundation so that the handhole faces away from the curb. The nuts on the foundation must be tightened to secure the post to the foundation such that there is no space separating the post from the foundation. There must be no double nutting. The post must be plumb; the use of shims will not be permitted. The height and the foundation of the ornamental traffic signal post will be as indicated on the traffic signal control plans.

B. **Ornamental Pedestrian Push Button Signal Post:** A hole must be drilled into the post at the

proper height and location for the pedestrian push button wiring. The post must be screwed into the base. The post may be tack welded to the base to insure the two parts do not loosen. The post and base must be mounted in the sidewalk using a minimum of ½" concrete anchors of the appropriate length. Cable must be pulled into the post before the post is mounted to the sidewalk. The nuts on the rods must be tightened to secure the post to the sidewalk such that there is no space separating the post from the sidewalk. There must be no double nutting. The post must be plumb; the use of shims will not be permitted. After the post is erected, the Engineer will determine if touch-up paint is required.

4 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ORNAMENTAL TRAFFIC SIGNAL POST, 15 FOOT shall not be measured for payment.

B. The work of ORNAMENTAL PEDESTRIAN PUSH BUTTON SIGNAL POST shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of ORNAMENTAL TRAFFIC SIGNAL POST, 15 FOOT included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

B. No separate payment shall be made for the work covered in this section. Payment for the work of ORNAMENTAL PEDESTRIAN PUSH BUTTON SIGNAL POST included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 05

SPLICE ENCLOSURE

PART 1 GENERAL

1.01 SUMMARY

A. This work shall consist of furnishing and installing a sealed fiber optic splice closure.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Closures for underground fiber splices shall be listed in the latest edition of the Rural Utilities Service (RUS) List of Materials Acceptable for Use on Systems of USDA Rural Development Telecommunications Borrowers, Item Designation pl.

B. It shall be designed for underground environments.

C. They shall include all materials necessary to make, organize, and protect the splices.

D. The closure shall be re-enterable without any special tools.

E. The closure shall be able to accommodate at least four fiber optic cables

F. The closure shall accommodate 144 single mode fiber splices.

G. It shall be possible to remove any splice tray without disturbing the others.

PART 3 EXECUTION

3.01 INSTALLATION

A. Splice closures in manholes shall be mounted to the side wall of the manhole in a manner approved by the Commissioner

4 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SPLICE ENCLOSURE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of SPLICE ENCLOSURE included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 04 06

FUSION SPLICE, FIBER OPTIC PIGTAIL, FIBER OPTIC JUMPER

PART 1 GENERAL

1.01 SUMMARY

A. This work shall consist of supplying fiber optic jumpers, pigtails, and connectors and making fusion splices and connections to electronic devices to enable communications external to the standard City of Chicago Department of Transportation communications cabinet.

1.02 REFERENCE

A. City of Chicago, Department of Streets and Sanitation, Bureau of Electricity Material Specifications

B. Chicago Department of Transportation, CDOT Division of Electrical Operations, Material Specifications, Appendix A

C. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fiber Optic Pigtail (non-special)

1. Pigtails shall be factory-made, buffered, and strengthened with aramid yarn to reduce the possibility that accidental mishandling will damage the fiber or connection.

2. All pigtails shall exactly match the specification of the fiber strands to which they will be fusion spliced.

3. Pigtails shall be yellow.

4. The connector type on the one end of the pigtail shall be compatible with the device port or patch panel it is connected to.

5. Each shall contain one fiber.

6. The fiber shall match the specification of the device fiber port.

7. Length shall suffice to provide two feet of slack after installation.

B. Fiber Optic Jumpers. The jumper shall meet the requirements of the fiber optic pigtail except it shall have a factory-made connector on both ends.

C. Fiber Optic Connectors

1. Connector type shall match the mating patch panel or device port.

2. Connector shall accommodate the associated fiber type and size.

3. Except where explicitly indicated on the plans, field termination of fiber is for authorized emergency repairs only. General termination of fiber cable shall be accomplished by fusion splicing the appropriate pigtail onto the fiber cable.

4. Connectors shall not exceed the maximum insertion loss listed below:
   a. Factory Installation - maximum loss: 0.25dB; return loss: >0.45Db

D. Fusion Splicing

1. Use of fusion splicer device shall be included.
2. Use of cleaver shall be included.
3. Supplying splice sleeves shall be included.
4. Supplying lint-free wipes and isopropyl alcohol for cleaning shall be included.

E. Use of equipment for testing shall be included with this work

PART 3 EXECUTION

3.01 INSTALLATION

A. Fiber Optic Pigtail (non-special)

1. Terminate fibers by splicing them to factory-made pigtails
2. After the pigtail is fusion spliced to the fiber optic cable, connect the pre-terminated connector to the patch panel of the interconnect center.
3. The fiber optic pigtail shall be handled with care and not bent excessively per manufacturer specifications to avoid damage to the fiber.
4. The ferrule shall be protected with a cap and kept clean when not connected to a mating connector.
5. All pigtails shall be secured within the cabinet and neatly organized

B. Fiber Optic Jumpers

1. Connect the fiber optic jumper to the devices and/or patch panels as shown on the plans.
2. The fiber optic jumper shall be handled with care and not bent excessively to avoid damage to the fiber.
3. Connection to the device fiber port shall also be performed with care to avoid damage to the ferrule.
4. The ferrule shall be protected and kept clean when not connected to the device port.
5. All jumpers shall be secured within the cabinet and neatly organized.

C. Fiber Optic Splicing

1. Fusion splicing shall be performed only by a qualified, trained and experienced technician. The Commissioner will determine if the Contractor is qualified to perform the work.
2. Fusion splices shall be made at locations and fibers shown on the plans.
3. Fusion splicing fibers other than those shown on the plans require preapproval by the Commissioner.
4. Make all splices using a fusion splicer that automatically positions the fibers using the Light Injection and Detection (LID) system.
5. Each spliced fiber shall be packaged in a heat shrinkable splice protection sleeve with strength member. The protective sleeve will cover the splice and any bare fiber stripped of its coating. The use of RTV or silicone is strictly prohibited.
6. Whenever possible, use one splice tray per buffer tube, with no more than two buffer tube colors per tray.
7. All fusion splices shall be carefully and neatly secured in a splice tray.
8. For ribbon fiber, a mass fusion splicer shall be used to fusion splice an entire ribbon of fiber at once. Each ribbon shall be treated as one assembly using special tools to hold, strip, cleave, and fusion splice the entire ribbon.

D. Acceptance Testing

1. For each fiber optic link, follow this procedure:
   a. If the link includes fiber installed by others, use an optical loss test set to measure and record the optical loss over that portion of the link before it is spliced to new fiber.
   b. Calculate the maximum allowable loss for the completed link, at the wavelength used by the end equipment. Use the following formula: Maximum link loss = Measured loss over portion installed by others, if applicable
   c. + (Fiber length in km) x (0.35 for 1310 nm and 0.25 for 1550 nm)
   d. + (Number of fusion splices) x (0.05)
   e. + (Number of mechanical splices [for temp. connection]) x (0.3)
   f. + (Number of connections, non-MTP) x (0.3) + (Number of connections, MTP) x (0.5)

   g. Provide this calculation to the Commissioner along with the test results.
   h. Calibrate an optical loss test set and provide evidence satisfactory to the Commissioner that the set produces accurate results at both wavelengths. This can be a demonstration that the set correctly measures the loss of a test fiber whose loss is known.
   i. Use the test set to measure the loss of the link under test. Record the results at both 1310 nm and 1550 nm.
   j. If the measured loss exceeds the calculated maximum, use an optical time domain reflectometer and other test equipment to troubleshoot the link. Take whatever corrective action is required, including cable replacement, to achieve a loss less than the calculated maximum. All corrective action shall be performed at no additional cost to the Commissioner.

2. Test the fiber optic cable before and after it is installed in conduit. Document and submit the performance test results to the Commissioner. Proceed only if there are acceptable test results approved by the Commissioner.

3. Test the fiber link after each fusion splice is made and after each connector is installed. Document and submit the performance test results to the Commissioner. Proceed only if there are acceptable test results approved by the Commissioner.

4. For each fiber optic link, including spare fibers, determine whether the optical loss is within the limits permitted by these specifications. A link is a continuous segment of fiber between one connector (or unterminated end) and another connector (or unterminated end).

5. When testing links that do not have connectors on both ends, use a temporary mechanical splice with known and documented optical loss to attach a pigtail to the unterminated fiber for the duration of the test. Mechanical splices shall be included with this work and will not be measured separately for payment.

E. Documentation

1. Prepare a diagram showing all of the links tested in this project.
2. For the portions installed in this project, show the equipment cabinets, splices, and pigtails.
3. On each line representing a link, show the maximum allowable loss and the actual loss. The actual loss shall be the one measured after all corrective actions have been taken.

4 PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of FUSION SPLICE, FIBER OPTIC PIGTAIL, FIBER OPTIC JUMPER shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of FUSION SPLICE, FIBER OPTIC PIGTAIL, FIBER OPTIC JUMPER included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 05 00

RACEWAYS AND BOXES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. All raceways and boxes as well as appurtenances thereto required under Division 26.

1.03 RELATED WORK

A. RACEWAYS AND BOXES specified to be furnished and installed herein have related work in various other sections including but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 261000 “Basic Electrical Materials and Methods”
4. Section 261230 “Wires, Cables, Splices, Terminations”
5. Section 261410 “Wiring Devices”
6. Section 261700 “Local Control”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 265030 “Cable and Light Tray Enclosure”
13. Section 269500 “Electrical Testing”
14. Division 27 - Communications
15. Division 28 – Electrical Safety and Security

1.04 MOCKUPS

A. Platform Structural Mockups: Provide and install the required conduit and support system in a platform column and rib assembly mockup to verify selections and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup per Construction-Mock-Ups drawings.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Commissioner specifically approves such deviations in writing.
3. Turn over materials used to CTA.

PART 2 - PRODUCTS

2.01 RACEWAYS AND BOXES

A. General:

1. All wire and cable to be installed in electrical raceways of the type specified herein and shown on the Drawings.
2. Minimum size conduit to be 3/4 inch for GRS, 1-1/2 inch for fiberglass.
3. All raceways and boxes located in the Station House, located in each elevator shaft, located in Bridge Walkway and located in North Platform Stairway that are attached to the track structure shall be electrically isolated from the steel track structure.
4. Manufacturers which may be incorporated in the Work include but not limited to Appleton, Crouse-Hinds, or O-Z/Gedney.

B. Galvanized Rigid Steel Conduit:

1. Galvanized rigid steel (GRS) conduit and fittings to be installed in all above ground areas of this Project except as noted herein.
2. GRS conduit to be heavy wall type, hot-dipped galvanized with zinc-coated threads, and Underwriters' Laboratory labeled.
3. GRS conduit and couplings to be threaded, rigid steel, hot-dipped galvanized after fabrication and to be in accordance with UL 6.

C. Electrical Metallic Tubing (EMT) conduit and fittings may be installed in temperature-controlled spaces only. EMT shall not be installed below grade and lower than 3’-6” above grade and areas that are exposed to moisture or the weather.

D. Intermediate metal conduit (IMC) is not acceptable.

E. Rigid Non-Metallic Conduit (RNMC or FRE):

1. Non-metallic rigid conduit to be used for underground feeders, service feeders, and in concrete slabs on grade only.
2. Non-metallic rigid conduit to be of the fiberglass reinforced epoxy (FRE)type, for sizes 1-1/2 inches and larger and PVC schedule 40 for 1 inch and smaller.
3. No threads or adhesives to be required to assure watertight joints for underground installations.
4. Conduit to be suitable for continuous operation from minus 40 degrees C to plus 100 degrees C without significant change of mechanical properties. Conduit to be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for UV protection.
5. Conduit to be UL listed.
6. Conduits must be fiberglass reinforced epoxy composed of glass filaments encapsulated in an epoxy matrix. All conduits must be filament-wound and must have pigment dispersed homogeneously throughout the epoxy glass matrix for ultraviolet protection. Size must be as indicated on the drawings.

    a. Average wall thickness must be 0.070 inches, with a minimum wall thickness of 0.062 inches.
    b. Conduits must be fire retardant, as required in NEMA TC-14, when tested in accordance with Section 12 of UL 651.
    c. Conduits must have the following minimum physical properties:
        1) Minimum Tensile strength, axial: 11,000 psi.

2) Compression: Conduit deflection of a maximum of 5 percent per load on conduit of 100 pounds per foot of length per ASTM D2412.
3) Ultimate elongation: 2 percent when tested per ASTM D2105.
4) Modulus of elasticity in tension: 1,250,000 psi when tested per ASTM D2105.
5) Modulus of elasticity in bending: 1,250,000 psi when tested per ASTM D790.
6) Thermal conductivity: Minimum of 2.0 BTU/Hour/Square Foot Degree F./inch when tested per ASTM D696.
7) Coefficient of linear thermal expansion: 1.25 x 10 -5 Inch/Inch/Degrees F. when tested per ASTM D696.
8) Temperature range: -40 degrees F. to +220 degrees F.
9) Dielectric strength: 450 volts/mil when tested per ASTM D149.
10) Dissipation factor: 0.5 percent average at room temperature when tested per ASTM D150.
11) Water absorption: Less than 0.2 percent (14 days at room temperature) when tested per ASTM D570.
12) The conduit must, in addition to the above, conform to the performance requirements specified in NEMA TC14. Furnish test data to verify compliance.
13) Minimum compressive strength, axial must be 12,000 psi when tested per ASTM D695.

d. The conduit must be thoroughly cured and must not contain any material in sufficient quantities to cause damage to cables. They must be straight and must have a circular bore with the inner surface smooth and free from dents, obstructions, or any other defects which would cause damage to cables. The bores must pass freely a mandrel ¼ inch less in diameter than the nominal diameter of the duct.
e. All fiberglass conduits must be UL listed and bear the UL label.
f. Each length of exposed conduit, 2” and larger in diameter, must have an integral end bell insuring a bell-and-spigot system of connection with method dependent on manufacturer.
g. Conduit must have a burning point in excess of 130°C and combustion must cease when the heat source is removed. When tested in accordance with ASTM D635, conduit must not outgas chlorine. Other toxic gases must not outgas in excess of 0.0015 ft3/ft2 of material.

7. All couplings, elbows, offsets and fittings must be performed and must conform to NEMA TC 14 and UL Standard No. E78442.
8. When work is not in progress, open ends of conduit and fittings must be securely closed so that no water, earth or other substance will enter. The Contractor must use threaded caps, plugs, and rubber duct plug made with wingnut or bolt to squeeze rubber between steel plates to seal tight against inside of the conduit.
9. Fiberglass conduit to be manufactured by FRE Composites, Inc, or Champion Fiber Glass, Inc.

F. Liquid-Tight Flexible Metal Conduit (LFMC):

1. Liquid tight flexible metallic conduit to be used for termination at recessed light fixtures, in non-plenum ceilings, motors, transformers, and installations subject to vibration.
2. Liquid-tight galvanized steel flexible conduit to conform to UL 360. Fittings to be of a type designed to provide a liquid-tight continuation of the conduit system.

G. Liquid Tight Flexible Metal Tubing (LTFMT):

1. Liquid tight flexible metal tubing to be used for termination at recessed light fixtures, in plenum ceilings.
2. Liquid tight metal flexible metal tubing to conform to UL 360, Fittings to be of a type designed to provide liquid-tight continuation of the conduit system.

H. Conduit Fittings:

1. Galvanized Rigid Steel Conduit GRS:

   a. All fittings to be malleable iron; threaded type; hot dip galvanized or cadmium plated. Feraloy, aluminum, or threadless fittings are not acceptable and not to be provided.
   b. All LB, LR, and LL fittings to have detachable cover, captive brass machine screws, and full neoprene gasket. All LB, LR and fittings to be NEC Series Mogul Type.
   c. Locknuts to be malleable iron or steel, with non-slip notches.
   d. All bushings to be of the insulated and grounding type.
   e. Expansion couplings to have capability of eight-inch movement and be complete with flexible bonding jumper.
   f. Fittings to be UL listed.

2. Rigid Non-Metallic Fiberglass Reinforced Epoxy Conduit:

   a. All fittings to be composed of glass filaments encapsulated in an epoxy matrix.
   b. All fittings to be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for ultra-violet protection.
   c. All fittings to be suitable for continuous usage in ambient temperatures ranging from minus 40 degrees C to plus 100 degrees C without significant change of mechanical properties.
   d. Fittings in all sizes to have inside diameters equal to the trade sizes.
   e. Fittings to be UL listed.

3. Liquid-tight Flexible Metallic Conduit (LFMC):

   a. All fittings for use with liquid-tight flexible metallic conduit to require the use of a wrench during installation.
   b. All fittings to; have a deep grip ferrule for thorough engagement of the flexible conduit and grounding continuity; provide high resistance to pull out of the flexible conduit from the fitting; withstand extreme external flexing, vibration and moist environments.
   c. Fittings to be UL listed.

I. Conduit Hangers and Supports:

1. The Contractor to provide all necessary conduit hangers, and equipment supports or hangers, including all structural steel members and shapes, standard rods, nuts, bolts, concrete inserts, expansion shells, pipe brackets, tubing and conduit clamps, as indicated, hereinafter specified, or as required to support and/or suspend all equipment and conduit.
2. Exposed conduit on walls or ceilings to be supported, a minimum of every five feet, with galvanized malleable iron one-hole clamps and matching backs, utilizing anchors as specified herein.
3. For concrete or brick construction, when stray current isolation is not required, insert anchors to be zinc alloy steel or steel anchors as manufactured by Ackerman-Johnson, Paine or Philips with noncorroding round head machine screws.
4. For wood construction provide galvanized round head wood screws.

5. For exposed work, where two or more conduits, one inch or larger are run parallel, trapeze hangers, spaced on five-foot centers may be used.
6. The Contractor to securely fasten conduits to each support with U-bolts, or conduit straps. Conduit supports to be as manufactured by B-Line, OZ/Gedney, Unistrut Corp. Supports to be held to concrete walls and ceilings by electro-galvanized steel inserts as manufactured by B-Line, Ramset, or Unistrut Corp. Supports suspended from steel structure to be supported from drilled holes in the steel flange. The use of beam clamps for this work is not acceptable.
7. The Contractor to provide hanger rods for trapeze-type hangers made from high tensile strength carbon steel not less than 1/2-inch diameter. The rods to have free-running, burr-free Unified National Coarse threads, with an electro-galvanized finish. Conduit supports to be located at intervals not exceeding 5 feet as required by City of Chicago Electrical Code.
8. For exposed work attached to the support structure of the Rapid Transit right of way, conduits to be supported as shown on the Drawings. The use of beam clamps, and or trapeze type hangers for this work is not acceptable.
9. The use of explosive force, hammer actuated, booster assist, piston drive, or like devices is strictly prohibited.
10. The use of perforated strap hangers, plastic, or composition inserts is not acceptable.
11. The Contractor to support vertical conduits by heavy wrought iron clamps or collars anchored in construction at each floor.
12. Where threaded fasteners are provided, either a jam nut or aerobic thread sealant manufactured by Loctite to be used.

J. Outlet, Junction and Pull Boxes:

1. Outlet boxes, to be hot dipped galvanized sheet steel or cast ferrous metal conforming to UL 514, suitable for use in damp areas.
2. Outlet boxes installed outdoors, on, or under the platform, to be cast iron type with a cast or malleable iron gasketed cover.
3. Junction and pull boxes to be constructed of galvanized sheet steel, with continuously welded seams, and to be hot dipped galvanized after construction. or cast Ferrous metal conforming to UL 50.
4. The size to be as shown on the Drawings or required by the NEC and Chicago Electrical Code.

K. Cable Trays:

1. Cable trays to be of the ventilated, steel ladder type with 9 inch rung spacings. Trays to have the depth and width as specified, required or shown on the Contract Drawings. All components of the tray system to be of the same design and manufacture.
2. Cable trays and accessories to conform to NEMA Standard VE 1 and to be hot dipped galvanized after fabrication.
3. Cable trays to have minimum load rating of 50 pounds per linear foot with safety factor of 1.5 at 12-foot support span.
4. Fittings in cable trays system to have a minimum radius of 24 inches for both vertical and horizontal turns.
5. Trays and fittings to be of Ventray Design as manufactured by B-Line Systems, Chalfant Mfg Co., or MP Husky Corp.

PART 3 - EXECUTION

3.01 CONDUIT INSTALLATIONS

A. General:

1. There to be no exposed conduit in public areas. Whenever possible conduit to run inside walls, ceilings, custom enclosures, or behind structural members. Exposed conduit runs to be approved by Commissioner.
2. Exposed conduit to be limited to nonpublic areas and conduit attached to elevated train structure.
3. All conduits to be installed as required. The conduit system to be installed complete with all accessories, fittings, and boxes, in an approved and workmanlike manner to provide proper raceways for electrical conductors.
4. All conduit runs shown on the Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits. Conduit to be run underground or in concrete slabs only when shown on the Drawings. It to be the Contractor's responsibility to avoid interferences.
5. Exposed conduit runs to be installed true, plumb, parallel with or at right angles to adjacent structural members, and to present an orderly, neat and workmanlike appearance.
6. Factory made conduit bends or elbows to be used wherever possible in making necessary changes in direction. Field bends to be made with proper tools for the size and type of conduit being used. Field bends to be carefully made to prevent conduit damage or reduction in internal areas. The bending radius to not be less than six times the nominal diameters of the conduit, with carefully matched bends on parallel runs to present a neat appearance. The number of crossovers to be kept to a minimum.
7. All conduit cut on the job to be carefully reamed after threading, to remove burrs. All field cut threads to be tapered. No running threads will be permitted. Field cut threads on steel conduit to be given a coat of zinc dust in oil, or other approved compound.
8. All threaded joints to be watertight and ensure a low resistance ground path in the conduit system.
9. All conduits to be carefully cleaned before and after installation and all inside surfaces to be free of imperfections likely to injure the cable. After installation of complete runs, all conduits to be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Any conduits through which the mandrel will not pass to be removed and replaced. After snaking, the ends of the dead ended conduits to be protected with standard malleable metal caps to prevent the entrance of water or other foreign matter.
10. Lines of nylon or polypropylene, propelled by carbon dioxide or compressed air, to be used to snake or pull wire and cable into conduits. Flat steel tapes or steel cables may be used for branch circuit runs less than 50 feet long.
11. Where conduits are connected to boxes or equipment enclosures, drilled holes or full-size knockout openings to provide electrical continuity for grounding and to be assured by the use of bonding type locknuts. Where connections are at eccentric or concentric knockouts, jumper type grounding bushings and wire jumpers to be installed.
12. At pull and junction boxes that have any dimension in excess of 18 inches and having a total of more than four conduit terminations, jumper type grounding bushings to be installed on conduit ends and jumper wires to be installed to bond all conduits and to bond conduits to boxes.
13. Communication conduit radius to not be less than 10 conduit diameters.
14. Conduit bends which are crushed or deformed in any way to not be installed.
15. Conduit systems to be installed, with fittings, double locknuts and bushings, and made up tight to insure ground continuity throughout the system.
16. Conduit connections to NEMA Type 3R enclosures to terminate in a threaded hub with an insulated throat to provide a positive seal, an electrical ground and a watertight connection. Each hub to be manufactured by Meyers, or 0Z/Gedney Type CH-T.

17. Conduit crossing from north station structure to south station structure to be attached to elevated train structure in methods mentioned in this section for exposed conduit.
18. Conduit shown on drawings to be attached to elevated train structure to be installed in methods indicated for exposed conduit.
19. Service conduit and service drop/head to be of nonmetallic type as mentioned and to be attached to structure with nonmetallic equipment.
20. Conduit attached to elevated train structure to be rigid type.
21. Right after conduit exits station structure to be connected to elevated train structure, it should transition to liquid tight flexible conduit, and then connected to rigid conduit attached to structure.
22. Nonmetallic conduit to utilize nonmetallic junction boxes and supporting devices.
23. Provide the conduit type as stated elsewhere in this specification.
24. All raceways routed from station to Platform or North Stairway and electrical closets to be electrically isolated from the steel track structure.
25. Exposed conduit, boxes and fittings attached to track structure to be painted to match structure.
26. Conduits installed in Station Level columns to be coordinated with column fabricator/installer.

    a. Conduits and raceway attachment will require the Contractor to provide internal to column welded supports/attachments.
    b. These attachments and conduits to be installed during fabrication of the columns or prior to columns being installed in field.
    c. Contractor to install all power and data conduits inside columns such that all externally column mounted devices (lighting, illuminated signs, others) have the rigid conduit threaded end extended from edge of column face to be extended to light, sign or device with liquid tight flexible conduit.
    d. Coordinate this work with Architectural Drawings and Details.

B. As far as practicable, conduit to be pitched slightly to drain to the outlet boxes, or otherwise installed to avoid trapping of condensate. Where necessary to secure drainage, a breather-drain fitting, to be installed in the boxes or trapped conduit at low points. Each breather drain fitting to be manufactured by Eaton, Crouse-Hinds Co., or Appleton Electric Co.

C. Conduit is not to be run through columns or beams unless so specifically detailed on the drawings.

D. Conduit Installed in Concrete Slab

1. Metal conduits shall not be installed in concrete slabs on grade. Where installed in slabs, conduit to be placed in the center of the slab and no closer than 3 diameters from adjacent conduits. The maximum outside diameter of conduits in the slab to be no greater than 1/3 of the slab thickness.
2. Joints in conduit installed in concrete slabs to be made watertight.
3. Conduit openings to be temporarily plugged with metal caps to exclude water, concrete, plaster and other foreign material.
4. Conduits run in earth below any floor slab to be rigid non-metallic conduit and to be entirely encased in reinforced steel concrete. In no case shall conduit be laid in fill below the slab.
5. Conduits embedded in concrete to be blocked and braced in place by use of adequate conduit separators to prevent displacement during the placing of concrete.
6. The Contractor to be held responsible for proper position of conduits and to rearrange any conduit that may be displaced while concrete is placed.
7. Conduits run in floor slabs to be a minimum one inch in size, and as shown on the Drawings.

E. The number of 90 degree bends to be limited to 3 or a total of 270 degrees including all offsets, sweeps, kicks, etc. This to include conduit runs between panelboards, switchboards, pullboxes, outlets boxes, fittings, or between outlets and fittings including bends located immediately adjacent to outlets or fittings. The maximum run without pull boxes to be 150 feet.

F. The Contractor to furnish and install expansion fittings and bonding jumpers for the metallic conduit system where conduit crosses each building expansion joint, at each straight uninterrupted run of surface mounted conduit, or each vertical riser in excess of 100 feet and where conduits transfer between structurally independent buildings or supports. The distance between fittings as installed to not exceed 200 linear feet.

1. Expansion fittings to provide for 8 inch movement and to include bonding jumpers.
2. Expansion fittings to be Appleton XJ with XJB jumpers, Crouse-Hinds, or OZ/Gedney.

G. All wiring systems to be "pullable" and use of "BX" is prohibited.

H. Conduits entering motor control center conduit compartments, free standing panels, and free standing control cubicles to be fitted with jumper type insulated grounding bushings, bonded together and to the structure of the enclosure by a continuous bonding wire.

I. Conduits and concrete type boxes, masonry boxes, and other flush mounted boxes to be installed concealed in masonry walls, plaster walls, dry wall and concrete walls.

J. All concealed conduits to be placed in walls, floors, ceilings, or ducts at the proper time, in accordance with the progress of the structural work.

K. Concrete encased conduit runs extending through structural expansion joints to have fittings permitting longitudinal and lateral movement of the conduit ends without damaging the contained wires. The fittings to be watertight and include a grounding bond jumper.

L. Conduit runs that enter the building from outdoors are subject to moisture accumulation due to condensation. A pull box to be provided in the conduit run near the point of temperature change, to prevent trapping of moisture within the conduit system. A 1/4 inch weep hole to be drilled in the bottom of the pull box. After the wires and cables are installed, the end of the conduit continuing into the warmer area to be packed with a non-setting sealing compound.

M. All communication, telephone, data and computer conduits to have a minimum separation of 12 inches from any AC power and control conduits.

N. When work is not in progress, open ends of conduit and fittings to be securely closed so that no water, earth or other substance will enter.

O. Fiberglass Conduit

1. Use long radius bends on 3-inch size fiberglass conduits.
2. Bends must be made only with manufactured bends from the manufacturer of the conduit.
3. All joints in conduit must be cut square and must butt solidly into couplings. All joints between conduit and couplings must be made by a method specifically approved for this purpose.
4. No conduit may be smaller than 1-1/4” UNLESS OTHERWISE INDICATED ON Drawings.
5. Fittings

a. Where a conduit enters a box, cabinet or other fitting, a bushing or other adapter must be provided for protection of all wire and/or cables at all conduit terminations.
b. All joints and fittings must be provided in accordance with the recommendations of the manufacturer, to assure conduit to be leak-proof, moisture-proof, and permanent.
c. Transition fittings for connection to other type of conduit must maintain the integrity of the conduit systems.

3.02 CONDUIT CONNECTIONS TO EQUIPMENT

A. The conduit system to be terminated at the conduit connection point of electric motors, devices, and equipment. Terminations of conduits at such locations to permit direct wire connections to the motors, devices, or equipment.

B. Conduit connections to be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement, or vibration. Rigid conduit connections to have union fittings, to permit removal of equipment without cutting or breaking the conduit.

C. Conduit connections to be made with approved flexible metallic conduit if the equipment is subject to adjustment, mechanical movement, or vibration. Flexible conduit connections to be watertight.

3.03 OUTLET BOX INSTALLATION

A. Boxes to generally be 4 inches square or octagonal except as follows:

1. In masonry walls, where conduit is installed concealed, each box to be installed square cut masonry boxes. Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
2. In concrete walls and floor slabs, where conduit is installed concealed, boxes to be suitable and constructed for installation in concrete.
3. In exposed work, surface outlet boxes to be used for switches and receptacles.
4. Outlet boxes for use with rigid conduit to be of the threaded hub, malleable iron cast metal type, with malleable iron cast covers and gaskets.
5. In finished plaster walls, drywall, etc., raised device covers on outlet boxes to be provided.
6. Where 1-1/4 inch conduits are required, the box size to be a minimum of 4-11/16 inches square.
7. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

B. Proper covers on boxes mounted flush to be provided.

C. All ceiling outlets to have adequate supports and to be equipped with adequate devices to carry and mount lighting fixtures provided fixtures do not weigh more than fifty pounds.

D. An outlet box to be provided at each device location requiring one.

1. Outlet box locations as shown on the Drawings to be considered as approximate only.
2. Exact locations to be determined from the Drawings or from field instructions. The Contractor to coordinate box locations with the work of other trades.
3. Outlet box mounting heights shall comply with ADA requirements.

4. Boxes to be installed true and plumb, so that the covers or plates to be level and at uniform elevations for the type of outlets contained.
5. Boxes for toggle switches and pilot lights at doorways to be located at the strike side of the door.
6. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
7. Locate boxes so that cover or plate will not span different building finishes.
8. Support boxes of three gangs or more from more than one side by spanning two framing members of mounting on brackets specifically designed for the purpose.

E. There are to be no more openings made in any box than are required for the conduits entering same. Depths of boxes to be such as to allow for easy wire pulling and proper installation of wiring devices.

F. Switches and receptacles to be ganged in a common box only where the Drawings so indicate.

G. Device Boxes:

1. Recessed ceiling fixtures to have 4 inch square sheet steel box with cover and suitable hanger bar. The box to be secured to the ceiling suspension members not more than 1 foot from the fixture opening.
2. Surface mounted ceiling fixtures, for plaster or dry wall ceilings, to have 4 inch sheet steel octagon box with round opening plaster ring and suitable hanger bar with 3/8 inch fixture stud.
3. Fixtures which weigh more than fifty pounds to be supported independently of the outlet box.
4. Surface mounted wall bracket fixtures (concealed conduit) to have 4 inch square sheet steel box with plaster ring as required for the fixture.
5. Ceiling outlets and wall bracket outlets (exposed conduit) in dry locations to have 4 inch sheet steel octagon box with 3/8 inch fixture stud.
6. Outlet boxes on exposed conduit run in wet or damp locations to have 4 inch cast box with threaded hubs and gasketed covers.
7. Wall switch and receptacle boxes installed in tiled or plastered walls to have 4 inch square sheet steel boxes or multigang boxes with proper tile or plaster ring as required. Two gang may be provided by means of 4 inch square box with two gang tile or plaster ring.
8. Wall switch and receptacle boxes in dry locations in brick walls, unfinished walls, woodwork, etc. to have single or multigang 4 inch square sheet steel boxes.

H. Plaster rings to have threaded ears and to be of suitable depth for the application.

I. The Contractor to provide boxes with metal barriers, baffles or separators for grouping of dissimilar conductors or system separation.

J. Set metal floor boxes level and flush with finished floor surface.

K. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.04 PULL BOX INSTALLATION

A. Pull boxes to be installed where shown and where necessary to insure that finished cable will not be damaged.

B. Pull boxes to be supported independently from the conduit system.

C. The Contractor to add pull boxes where needed even though not shown on the Drawings.

D. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.05 CABLE TRAYS

A. The entire cable tray system to be installed and supported by devices as shown on the Drawings. A system of preformed galvanized channel members may be used to support cable trays subject to the approval of the Commissioner.

B. To prevent fire from spreading between cable trays, the fire resistant blanket, "Flame-Safe" blanket manufactured by Thomas & Betts and to be installed as required whether or not it is shown. For control cable trays, fire resistant blanket to be installed on top of the cable tray as shown.

3.06 FILLING OF OPENINGS

A. Where conduit and raceway pass through interior fire-rated walls, ceilings or floors, the Contractor to provide seals to prevent passage of fire and fumes and to maintain integrity of fire-rated structure.

B. The Contractor to close unused openings or spaces in floors, walls and ceilings, and plug or cap all unused conduit and sleeves.

C. Where conduit passes through walls or floors which are below grade, the Contractor to provide watertight sealing fittings, OZ/Gedney Type W5K,

3.07 IDENTIFICATION

A. Conduit runs to be identified as specified under Section 261950 Identification.

3.08 FIELD QUALITY CONTROL

A. The Contractor to arrange with the Commissioner for inspection and approval of embedded conduit and boxes prior to concrete placement.

B. The Contractor to test metallic conduit and boxes for electrical continuity. The tests to be conducted in presence of the Commissioner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of RACEWAYS AND BOXES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of RACEWAYS AND BOXES to be included in the Contract Lump Sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 09 43

DIGITAL NETWORK LIGHTING CONTROLS

Part 1. GENERAL

1.01 WORK INCLUDED

A. The Electrical Contractor, as part of the work of this section, shall provide, install and test a complete lighting control system as specified herein for areas indicated on the drawings and circuit schedules.
B. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and proper operation of the lighting control system.
C. The Electrical Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to:
    1. General Conditions
    2. Electrical Section General Provisions
    3. Conduit
    4. Wire and Cable

1.02 SYSTEM DESCRIPTION

A. The system shall be designed for the control of architectural and theatrical lighting and shall consist of factory pre-wired dimming and processing rack enclosures containing dimmers, relays, power supplies, breakers, terminals and/or control electronics.
B. System shall work in conjunction with specified low-voltage control stations.

1.03 SUBMITTALS

A. Manufacturer shall provide 4 sets of full system submittals. Submittals shall include:
    1. Full system riser diagram(s) illustrating interconnection of system components, wiring requirements, back box sizes and any special installation considerations.
    2. Full set of printed technical data sheets.
    3. Detailed set of dimmer schedules
    4. Detailed set of circuit and control schedules, including a complete list of all deviations from specifications.
B. Manufacturer shall provide any additional information, including equipment demonstrations, as required by the engineer or specifier to verify compliance with specifications.

1.04 QUALITY ASSURANCE

A. Manufacturer shall be one who has been continuously engaged in the manufacturer of lighting control equipment for a minimum of ten years. All dimmer and cabinet fabrication must take place in a U.S.manufacturing plant.
B. The manufacturer shall have a factory authorized stocking service center with at least one full time service technician on staff located within 150 miles of the job site. In addition, the manufacturer shall have a toll free 24-hour hotline with a maximum response time of 20 minutes, 24 hours a day and 365 days a year.
C. All equipment, where applicable standards have been established, shall be built to the standards of Underwriters Laboratories, Inc., the National Electric Code and the United States Institute for Theater Technology. Permanently installed power distribution equipment such as dimmer racks and distribution shall be UL and C-UL Listed, and/or CE marked (where applicable) and bear the appropriate labels. Portable equipment such as consoles and fixtures shall be UL and C-UL Listed, ETL Listed and/or CE marked (where applicable) and bear the appropriate labels.

1.05 ACCEPTABLE MANUFACTURERS

A. The equipment herein specified shall be manufactured by
    - Electronic Theatre Controls
    - PO Box 620979
    - Middleton, WI 53562
    - Phone: 608/831-4116
    - Fax: 608/836-1736

B. Alternative manufacturers must submit a full pre-approval package ten days prior to bid date. Package shall consist of items listed in Part 1, Section 1.03A.
C. Permission to bid does not imply acceptance of the manufacturer. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for controls systems that meet or exceed the specifications.

Part 2. PRODUCT

2.01 Unison Mosaic Show Controller X (MSCX)

1. Control Hardware
    A. General
        1. The Controller shall be a microprocessor-based system specifically designed for control of lighting and related systems in an architectural or entertainment application. A personal computer running emulation software shall not be acceptable.
        2. The Controller shall store operating software and show data in non-volatile solid-state memory. This memory shall be removable for purposes of backup or disaster-recovery.
        3. Show data may be downloaded from a remote personal computer over an Ethernet or USB connection.

4. It shall be possible to update the Operating Software by download from a remote personal computer over an Ethernet connection.
5. The Controller shall commence show playback automatically on receiving power without additional external inputs.
6. The Controller shall have an internal real-time clock that continues to operate when external power is absent. It shall be capable of adjusting for Daylight Savings Time automatically and can be updated over the Internet using the Network Time Protocol (NTP).
7. The Controller shall be able to calculate sunrise and sunset times based on longitude and latitude information, and use these as triggers for events.
8. The capacity of the controller shall be defined in terms of number of control channels being used, and the maximum capacity of each unit shall be factory-configured to user requirements.
9. There shall be visual indicators on the Controller showing status of the controller and its interfaces.
10. The Controller shall operate a web server on its Ethernet interface. This shall allow status information, control and configuration options to be accessed remotely.
11. The appearance and content of the web interface may be customized by the user.
12. The Controller shall allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.
13. The Controller shall support multiple timelines, crossfades and effects running concurrently.
14. The Controller shall support playback of video media with individual pixels mapped to lighting fixtures in an array.
15. The Controller shall output control data as digital video via Firewire DV and DVI
16. The Controller shall be capable of receiving a live video input via Firewire DV and mapping individual pixels to lighting fixtures in an array.
17. The Controller shall support two full-duplex RS232 Serial Ports for interfacing to show control devices.
18. The Controller shall support DMX-in for receiving triggers
19. The Controller shall support multiple remote modules connected via Ethernet for support of additional show control interfaces, such as contact closures, analogue inputs, relay outputs and serial.
20. The Controller shall support multiple streams of timecode and audio data within a single networked system.
21. The Controller shall have a recessed switch for resetting the unit without removal of power.
22. The Controller shall have an internal watchdog feature that will restart the unit in the event of program failure.

23. Multiple Controllers shall automatically synchronize and share triggers when programmed as part of a single show and linked via Ethernet during playback.
24. The Controller shall support conditional logic and execute user-defined Lua scripts to support advanced show control operations.
25. The Controller shall be provided with a 5 year manufacturer warranty.
26. The Controller shall support network DMX protocols including sACN (ANSI E 1.31), Philips KiNET, Pathway Pathport and Art-Net protocols.
    a. The controller shall be able to output multiple Ethernet DMX protocols simultaneously, up to the output control channel limit.

B. Mechanical
    1. Enclosure and mounting shall comply with IEC 60297
    2. The controller shall be a 2U 19" rack mount enclosure (19" x 3.5" x 15")
    3. The controller shall be entirely solid-state with no moving parts, fans or hard disc drives

C. Electrical
    1. The Controller shall be designed to support the following standard connectors:
        a. RJ45 socket for 10/100/1000 Base-TX Ethernet for control data
        b. RJ45 socket for 10/100/1000 Base-TX Ethernet for system management
        c. USB-A Socket for USB 2.0
        d. (2) IEEE 1394 socket for DV input and/or output
        e. (2) 9-pin D plug for RS232 serial input/output
        f. DVI-I socket for DVI output
        g. Fused IEC socket for 115-250VAC/47-63Hz/2-1A mains input and power cables for North America, Europe and UK shall be provided.

D. Thermal
    1. The controller shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

E. Software
    1. The Controller shall be supported by programming software running on either a PC or Mac platform. Programming features shall include:
        a. Comprehensive architectural and automated fixture library
        b. Drag and drop placement of fixtures on plan
        c. Drag and drop patching of fixtures to output addresses
        d. Import of any media for mapping to fixture arrays
        e. Timeline-based programming and playback
        f. Extensive range of editable effect presets

g. Drag and drop placement of effect presets and media on timeline
h. Variety of triggering options for firing system-wide events
i. Each trigger event may be configured to initiate one or more lighting or show control action
j. Each trigger event may be configured to test one or more conditions before executing its actions
k. Simulation of individual timelines, and entire project with triggers
l. Live output from software for programming verification purposes
m. Controller and network management tools
n. Export TSV reports for all aspects of programming

2.02 Touchscreen Station

A. General
1. The Touchscreen shall be a microprocessor-based system specifically designed for trigger of lighting control and other related systems in an architectural or entertainment application. A personal computer running emulation software shall not be acceptable.
2. The Touchscreen shall be provided with a 5 year manufacturer warranty.

B. Mechanical
1. The Touchscreen shall have a fully integrated capacitive touchscreen driven by the application running on the microprocessor. A web browser displaying remotely served content shall not be acceptable.
    a. The capacitive touch screen shall be 4.3" with a resolution of 480x272 pixels with 24-bit color depth
2. The touchscreen application shall be dedicated to displaying a user interface for the controller. No other processes shall run on the touchscreen.
3. The Touchscreen shall have a recessed switch for resetting the unit without removal of power.
4. No physical buttons shall be visible or exposed when the Touchscreen is correctly installed.
5. There shall be visual indicators on the Touchscreen showing status of the Touchscreen and its interfaces.
6. The Touchscreen shall be entirely solid-state with no moving parts, fans or hard disc drives
7. The Touchscreen shall operate in a temperature range from 0°C to 50°C (32°F to 122°F)

C. Electrical
1. The Touchscreen shall have the following standard connectors:
    a. RJ45 socket for 10/100Base-TX Ethernet
2. The Touchscreen shall utilize Power over Ethernet (IEEE 802.3af PoE powered device).
3. The Touchscreen shall be ETL/ cETL listed and CE compliant

D. Functional
    1. The appearance and content of the user interface shall be customizable by the user
    2. The user interface shall support portrait or landscape orientation.
    3. The Touchscreen shall store show data in non-volatile solid-state memory. This memory shall be removable for purposes of backup or disaster-recovery.
    4. Show data may be downloaded from a remote personal computer over an Ethernet connection.
    5. The Operating Software of the Touchscreen shall be stored in a dedicated non-removable non-volatile solid-state memory. It shall be possible to update the Operating Software by download from a remote personal computer over an Ethernet connection.
    6. The Touchscreen shall commence show playback automatically on receiving power without additional external inputs.
    7. The Touchscreen shall have an internal real-time clock that continues to operate when external power is absent. It shall be capable of adjusting for Daylight Saving Time automatically and can be updated over the Internet using the Network Time Protocol (NTP).
        a. The Touchscreen shall be able to calculate sunrise and sunset times based on longitude and latitude information, and use these as triggers for events.
    8. The Touchscreen shall allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.
    9. The Touchscreen shall support an ambient light sensor to automatically adjust the touchscreen backlight level.
    10. The Touchscreen shall support a proximity sensor to automatically wake up the screen.
    11. The Touchscreen shall support a learning IR receiver.
    12. The Touchscreen shall be capable of providing show feedback via the user interface.
    13. The Touchscreen shall have an internal security feature that will restart the unit in the event of program failure.
    14. Multiple Touchscreens shall automatically synchronize and share triggers when programmed as part of a single show and linked via Ethernet during playback.
E. Software
    1. The Touchscreen shall be supported by user interface creation software running on PC or Mac platform. User interface configuration features shall include:
        a. Create multiple pages of user interface controls
        b. Library of page control layouts with buttons, sliders and color pickers
        c. Change the appearance of pages and controls by applying themes
        d. Use themes from the theme library, or create custom themes
        e. Choose a background image for each page

f. Assign local functionality to controls, e.g. change page or screen brightness
g. Add navigation controls to pages and configure page transitions.

F. Protection and Patents
1. The Touchscreen is protected under license by the following patents:
a. U.S. Patents: 6,016,038; 6,150,774; 6,166,496; 6,211,626; 6,292,901; 6,340,868; 6,459,919; 6,528,954; 6,548,967; 6,577,080; 6,608,453; 6,624,597; 6,636,003; 6,717,376; 6,720,745; 6,774,584; 6,777,891; 6,781,329; 6,788,011; 6,801,003; 6,806,659; 6,869,204; 6,883,929; 6,888,322; 6,897,624; 6,936,978; 6,965,205; 6,967,448; 6,969,954; 6,975,079; 7,014,336; 7,031,920; 7,038,398; 7,038,399; 7,042,172; 7,064,498; 7,113,541; 7,132,635; 7,132,785; 7,132,804; 7,135,824; 7,139,617; 7,288,190; 7,231,060
b. Canadian Patent: CA 2,302,227
c. Hong Kong Patent: HK 1025416
d. Australian Patent: AU 757000; AU 2003203584
e. European Patents: EP 1 016 062 B1; EP 1 224 845 B1; EP 1 234 140 B1; DE 698 07 092 C0; DE 600 21 911 C0; DE 600 23 730 C0

2.03 DMX ETHERNET GATEWAY – FOUR PORT

A. General
1. The lighting control gateway shall be a microprocessor-based unit specifically designed to provide DMX-512 control of lighting systems and transport of RDM configuration and status messages. The gateway shall permit DMX-512 data to be encoded, routed over an Ethernet network and decoded back to DMX-512. The unit shall be a Response Mk2 4-port DMX Gateway as provided by ETC, Inc.
2. Gateways shall communicate over Ethernet directly with at least ETC, Inc.' s entertainment and architectural lighting control products and other Ethernet interfaces.
3. Connections shall be made between gateways, consoles, architectural systems, and PCs over standard Ethernet distribution systems using 10/100BaseT.
4. The gateway shall support multiple protocols including:
a. ANSI E1.17 Architecture for Control Networks (ACN)
b. ANSI E1.31 Streaming ACN (sACN)
c. ANSI E1.11 USITT DMX512-A
d. ANSI E1.20 Remote Device Management (RDM)
5. The gateway shall be tested to UL standards and labeled ETL Listed.
6. The gateway shall be RoHS Compliant (lead-free).
7. The gateway shall be CE compliant.
8. The gateway shall be UKCA compliant.
9. The gateway shall have a graphic OLED display and four buttons for identification (soft-labeling), configuration, status reporting and troubleshooting

a. Labeling shall be user configurable using ANSI E1.17 Architecture for Control Network (ACN), or a purpose built software configuration tool.
b. The OLED display shall show DMX port configuration indication as well as indicate the presence of valid signal.
c. Gateways that do not indicate port configuration (input/output) and valid data shall not be acceptable.

10. Each gateway shall have power and data activity LEDs on the front of the gateway

B. DMX Ports
1. DMX Ports shall comply with the requirements of ANSI E1.11 USITT DMX512-A standards.
2. Each DMX port shall be software or locally-configurable for either input or output functionality.
3. DMX input shall be optically-isolated from the gateway electronics.
4. DMX Port shall provide at least 500V isolation to ground and the rest of the electronics
5. Each port shall incorporate one DMX512-A Connection
a. Gateways shall be available with the following connection options: 5-pin male XLR, 5-pin female XLR, Ethercon RJ-45, or terminal strip for DMX wiring.
6. Network gateways that do not indicate input/ output port configuration or presence of valid data shall not be accepted

C. Processor
1. Each gateway shall have sufficient processing power to manage up to 63,999 universes (32,767,488 addresses).
2. Maximum delay time from input to output shall not be greater than one packet time (approximately 22 mSec.).
3. A minimum DMX update rate of 40Hz shall be sustained under all conditions unless specifically configured for a slower rate for the sake of compatibility with 3rd party DMX devices.

D. Mechanical
1. The Gateway shall be fabricated of 16-gauge steel, finished in fine-texture, scratch-resistant, black powder coat (RAL 9004).
2. The gateway shall support table top use
3. The gateway shall support field configuration allowing the Ethernet port to be either on the front or the rear of the unit
4. Optional accessories for rack-mount and pipe applications shall be available from the manufacturer. These accessories shall support installation by an end-user

E. Power
1. Power for the gateway shall be provided over the Category 5 (or better) cable, utilizing IEEE 802.3af compliant Power over Ethernet (PoE). Power consumption using shall not be greater than 7 watts.
2. An optional low-voltage DC power input shall be available utilizing an isolated in-line power supply capable of an operating range of 12-24VDC.

F. Configuration
    1. The Gateway must support local or remote configuration.
    2. Each gateway on the network shall be individually configurable using freely available software configuration tools. The primary configuration tool shall be Net3 Concert configuration software running on a network connected PC. The PC shall only be required for configuration, and shall not be required for normal operation of the system.
    3. Each port of the DMX gateway shall control up to 512 DMX addresses, within the confines of 63,999 universes.
    4. The specific DMX data input or output by the gateway shall be freely configurable by the user.
    5. Duplicate outputs of DMX lines (DMX splitter) and discrete outputs shall be fully supported.
    6. Multiple DMX universes may be configured with any length up to 512 total addresses. Any range of DMX input addresses shall support selection and routing to the specified sACN output.
    7. Multiple sACN sources may be combined with a priority may be assigned to each source sending data to the gateway
    8. All relevant routing information shall be stored in non-volatile memory at each gateway. The system shall recover from a power outage without requiring the PC to be online. Gateways that do not support non-volatile storage of data routing shall not be accepted.

G. Network
    1. Communications physical layer shall comply with IEEE 802.3i for 10BASE-T, 802.3u for 100BASE-TX and 802.3af for Power over Ethernet specifications
    2. All network cabling shall be Category 5 (or better), conforming to TIA-568A/B, and shall be installed by a qualified network installer.
    3. Data transport shall utilize the TCP/IP suite of protocols to transfer the DMX data.
    4. ANSI E1.17 Architecture for Control Networks (ACN) and streaming ACN (sACN) shall be supported. Gateways that do not support ANSI E1.17 shall not be acceptable.
    5. Each DMX gateway shall control up to 512 DMX addresses, per DMX port within the confines of up to 63,999 universes (32,767,488 addresses) using Streaming ACN (sACN).
        a. Any range of DMX addresses may be selected for each universe.
        b. Multiple sources shall be supported by prioritized Highest Takes Precedence (HTP with priority). Each source shall support assignment of priority to allow override of default HTP behavior.
        c. Each DMX port shall support its own universe and start address.
    6. Gateways shall have built in DMX merger capability on a universe or channel-by-channel basis.
    7. Gateways shall support have built in priority on a per-universe or channel-by-channel basis. Gateways that do not support prioritized merging of multiple network sources at independent priorities shall not be accepted.

H. Environmental
    1. The ambient operating temperature shall be 0° to 40°C (32° to 104°F).
    2. The storage temperature shall be -40° to 70°C (-40° to 158°F).
    3. The operating humidity shall be 5% - 95% non-condensing.
I. Accessories
    1. Hanging bracket kit shall allow unit to be mounted in three orientations
        a. U-Bolt or C-Clamp mounting hardware shall be available
    2. One E.I.A. rack space mounting bracket kit shall support either one or two complete units and allow for up to eight ports of DMX
    3. Front Access Panel kit shall allow the connectors on the rear of the gateway to be accessed from the front of an equipment rack. Options for 5-pin XLR style connectors that support DMX input or output shall be available
    4. A Universal Power Supply with international plug-set shall be available. Multiple power supplies shall be able to fit in a vertically stacked power strip.
    5. ETC Net3 Concert Configuration and monitoring Software
J. System Requirements
    1. Provide the quantity and type of gateways required, as scheduled. Gateways and software shall be as manufactured by ETC Inc. of Middleton, WI.

2.04 GENERAL NETWORK

A. General
    1. The Electronic Theatre Controls Net3 network shall provide data distribution over TCP/IP Ethernet networks. Data shall be layer 3 routable. Systems using proprietary formats or formats other than 10/100/100Mbit wired Ethernet or non-layer 3 routable networks shall not be accepted.
    2. Connections shall be made between consoles, face panels, architectural processors, dimmers, Net3 Gateways, and computers over standard Ethernet distribution systems using 100BaseT, 100BaseFL, or greater wiring. All installations shall conform to established Ethernet wiring practice, and installation shall be performed by contractors qualified to do this type of work. All wiring shall be tested at Category 5e or higher for full bandwidth operation to the appropriate IEEE standard.
    3. The Lighting Control system must be supplied by a single manufacturer and must have seamless integration over Ethernet between the Entertainment and Architectural lighting control.
B. Capacities
    1. The network shall support DMX routing, patching, and prioritization for up to 63,399 universes (32,767,488 DMX addresses). Each address may be input or output from any port on any DMX gateway in the system. DMX input, routing and output shall be specifically supported on the system from multiple sources and locations up to the maximum number of gateways supported by the Ethernet topology.

2. The network shall support multiple network hosts including consoles, gateways, dimming racks, computers, file servers, printers, and architectural control processors with discrete command lines and control. The lighting network shall support multiple venues within a system and discrete systems on the same network.

C. System Configuration and Monitoring
   1. Network device configuration shall be via Net3 Gateway Configuration Editor (GCE) software and/or ANSI E1.17 Architecture for Control Networks (ACN).
   2. Patch addresses shall support viewing and manipulation via ANSI E1.17 ACN.
      a. The system shall permit complete user flexibility allowing the system operator to patch each DMX input address to any ANSI E1.31 streaming ACN address, and DMX output to span streaming ACN universes.
      b. The lighting system shall support assignment of DMX offsets, truncation of DMX universes, and provide choice of DMX port prioritization.
      c. The lighting system shall support the DD start code extension to ANSI E1.31 which provides priority per address such that multiple control sources can share universes with discrete control per address.
      d. Lighting systems that do not support the above mentioned address patching capabilities shall not be suitable.
   3. The system shall allow assignable labels for all network devices to allow easy identification by system users.
   4. Each network device shall have a discrete and unique IP address provided automatically by the software. The user may edit this IP address. Systems that do not support automated IP allocation with IP collision avoidance, and systems that do not allow complete reconfiguration of the above mentioned features over ANSI E1.17 ACN shall not be acceptable.
   5. All configuration data for each network device shall be held at the device and system operation shall not require continuous on-line operation of the network configuration software.
   6. Lighting console operators shall be able to backup the network configurations in the lighting control console. In the event of a network device failure, the operator shall be able to apply the configuration of the failed device to a replacement device of the same type without manually reentering settings. Systems that do not support configuration backup as described above shall not be accepted.
   7. Architectural and Entertainment systems connected to the same network shall be capable of arbitrating control over E1.31 Streaming ACN (sACN) level data. The system shall be capable of alternating control of individual address data between architectural and entertainment systems without intervention by the user. The user shall dictate the conditions under which system shall automatically take control. The network shall allow user

override of the selected defaults. Systems which require direct user intervention to allocate control of dimmers between architectural and entertainment lighting systems shall not be accepted.

8. The Net3 network shall allow multiple DMX input sources to be prioritized on the same universe as network native sources using E1.31 Streaming ACN prioritization. Multiple DMX inputs may be assigned to the same streaming ACN address (this provides multi-source control for a particular address). Likewise, the system shall support E1.31 prioritization of multiple simultaneous network sources. Systems that cannot prioritize multiple DMX inputs and multiple native network sources on a network shall not be deemed suitable.
9. The lighting network shall allow each DMX input address to be assigned a priority on the network allowing each DMX control level coming into the system to participate in full arbitration. Addresses with the highest priority shall have control, with lower priority addresses being ignored. Addresses assigned the same numeric priority, between 1 and 200, shall respond in highest level takes precedence (HTP) manor. The network shall require a valid DMX signal present at the input to initiate prioritization. Systems that do not allow for prioritized HTP for DMX inputs to the network shall not be allowed.

D. Operational Features
   1. Each DMX gateway shall control up to 512 DMX addresses per port, within the confines of up to 63,999 DMX universes (32,747,488 address). The specific DMX data input or output by the gateway shall be configurable by the user.
   2. Duplicate outputs of DMX data (DMX splitter) and discrete outputs shall be fully supported.
   3. Merging of multiple DMX input sources on a single gateway without gateway with DMX output on the same gateway shall be supported without connection to the network. The gateway shall support assignment of priority to each input source independently
   4. File transmission, synchronization and access to software shall be supported.

2.05 Control System Configuration Software

1. Configuration And Control Software
   A. System Configuration
      1. The Control System Configuration software shall be the Unison Mosaic Designer 2 software as provided by ETC, Inc., or equal
      2. Definitions
         a. A system is the configuration of one or more Mosaic Show Controllers
         b. A fixture is a controllable entity with one or more attributes
         c. An attribute is a parameter of control such as intensity, pan or gobo select

d. A group is a selection of fixtures that can be stored and recalled
e. A trigger is a single point of control to the system (e.g. contact closure, serial command, timed event, etc.
f. Actions are items of functionality that can occur within a running Mosaic system in response to events (e.g. start timeline, pause timeline, set intensity, etc.
g. A timeline is a series of connected steps referencing control with timing information
h. A scene is a static look created for any fixture type.
i. Effects are attribute settings that result in continually varying levels following a specified curve and using additional timing parameters (e.g. period, offset)

3. System Configuration
    a. The application interface shall be based around (i) a tree-view; (ii) a workspace area; (iii) item selector
    b. There shall allow multiple 2-dimensional layouts that display the organization or layout of the project
    c. It shall be possible to represent data about the workspace area graphically (layout) or in tabular form
    d. Items displayed on the layout may be arranged using drag-and-drop interaction
    e. Layout views shall support zoom
    f. Layout views shall support a management grid with user-defined spacing and color with associated snap-to-grid functionality
    g. There shall be an auto-backup feature
    h. It shall be possible to add fixtures by selecting a fixture template from the provided library or download additional fixture templates from an internet hosted service
    i. It shall be possible to create a fixture layout based on data imported from a defined documentation format. (E.g. CSV)
    j. There shall be provision for help functionality to be accessed from within the application
    k. It shall be possible to import images as a background image to the layout view
4. Channel Configuration
    a. There shall be functionality to patch channels to DMX and/ or Ethernet Protocols including sACN, Philips KiNet Pathway XDMX and ARTNET
    b. There shall be support for Channels with split patches (e.g. VL5)
    c. It shall be possible to swap pan and tilt axes for a moving-light fixture
    d. It shall be possible to invert pan and tilt axes for a moving-light fixture

e. It shall be possible to specify a minimum and maximum value for an attribute
f. It shall be possible to specify a default value for an attribute

5. Design and Simulation
    a. There shall be control of LED arrays supporting pixel mapping of static or video media in any Apple® QuickTime® supported file format
    b. There shall be control of moving lights (as a type of fixture)
    c. There shall be independent control of every attribute of a channel or fixture
    d. Appropriate graphical controls shall be provided for non-intensity attributes (e.g. color picker)
    e. It shall be possible to create groups as a selection shortcut
    f. The plan shall show simulation feedback for channels in a graphical form
    g. It shall be possible to simulate control events
    h. The simulation may be linked to the actual online system to synchronize playback and inject control events
6. Timelines
    a. Timelines may be displayed and modified in linear form
    b. Timelines may be set on an individual attribute basis
    c. All timelines may include split timing
    d. Timelines shall be applied based on priority
    e. It shall be possible for all timelines to include effects
    f. The end state of a timeline shall be user configurable
7. Scenes
    a. Scenes may be displayed and modified in a graphical form
    b. Multiple fixtures may be selected and modified at once
    c. Scenes may be inserted into timelines
    d. Scenes may be able to be recalled independent of timelines
8. Triggers
    a. It shall be possible to trigger actions using external trigger or individual events
    b. It shall be possible to set conditions for each trigger
    c. It shall be possible to specify timed events, including repeat intervals such as daily, weekly etc.
    d. It shall be possible to specify astronomical timed events
    e. Serial input data shall be treated as a trigger and shall be handled as a standard or custom action
9. Actions
    a. There shall be a standard Actions for starting, and stopping timelines and scenes
    b. There shall be a standard action for pausing and resuming timelines.
    c. There shall be standard actions to set timeline intensity
    d. There shall be standard actions to set timeline position

e. There shall be standard actions for setting fixture color
f. There shall be standard actions for working with external triggers connected to Expansion Modules
g. It shall be possible to initiate custom scripts as actions

10. Network
    a. Shall report online status of Mosaic Show Controller and remote devices
    b. Shall allow for configuration of network properties (IP) of Mosaic Show Controllers
    c. Shall allow for upload of configuration data to all or individual Mosaic Show Controllers
    d. Shall allow for download of configuration data from Mosaic Show Controllers
    e. Shall allow for download of logging data from Mosaic Show Controllers
    f. Shall provide for performing firmware upgrades to Mosaic Show Controllers
    g. Shall allow for discovery of connected Mosaic Show Controllers
    h. Shall supports an integrated web server for remote connectivity and control of programmed timelines
11. Reports
    a. It shall be possible to generate tabular reports and customize their layout and appearance
    b. It shall be possible to print reports
12. Resources
    a. Effect curves and fade profiles shall use a common format and allow custom variants to be generated by the user
    b. Additional fixture templates may be defined by the user (custom fixtures)

B. Minimum Computer Requirements
1. Microsoft Windows
    a. The software shall require the Windows 7,8 or 10 (32/64bit) operating system running on a Windows-compatible computer (1 GHz Intel processor or better) with a minimum of 100 MB of hard drive space and 1 GB RAM, OpenGL graphics acceleration, a monitor capable of displaying at least 1024 x 768 screen resolution, Ethernet or USB port keyboard and mouse.
2. Macintosh OS
    a. The software shall require Macintosh OS-X 10.7.x (Mountain Lion) or later operating system running on a compatible computer (1 GHz Intel processor or better) with a minimum of 100 MB of hard drive space and 1000GB RAM, OpenGL graphics acceleration, a monitor capable of displaying at

least 1024 x 768 screen resolution, Ethernet or USB port keyboard and mouse.

C. Protection and Patents
    1. The Mosaic Controller is protected under license by the following patents:
        a. U.S. Patents: 6,016,038; 6,150,774; 6,166,496; 6,211,626; 6,292,901; 6,340,868; 6,459,919; 6,528,954; 6,548,967; 6,577,080; 6,608,453; 6,624,597; 6,636,003; 6,717,376; 6,720,745; 6,774,584; 6,777,891; 6,781,329; 6,788,011; 6,801,003; 6,806,659; 6,869,204; 6,883,929; 6,888,322; 6,897,624; 6,936,978; 6,965,205; 6,967,448; 6,969,954; 6,975,079; 7,014,336; 7,031,920; 7,038,398; 7,038,399; 7,042,172; 7,064,498; 7,113,541; 7,132,635; 7,132,785; 7,132,804; 7,135,824; 7,139,617; 7,288,190; 7,231,060
        b. Canadian Patent: CA 2,302,227
        c. Hong Kong Patent: HK 1025416
        d. Australian Patent: AU 757000; AU 2003203584
        e. European Patents: EP 1 016 062 B1; EP 1 224 845 B1; EP 1 234 140 B1; DE 698 07 092 C0; DE 600 21 911 C0; DE 600 23 730 C0

Part 3. EXECUTION

3.01 INSTALLATION

A. It shall be the responsibility of the Electrical Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.

B. The electrical contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.

C. The electrical contractor shall install all lighting control and dimming equipment in accordance with manufacturers approved shop drawings.

D. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

3.02 MANUFACTURER'S SERVICES

A. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.

B. Notification shall be provided in writing, two weeks prior to the time that factory-trained personnel are needed on the job site.

C. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.

D. The Contractor shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.

E. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the City's representatives. Training shall not exceed four working hours. Additional training shall be available upon request.

3.03 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of five years from date of delivery.

B. Warranty shall cover repair or replacement of such parts determined defective upon inspection.

C. Warranty does not cover any accessories or parts not supplied by the manufacturer.

D. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization. This warranty is in addition to and does not limit other warranties or other requirements in the Contract or law.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DIGITAL NETWORK LIGHTING CONTROLS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of DIGITAL NETWORK LIGHTING CONTROLS shall be

included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000.

END OF SECTION

SECTION 26 10 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Electrical fittings access panels vibration isolation.
2. Equipment bases and Equipment painting.

1.03 RELATED WORK

A. BASIC ELECTRICAL MATERIALS AND METHODS specified to be furnished and installed herein have related work in various other sections, including, but limited to:

B. Related Sections:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261230 “Wires, Cables, Splices, Terminations”
5. Section 261410 “Wiring Devices”
6. Section 261700 “Local Control”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

PART 2 - PRODUCTS

2.01 ACCESS PANELS

A. Where items such as pull boxes, junction boxes, other specialties, or any piece of equipment or device requiring adjustment or service, are concealed in the construction, the Contractor to furnish an access panel for ceilings or walls to permit adjustment or service of the concealed item. The access panel to be of a design suitable for installation in the material forming the finished surface in which panel is mounted.

B. Panels to be flangeless hinged type with vandal-proof fasteners.

C. Panels to be furnished and installed under this Contract.

D. Manufacturers which may be incorporated in the Work include but not limited to Crouse-Hinds, Miami-Carey Co., Milcor Division, or Inland-Ryerson Co. Nystrom, Inc.

2.02 EQUIPMENT BASES

A. The Contractor to provide concrete pedestals, bases, pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc., for installation of all electrical equipment and apparatus that is floor mounted.

B. Concrete pads to be 4 inches high, unless otherwise indicated on the Drawings, complete with steel reinforcing and necessary bolts, anchors, etc. Where concrete pad is set directly on concrete floor, dowels in floor to tie base to floor to be provided. These pads to be extended at a minimum of 4 inches beyond the equipment outlined on all four sides, unless otherwise indicated on the Drawings. The Contractor shall chamfer the edge of the pad at 45 degree angle.

C. The concrete shall be 3000 psi, 28-day compressive strength.

2.03 VIBRATION ISOLATION

A. Suspended vibration producing equipment to have spring elements in the hanger rods or isolation pads under the equipment.

B. Conduit connections to vibration producing equipment to be made with flexible conduit.

C. Manufacturers which may be incorporated in the Work include but not limited to Barry Division of Barry Wright Corp, Consolidated Kinetics Corp., Crouse-Hinds, or Mason Industries.

2.04 EXPANSION FITTINGS

A. The Contractor to furnish and install expansion fittings and bonding jumpers for the metallic conduit system where conduit crosses each building expansion joint, at each straight uninterrupted run of surface mounted conduit, at each vertical riser in excess of 100 feet and where conduits transfer between structurally independent pipes, poles or supports. The distance between fittings as installed to not exceed 200 linear feet.

B. Expansion fittings to provide for 8 inch movement and to include bonding jumpers.

C. Expansion fitting manufacturers which may be incorporated in the Work include but not limited to Appleton XJ with XJB jumpers, Crouse-Hinds, or OZ/Gedney.

2.05 STRAY CURRENT ISOLATION

A. Electrical equipment, conduit, etc. to be installed so as to maintain the integrity of the isolation between the structure ground and earth ground.

B. Conductive materials shall be isolated from the earth ground by the use of insulating pads washers, and sleeves.

C. The insulation fabric pads, sleeves and washers shall be manufactured of all new materials and composed of multiple layers of pre-stressed cotton duck, 8.1 ounce per net square yard, duck warp count 50 + 1 threads per inch of finished pad thickness, impregnated and bound with a high quality oil impervious nitrile rubber compound, containing rot and mildew inhibitors and anti-oxidants, compounded into resilient pads, sleeves or washers of uniform thickness.

D. The insulation material shall have a dielectric strength of 12.5 KV per 5/32 inch thickness. The pads shall withstand compressive loads perpendicular to the plane of lamination of not less than 10,000 psi before breakdown. Load deflection properties in accordance with procedures of Military Specification (MIL) C-882 shall be the following maximum percentages of total pad thickness: 10 percent at 1.000 psi, 15 percent at 2,000 psi. When loaded to 1,500 psi, permanent set as load is removed in accordance procedures of Mil - C 882 shall be a maximum of 2.5 percent of the original "zero Point" thickness. Shore Durometer shall not be less than 85 and not more than 95. The ratio of lateral expansion to vertical deflection shall not exceed 0.25 when loaded to 1500 psi. The material shall not lose effectiveness throughout a temperature range of minus 65 degrees F to plus 150 degrees F. No visual evidence of damage or deterioration by environmental effects of sunshine, humidity, salt spray, fungus, and dust in accordance with MIL-E-52722. Thickness shall be as shown Drawings within tolerances of plus 5 percent.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Interferences:

1. Locations of conduits, fixtures and equipment to be adjusted and supported to accommodate field conditions encountered, including any potential interferences with other construction or equipment to be installed.
2. The Contractor to determine the exact route and location of each duct bank and electrical raceway prior to fabrication.

B. Accessibility:

1. The Work to be installed to permit removal (without damage to other parts) of parts requiring periodic replacement or maintenance.
2. Conduits and equipment to be arranged to permit ready access to components and to clear the openings overhead doors and access panels.
3. The Contractor to provide necessary access panels in equipment as required for inspection and maintenance.

C. Exterior Wall Openings:

1. Openings in exterior walls, particularly at or below grade, to be kept properly plugged and caulked at all times to prevent the possibility of flooding due to storms or other causes.
2. After completion of the Work, openings to be permanently sealed and caulked so as to provide leak-proof conditions.

3.02 SLEEVES

A. The Contractor to provide sleeves where conduits pass through walls, floors, partitions as required by the Drawings, and/or field conditions.

B. Sleeves to be 18 gage galvanized sheet metal or plastic, as approved by Code, of sufficient length to finish flush with finished surfaces at both ends of sleeves.

C. Sleeves to be not less than 1 inch larger than outside diameter of conduit.

D. Floor sleeves to be galvanized steel or plastic pipe as approved by Code, to be of sufficient length to finish flush with the top and bottom of the floor, and to be watertight.

E. Sleeves through walls, ceilings, and floors, to have the net openings packed with glass fiber insulation. Each sleeve to be fire sealed to match the fire rating of the structure they penetrate. Both ends of the sleeves are caulked with waterproof mastic to prevent noise, dirt, air and water transmission.

F. Where conduits pass through floors on grade or exterior walls, the Contractor to provide watertight sealing fittings, OZ/Gedney Type WSK.

G. Sleeves to be set true to line level plumb and to be so maintained during construction. Where sleeve is provided in poured concrete, the Contractor to inspect during and after concrete is poured, to insure proper position and to correct any deviation.

3.03 PAINTING

A. All electrical equipment not specified for factory finish painting under other sections of these Specifications to be painted as specified herein.

B. Prime Coat:

1. Before delivery to the site, the shop fabricated and factory built equipment, which is not galvanized or protected by plating, to be cleaned and given one shop coat of zinc-chromate primer before delivery to the site.
2. Any portions of the shop coat damaged in delivery or during construction to be recoated.
3. Nameplates, labels, tags, stainless steel, or chromium-plated items such as motor shafts, levers, handles, trim strips, etc, to not be painted.

C. Finish Coat:

1. Conduit and equipment to be left cleaned and primed, ready for finish painting provided under the Painting section of this Specification.
2. All equipment to be factory finished in baked enamel or lacquer, or as specified. Standard finishes to be approved. All scratches to be touched-up by the Contractor.
3. All metal work installed by the Contractor exposed to weather and not factory finished to be painted with one coat of red lead, and two coats of lead and oil paint of color selected by the Commissioner.

3.04 PATCHING

A. The Contractor to provide all cutting and patching of building materials required for the installation of the Work herein specified.

1. No structural members to be cut without the approval of the Commissioner.
2. Roof deck is considered a structural member.
3. Approved cutting to be done with concrete saws or core drills.

B. Patching to be provided by mechanics of the particular trade involved and done in a neat and workmanlike manner.

C. Slots, chases, and recesses with openings in the walls, ceilings, floors and roofs to be provided by the Contractor. The Contractor to see that they are properly located.

D. Slots, chases, openings and recesses in the structure to be cut by the Contractor. The Contractor to patch and repair as required.

3.05 CLEANING

A. All rubbish and debris resulting from the Work of this Specification to be collected, removed from the site and disposed of legally on daily basis.

B. All floors to be kept in a broom clean condition.

C. After completion of the electrical installations the entire system to be thoroughly cleaned to remove all foreign materials from the conduits, boxes and enclosure, equipment, lighting fixtures, light standards, panels, cords, etc.

D. Cleaned to mean the thorough removal of, but not limited to, dust, dirt, oil, grease, cement, plaster, welding spatters and paint spatters.

E. All cleaning agents and methods to be in accordance with the electrical equipment manufacturers' recommendations and subject to approval of the Commissioner.

3.06 ALTERATION AND DEMOLITION

A. A complete and accurate description of all electrical Work within the affected areas cannot be accomplished through the media of Drawings and Specifications. Where existing electrical work prevents proper construction of new materials, the Contractor to remove, reroute, relocate, or in other ways alter the existing work in order to accommodate the new work requirements. Such performance to be as generally outlined herein and found necessary under field conditions and to be considered as included under the Contract.

B. The Drawings are generally instructive of the alterations which involve the existing electrical work. It is not intended that such alterations be limited to these instructions.

C. Where existing electrical equipment shall be removed as a result of the alterations, it to be completely demolished, back to the first outlet or junction box which is left unaffected by this Work. All conduit, wire, supports, hangers, etc. to be included under this requirement. Conduit which is encased in concrete or otherwise inaccessibly positioned may be abandoned. In such cases wire to be pulled out of conduit and the conduit itself to be plugged and capped at each end.

D. Existing electrical material and equipment, including lighting fixtures, switches, receptacles, conduit outlets, fittings, and other devices which are removed as a result of the alterations to remain the property of the Commissioner and to be stored on the site as directed.

E. Existing electrical material and equipment with the exception of wire and cable, as generally outlined in the previous paragraph, to be re-used as completely as is found practical. The Contractor to examine the condition of such material and equipment and make a prior determination of whether it is suitable for re-use. The Contractor to present findings periodically

to the Commissioner who in turn will make the final decision regarding re-usability. Wire and cable to be new.

F. Various signal, communications, and other services to remain in service to provide continuous operation for the Commissioner's functions. No interruptions of any services will be allowed without written approval from the Commissioner.

G. The Contractor to remove or reroute electrical feeders, risers, branch circuits, and other wiring as required by the alterations or as shown on the Drawings. Wiring extending through remodeled areas but serving loads which shall remain to be rerouted as required and reconnected to those loads.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of BASIC ELECTRICAL MATERIALS AND METHODS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of BASIC ELECTRICAL MATERIALS AND METHODS shall be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

Electrical Work: 260000

END OF SECTION

SECTION 26 12 30

WIRES, CABLES, SPLICES, TERMINATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This specifies all wires, cables, splices and terminations as well as appurtenances thereto required under this Contract.

1.03 RELATED WORK

A. Wires, cables, splices, terminations specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261410 “Wiring Devices”
6. Section 261700 “Local Control”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 265030 “Cable and Light Tray Enclosure”
13. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, maintenance data, shop drawings, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

1. Materials – AC Wire & Cable: The Contractor shall submit for approval, before ordering or purchase of wire or cable, the following for each type and size to be furnished:

a. Manufacturer of wire, cable, accessories.

b. Number and size of strands composing each conductor.
c. Conductor insulation, in 64ths of an inch.
d. Sheath thickness in 64ths of an inch.
e. Average overall diameter of finished cable.
f. Minimum insulation resistance in megohms per 1,000 feet.
g. Representative sample length including all labeling and identification.

B. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.06 DEFINITIONS

A. VFD – Variable Frequency Drive.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Drawings show the locations, type, size and number of wires and cables to be furnished under this Contract. Each type to comply with the Specifications contained herein.

B. Only new cables to be provided. Cables which have been manufactured more than two years prior to installation will not be accepted.

C. The conductors, unless otherwise noted, to be soft or annealed copper conforming to ANSI/ASTM B 33 if coated, ANSI/ASTM B 3 if uncoated. In addition, unless otherwise specified, stranded conductors to have concentric stranding as per ANSI/ASTM B 8.

D. Cables to be supplied with both ends of each length sealed against the entry of moisture.

E. Cable sizes to be increased as required for longer runs to comply with voltage drop per Code.

2.02 QUALITY ASSURANCE - AC CABLE

A. All wires and cables to be listed by Underwriter's Laboratories, Inc. and to be copper.

B. All wire and cable to be stamped every two feet indicating, voltage, type, temperature rating, manufacturers name, etc., all in conformance with latest applicable standard.

C. All conductors for wire and cable to be copper based on 98 percent conductivity according to Mattheisen's Standard.

2.03 MATERIALS - AC WIRE AND CABLE

A. Wire Number 10 AWG and smaller to be solid, wire Number 8 AWG and larger to be stranded. Control wiring to be stranded in all sizes and color coded, as approved by the Commissioner.

B. All wires Number 6 AWG and smaller, to have color coded insulation. All wires Number 4 AWG and larger in each, pull box, outlet, cabinet and every point where wires are accessible or visible, to be color coded. The same color coding to be used throughout the entire electrical system.

C. Color as selected for the purpose of identifying circuits to be applied to the wire. The colors to be fast, fadeless, and capable of withstanding cleaning in the event that the wire becomes soiled.

1. Green to be used only for ground wire.
2. All conductors to be color coded as follows:

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

D. All numerical references to wire size in the Specifications and on the Drawings refer to standard American Wire Gauge (AWG), or where so stated, thousands of circular mils (KCMIL).

E. The Contractor to submit for approval, before purchase of wire or cable, the following for each type and size to be furnished:

1. Manufacturer of wire, cable.
2. Number and size of strands composing each conductor.
3. Conductor insulation, in 64ths of an inch.
4. Sheath thickness in 64ths of an inch.
5. Average overall diameter of finished cable.
6. Minimum insulation resistance in megohms per 1,000 feet.
7. Representative sample length including all labeling and identification.

F. The Contractor to provide wire with thermoplastic insulation type "THWN/AWM." Wire insulation to consist of a tough, elastic, flexible rubber-like synthetic insulation compound made from 105 degrees C polyvinyl chloride or, its copolymer with vinyl acetate, covered with a nylon jacket. It to be highly resistant to oil and moisture and to not be affected by acid or alkali conditions and marked by UL label as "Gas and Oil Resistant II."

G. The insulation compound to be suitable for operating without undue injury or deterioration; under conductor temperatures not exceeding 90 degrees C wet or dry, and 75 degrees C in oil UL rating; and to be rated 600 volts.

H. The thermoplastic insulation and nylon jacket to be applied to the conductor in a manner that will provide continuous walls of uniform thickness, free from defects and of high dielectric strength.

I. Type "THWN/AWM" insulated wire and cable to be manufactured and tested in accordance with the requirements of UL and the latest ASTM Specifications for insulated wire and cable, polyvinyl insulation compound and nylon jacket, and to also comply with IPCEA Standard S-19-81.

2.04 MATERIAL - AERIAL AND UNDERGROUND CABLE, AC SERVICE

A. Aerial and underground cable shall be single conductor copper. Conductor shall be insulated with abrasion, moisture, heat, and sunlight resistant black cross-linked polyethylene (XLP). Conductors shall be UL-listed Type RHH or RHW-2 or USE-2, suitable for operation at 600 volts or less in wet or dry locations, including direct burial in the earth. All conductors shall have an overall jacket, resistant to ozone, sunlight and weather.

B. Cable shall be rated, for continuous full-load operation, 90 degrees C in dry locations or 90 degrees C in wet or dry locations.

2.05 MANUFACTURERS

A. Manufacturers which may be incorporated in the Work include but not limited to Draka, Okonite, Service Wire, or Carol Cable - Division of General Cable.

2.06 CABLE SPLICING, TERMINATING AND ARC PROOFING MATERIALS

A. TERMINATIONS - AC WIRES AND CABLES:

1. Special care to be taken to balance the loads on all phases, at all cabinets. The panelboard schedules show the proper circuiting, the Contractor to not change this circuiting without the approval of the Commissioner. Distinguishing colors to be used for identifying the particular phase on which the circuit belongs.
2. 600 volt cable lugs for terminations to bus bar, switch studs, and terminal blocks, for Number 22 AWG to Number 10 AWG wire to be color coded nylon insulated ring tongue lugs in vibration areas, and spade type in other areas. They are to have a secondary metal sleeve around the wire barrel for insulation strain relief. Type to be Panduit Pan-Term PN series terminals.
3. 600 volt cable lugs for termination to bus bar and switch studs for Number 8 AWG to Number 1/0 AWG wire to be with standard barrel one hole high conductivity seamless copper lugs with inspection holes to assure adequate wire insertion. The tongue to be stamped with wire size, UL label, CSA logo, and manufacturer. The base part number and stud size should also be stamped on the tongue to assure adequate identification in application. Barrels to contain color coded rings, die color code and/or number. Crimp locations to be indicated to assure correct installation. For further identification, the manufacturer should also be included on the barrel. Type to be Panduit Series LCB or LCC Power Connectors or Burndy Type YA.
4. 600 volt cable lugs for termination to bus bar and switch studs for Number 2/0 AWG and larger wire, to be terminated with long barrel, two hole high conductivity seamless, copper lugs. Barrels to contain color coded rings knurled markings indicating die color code, die index numbers, and crimp locations to assure correct usage and installation. For further identification, the manufacturer to also be included on the barrel. For Number 2/0 AWG, to 250 KCMIL sizes, the tongue may be stamped with wire size, UL & CSA logos and manufacturer. The base part number and stud size should also be stamped on the tongue to assure adequate identification in application. Type to be Panduit LCC series Power Connectors or Burndy Type YA.

B. SPLICES - AC WIRES AND CABLES:

1. Number 10 AWG and smaller wire to be spliced with insulated butt connectors. Connectors to contain a center wire stop for adequate wire insertion, translucent nylon insulated housings to insure accurate crimp location, and brazed seam construction for high performance terminations. Type to be Panduit BSN Pan-Term Butt Splices, or 3M "Scotch Lock."
2. Number 8 AWG and larger wire to be standard barrel, high conductivity seamless copper splices. Barrels to contain color coded rings knurled markings indicating die color code, die index numbers, and crimp location to assure correct usage and installation. For further identification, the base number and manufacturer should also be included on the barrel. Type to be Panduit SCS series, Power Connectors, or 3M "Scotch Lock."

3. Number 10 AWG and smaller wire taps for solid wires to utilize insulated compression type twist wing or nut style connectors with 105 degrees C, 600 volt rating, for UL listed wire combinations. Connectors to have a tough, nylon housing with a deep skirt to prevent shorts and flashovers, funnel entry to facilitate wire insertion, expanding square wire spring design to ensure reusability, as well as markings to indicate part number UL & CSA logos, and wire range. Nut Style connectors to be of industry nut style color coding; Blue, Orange, Yellow, and Red (small to large) with comfortable ribs for greater gripping. Industry standard Wing Style color coding to also be used; Yellow, Red, Blue (small to large), with offset wings to ensure comfort and torquing capability. In addition, black connectors may be used for temperature applications to 150 degrees C and green connectors for grounding applications. Type to be Panduit "P-Conn" Wire Connectors or 3M "Scotch Lock."
4. Number 10 AWG stranded and smaller, taps to be made with insulated compression type wire joints. Type to be Panduit Type JN.
5. Number 8 AWG and larger wire taps for stranded wire to utilize compression taps up through Number 4/0 AWG wire or parallel gutter taps for larger wire. Taps to have part number and wire range indicated on the body of the connector. Type to be Panduit C-Tap Power Connectors, or OZ Electrical Type XTP parallel gutter taps.

PART 3 - EXECUTION

3.01 INSTALLATION - AC WIRES AND CABLES

A. Wires and cables to be carefully handled during installation. Joints and splices to be made in an approved manner, and to be equivalent electrically and mechanically to the conductor itself.

B. Conduit fill to be based on Chicago Electrical Code for "New Work."

C. All branch circuit and control wiring, in conduit to be not less than Number 12 AWG wire unless noted otherwise.

D. Stranded control cables in Number 12 AWG size and smaller to be terminated into solderless lugs, then lug to be connected to terminal part.

E. At least six inch loops or ends to be left at each outlet for the installation of fixtures or devices.

F. All wires in outlet boxes not for the connection to fixtures, devices or other wires at that outlet, to be rolled up and the ends capped or taped.

G. All circuits in panelboards to be neatly grouped and tied with seine twine, or nylon wire ties.

H. No splice or any kind to be pulled into any raceway. All splices and taps to be accomplished in a manhole, handhole, junction, pull box or other accessible enclosure.

I. Wire and cable to be delivered to the site in marked manufactures cartons.

3.02 WIRE PULLING LUBRICANT

A. When necessary to use a lubricant for pulling wires in steel conduit, lubricant to be UL listed and be of such consistency that it will leave no obstruction or tackiness that will prevent pulling out old wires or pulling in new or additional wires. No soap flakes or vegetable soaps to be permitted.

3.03 TESTING

A. Wires and Cables:

1. After wires and cables are in place and connected to devices and equipment, the system to be tested for shorts and grounds as specified in Section 269500, “Electrical Testing”.
2. All hot wires, if shorted or grounded, to be completely removed and replaced in kind.
3. A voltage test to be made at the last outlet on each circuit. If the drop in potential is greater than permitted by the CEC, the Contractor to correct the condition by removing and replacing partly grounded connections or reconnecting high resistance splice.
4. All grounds, shorts and high resistance splices to be remedied immediately at the conclusion of testing for acceptance.
5. Any wiring device, or electrical apparatus provided under this Contract, if grounded or shorted to be removed, trouble corrected and reinstalled.
6. All high voltage cables, after in place and connected, to be megged, in presence of the Commissioner and the Authority.
7. All meters, cable connections, equipment or apparatus necessary for making all tests to be furnished by the Contractor at Contractor's own expense. The Contractor to provide copy of all tests for the Commissioner’s approval of result.
8. No work to be covered up without approval of the Commissioner.

3.04 IDENTIFICATION OF WIRES AND CABLES

A. General:

1. All wires and cables, to be identified by circuits in all cabinets, boxes, manholes, hand-holes, wiring troughs and other enclosures, at all terminal points.
2. The circuit designations to be as shown on the Drawings, or as directed by the Commissioner. Tags to be attached to wires and cables so that they will be readily visible.

B. Cable/wire markers to be installed on both ends of all conductors, both for internal and external cables. Cable/wire markers to be as specified under Section 261950 “Identification”.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of WIRES, CABLES, SPLICES, TERMINATIONS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of WIRES, CABLES, SPLICES, TERMINATIONS must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 14 10

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This Section specifies requirements for the furnishing and installing of wiring devices.
2. The Contractor to furnish, install and connect all wiring devices and plates as shown on the Contract Drawings and as hereinafter specified. Wiring devices include but are not limited to wall switches, wall plates, timers, surge protection devices, plugs, receptacles and disconnect switches.
3. All devices to be heavy duty specification grade conforming to the latest NEMA configurations.
4. In general, all devices to be one gang wide or wider as required for heavier rated devices.
5. All devices for wall system outlets to be supplied by one manufacturer. All furnished device plates to be supplied by one manufacturer.
6. All receptacle descriptions given herein are general in nature.

1.03 RELATED WORK

A. Wiring devices specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261700 “Local Control”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

1.01 QUALITY ASSURANCE

B. The Contractor to provide devices of the Specifications grade as minimum. Devices to be of NEMA configuration and to bear the label of the Underwriters Laboratories.

C. All devices must be heavy duty specification grade conforming to the latest NEMA configurations.

D. In general, all devices must be one gang wide or wider as required for heavier rated devices.

E. All devices for wall system outlets must be supplied by one manufacturer. All furnished device plates must be supplied by one manufacturer.

F. Comply with the requirements as specified in Section 01400 of the Specifications.

G. All receptacle descriptions given herein are general in nature. Exact receptacle type, rating and configuration must match the requirements of the connected equipment.

1.02 SUBMITTALS

A. Prepare and submit for approval catalog cuts in accordance with the Special Conditions and Section 260100 of the Specifications. Catalog cuts must be marked to indicate the item, model, sizes and other characteristics listed in the table or printed sheets of the submittal.

B. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

PART 2 - PRODUCTS

2.01 GENERAL WIRING DEVICE REQUIREMENTS

A. Wiring devices, components and accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. All wiring devices shall comply with NFPA 70.

2.02 LIGHTING SWITCHES AND TOGGLE SWITCHES

A. Switches to be UL listed to Federal Specification WS896 and shall comply with NEMA WD-1.

B. Switches to be mounted at man-doors where shown on the Drawings, in suitable outlet boxes in the wall or partitions except where noted on the Drawings.

C. Switches to be rated 20 amperes, 120/277 volts ac., surface mounted, and premium specification grade. The handle of each switch to be in color as required by the Commissioner. Switches shall be UL listed, and CSA certified, Federal Spec WS896 listed.

D. Wall switches to be two pole where indicated on drawings for heater and ventilation control.

E. The switch color to be brown or ivory as approved by the Commissioner.

F. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number CSB 120
2. Pass & Seymour Catalog Number 20 AC 1
3. Leviton Catalog Number 1221-2

G. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number CS1222
2. Pass & Seymour Catalog Number 20 AC 2
3. Leviton Catalog Number 1222-2

H. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number CS1223
2. Pass & Seymour Catalog Number 20 AC 3
3. Leviton Catalog Number 1223-2

I. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number 1224
2. Pass & Seymour Catalog Number 20 AC 4
3. Leviton Catalog Number 1224-2

2.03 CONVENIENCE OUTLETS

A. Receptacles to be duplex, premium specification grade, rated 20 Amperes, 125 Volts, 3-wire grounding type, NEMA designation 5-20R. All receptacles to be enclosed in high heat, non-flammable, non-hydroscopic molded compound case. Each terminal to be provided with binding screws located on the side of the receptacle and so arranged that back or side wiring is possible. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Pass & Seymour Catalog Number 5362.
2. Hubbell Catalog Number 5362.
3. Leviton Catalog Number 5362.

B. Receptacles to be UL listed to Federal Specification WC596. All outlets to be UL listed for wet locations.

C. Provide green terminal screw for grounding.

D. Receptacles exposed to the public to be of tamper resistant type. The presence of a metallic object in either the left or right slot to not energize the object. The presence of the plug blades in both the right and left hand slots is required to energize the load. The receptacle shall not have any exposed current carrying parts but to have six inch pigtail leads for feed connection.

E. Color of the outlets to be as approved by the Commissioner.

F. Convenience outlets for general use: duplex, 3 wire, 20 ampere, 125 volt, NEMA 5-20R grounding type.

G. Ground fault circuit interrupters to be heavy duty, feed through, duplex type rated 20 ampere, 125 volt, incorporating solid state ground fault sensing and signaling, 5 mA trip level. Outlets to be in color as required by the Commissioner with matching cover plate. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number GF 5352
2. Leviton Catalog Number 6899.
3. Pass & Seymour Catalog Number 2091-S.

H. Other outlets to be as called for on the Drawings and as specified herein.

I. Receptacles exposed to the public to have weatherproof vandal proof lockable covers. Covers to be as manufactured by Hubbell-Bell Model 5001-0. Provide actual sample of the cover to the Commissioner for approval prior to ordering.

2.04 SWITCH AND RECEPTACLE WALL PLATES

A. Plates to be manufactured by the device manufacturer.

B. Provide suitable plate for each device installed under this contract.

C. In finished areas, plates to be metal, smooth high abuse; color to match hardware in surrounding area, as approved by the Commissioner.

D. In unfinished areas, plates to be of the type designed for use with the particular boxes.

E. In toilets, and utility rooms, plates to be Type 302/304 nonmagnetic stainless steel.

F. Jumbo plates to be used on concrete block walls.

G. Weatherproof, gasketed, vandal proof lockable spring type covers to be provided for weatherproof receptacles.

H. Plates to be 0.040 inch thick, type 302/304, stainless steel unless otherwise noted.

I. Surface mounted plates to be cast metal.

J. Manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hubbell Catalog Number 5206
2. Pass & Seymour Catalog Number PS 4510
3. Leviton Catalog Number 4970

2.05 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) RECEPTACLES

A. The Contractor to provide one surge protective receptacle at each computer terminal, in addition to the computer data terminal shown on the Drawings. The color to be as required.

B. Each receptacle to comply with UL 1449 and ANSI/IEEE C 62.41, latest edition.

C. Each receptacle shall be Hubbell Number HBL 5360 SA, Leviton Catalog Number 5380 P or Pass & Seymour Catalog Number 6362 SP.

2.06 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) RECEPTACLES WITH ISOLATED GROUND

A. The Contractor shall provide duplex transient voltage surge suppression receptacles with isolated ground as shown on the Drawings. Each receptacle shall be provided with a power-on indicator light and audible alarm. The audible alarm shall energize when the surge protection is no longer functioning and shall keep alarming until the module is replaced.

B. Each TVSS shall comply with NEMA WD-1, NEMA WD-6; and shall be UL listed, UL 498, UL1449, and FSW-596. Each TVSS shall also comply with ANSI/IEEE C 62.41.2 and IEEE C 62.45

1. TVSS components shall be multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
2. Duplex TVSS convenience receptacles shall be straight blade, 125 V, 20 A; NEMA WD-6 Configuration 5-20R. Equipment grounding contracts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting.

C. The rating shall be shown on the drawings. The color shall be as required.

D. The receptacle manufacturers which may be incorporated in the Work shall include but not limited to Eagle Catalog Number IG 1210, Hubbell Catalog Number IG5362S and Catalog Number SM-D 125, or Pass & Seymour IG5262 color as required.

2.07 LIGHTING MOTION SENSOR

A. The Contractor to provide motion control occupancy sensor in nonpublic spaces as shown on the Drawings.

B. Each occupancy sensor to include an integral ON/OFF disconnect switch.

C. Multiple sensors are required for spaces with multiple entry doors.

D. Each occupancy sensor to bear the label of the Underwriters Laboratories.

E. The rating to be shown on the drawings. The color to be as required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Wall switches and receptacles to be located where indicated on the Drawings, arranged singly or in gangs and at the height specified or indicated and to have approved plates and finishes as specified herein.

B. The Contractor to install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

C. The Contractor to adjust the location of equipment to accommodate the work in accordance with field conditions encountered.

D. Provide rust-resistant mounting hardware for all wiring device boxes.

E. Receptacles on single outlet branch circuits to be the same rating as the branch circuit overcurrent protection.

F. The Contractor to install wall switches with OFF position down.

G. The Contractor to derate wall dimmers as instructed by the equipment manufacturer. The use of common neutral is not acceptable.

H. The Contractor to install each convenience receptacle with the grounding pole on bottom when mounted vertically or on the right when mounted horizontally.

I. The Contractor to install plates on all switch, and receptacle outlets and to install blank plates on all unused boxes.

J. The Contractor to install devices and plates flush and level.

K. The Contractor to seal all connections on GFCI with seal coat compound and wrap with two layers tape.

L. Each switch to be mounted 4 feet 0 inches above the finished floor. Each receptacle to be installed at 1 foot 6 inches above finished floor, or unless shown otherwise on the Drawings.

M. Each receptacle and switch to be side wired. Back wiring is not acceptable.

N. Receptacles installed in areas accessible to the public to be equipped with lockable covers.

O. Carefully install and connect switches, receptacles, and related accessory materials in such a manner as to complete the electrical installation in accordance with the Contract Drawings and as specified herein.

P. Verify that electrical installation, structural, and related work by others to satisfy the requirements for the performance of the Work in accordance with the Contract Drawings and as specified herein.

Q. In areas where exposed conduit is used, receptacles and switches must be surface mounted in a galvanized steel outlet box or conduit fitting and provided with a cast cover.

R. Receptacles and switches located in finished areas where concealed conduit is used must be flush mounted and provided with a cover plate as specified in contract document.

S. Location of each switch and receptacle in public spaces must be coordinated with architectural finishes. An 8 inch by 8 inch stainless steel cover plate must be provided for each device and must be vertically and horizontally centered within wall tile.

3.02 PERFORMANCE TESTING

A. The Contractor to test the complete wiring device installations to assure proper operation.

B. The Contractor to test each ground fault interrupter to demonstrate each circuit trips between 2 to 5 milli-Amperes.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of WIRING DEVICES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of WIRING DEVICES must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 17 00

LOCAL CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. The requirements for the furnishing and installing of local control for this project.
2. The Contractor to furnish and install the disconnect switches, circuit breakers, fuses, motor starters, and control devices for local control as shown on the Drawings.

1.03 RELATED WORK

A. Local control specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261750 “Local Control Panels”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269 00 “Electrical Testing”

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor to provide the required disconnect switches, circuit breakers, fuses, motor starters, and control devices as shown on the Drawings and as required in other Sections of these Specifications.

B. All enclosures for the local control equipment to be NEMA Type 12 for indoor locations and NEMA Type 4X stainless steel for outdoor locations. Each safety switch shall be UL98 listed and shall comply with NEMA A KS1.

C. Specific site requirements may necessitate the use of different enclosure ratings or manufacturing techniques.

2.02 SAFETY SWITCHES

A. Safety switches to be, heavy duty type, rated at 600 volts for 480 volts AC and 250 volts AC for 208 volts AC and 120 volts AC circuits. Each safety switch shall be UL98 listed and shall comply with NEMA A KS1.

B. Each safety switch to be heavy duty, horsepower rated, fusible or non-fusible as required.

C. Each safety switch to have an external lockable handle that can be padlockable using three pad locks in the "OFF" position. The handle operation to be non-teasible, quick make-quick break and shall be interlocked with the cover in the closed position.

D. Each safety switch shall have an internal equipment ground kit and labeled for copper ground wire.

E. Each safety switch shall have two normally open/normally closed (NO/NC) form “C” auxiliary contacts arranged to activate before the switch blades open.

F. Safety switches to be provided with copper compression lugs and ground lugs suitable for the size and conductor material. In addition, fusible switches to be provided with rejection style fuse clips.

G. Noncorrosive nameplates to be laminated plastic with 3/8 inch black letters on a white background and to be mechanically affixed to the front of each door with self tapping stainless steel screws. This to not change the NEMA rating of the enclosure.

H. Disconnect switch manufacturers which may be incorporated in the Work include but not limited to Siemens, Eaton, or Square "D".

2.03 INDIVIDUAL MOTOR STARTERS

A. The Contractor shall provide a combination full voltage type motor starter for every 1/2 horsepower to 20 horsepower motor, suitable for the utilization voltage, 3 phase, 3 wire, 60 Hertz service as shown on the Drawings.

B. Manual motor starters shall be used for all 120 volt motors under 1/2 horsepower unless automatic control is required or the control device is not capable of carrying the load current. In such cases a suitable contractor or magnetic motor starter shall be provided.

C. Reduced voltage autotransformer, closed transition type starters shall be provided for motors 25 horsepower and larger.

D. The Contractor shall coordinate with the Work of other Sections of these Specifications for starters furnished integral with equipment to avoid omission or duplication.

E. The minimum starter size shall be NEMA Size 1.

F. Starters shall be of the manual or magnetic type where indicated on the Drawings. Combination type motor starters shall be of the full voltage magnetic types, with motor circuit protectors, disconnect handle and accessories as specified herein or as shown on the Drawings.

G. Individual 120 volt control transformer shall be provided in each starter. The control transformer shall have a fused primary and with one side of the secondary fused and the other side grounded. The control transformer shall have a minimum of 100 VA extra capacity. The minimum size shall be 200 VA.

H. Each starter shall be provided with solid state overload relays, sized in accordance with the current rating shown on the motor nameplate. The reset shall be operated from the outside door by a push button whose NEMA Type classification shall be the same as the enclosure type classification.

I. The motor circuit protector's external operating handle shall be lockable in the "open" position.

J. Each starter shall have a minimum of two normally open and two normally closed auxiliary contacts.

K. Each starter shall have a “Hand” – “Auto” – “Off” selector switch, heavy duty oil-tight type 35MM corrosion resistant.

L. Each starter shall have pilot lights, heavy duty, oil-tight type 35MM corrosion resistant, LED type with red (on) and green (off) lenses. A push to test circuit to be provided.

M. Motor starters shall be industrial heavy duty type, with a NEMA Type 12 enclosure for indoor locations and NEMA Type 3R stainless steel enclosure for indoor/wet and outdoor locations. Each starter shall be provided with motor identification nameplate.

N. The Contractor shall furnish spare parts for each motor starter and contractor consisting of one set moveable and stationary contacts, one holding coil, and one set overload heaters for a three phase installation.

O. The Contractor shall submit to the Commissioner a complete list of all overload heaters required and installed on this Project.

P. Cable Terminations and Tagging:

1. Compression type cable lugs for terminating cables and equipment within the entering and leaving the starter, shall be furnished by the equipment manufacturer for the cable sizes required. Copper compression connectors shall be long barrel, tin plated, closed end compression type. The barrel for each cable lug shall be sized for the exact cable size specified. Copper type connectors and terminations shall be furnished. Aluminum copper types are not acceptable. Cable lugs to be Anderson Type VHCL, Burndy Catalog Type YA, Panduit Series LCB or LCC, or Thomas & Betts Series 54800 and 54900.
2. Cable/wire markers shall be installed on both ends of all conductors, both for internal and external cables and as required under Section 261950 - Identification.

Q. Control Devices and Wiring:

1. Control devices, local instrument cables, and wiring required on the equipment shall be furnished and installed at the factory.
2. All small wiring for control or accessory equipment shall be installed in code approved wireways.
3. Control wiring shall be Number 14 AWG, minimum, except where larger size conductors are needed for current carrying requirements or smaller for incidental wiring on mass produced pre-manufactured sub-assemblies. The conductor shall be stranded copper for fixed wiring and extra flexible copper for hinged wiring. The conductors shall have 600

volts, 90 degrees C, polyvinyl chloride insulation with flameproof braid covering, Type TBS, or cross-linked polyethylene, Type SIS.

4. All control and instrument wiring, alarm leads, and instrument transformer secondaries, for connection to external cables, shall be terminated at terminal blocks. Terminal blocks shall be barriered molded blocks, 600 volt and 75 ampere rated, screw type, with washer head screws which shall be provided for terminating all small wiring. Acceptable terminal block manufacturers to be Marathon Series 1600, Westinghouse, or Buchannan.
5. Compression type solderless copper lugs shall be furnished for each terminal block for external control and instrument wires. All control wires shall be terminated utilizing insulated ring type connectors. Lugs to be Burndy Catalog Number YAEV 10 L 36, or Thomas & Betts Co. Catalog Number C1 insulated.
6. Cable/wire markers shall be installed on both ends of all conductors both for internal and external cables and as required under Section 261950 Identification.
7. The assembled control equipment, wiring and connections shall be insulated for a voltage of 600 volts and shall be subjected to a one-minute test of 2200 volts AC phase to ground at the factory, after fabrication and assembly is complete.

R. Manufacturers which may be incorporated in the Work include but not limited to Allen Bradley, Siemens, or Eaton.

2.04 FUSES

A. The Contractor to furnish and install fuses for all fusible equipment provided on this Project regardless of which trade has provided such equipment. All fuses to be provided in accordance with the indications of size and voltage ratings given on the Drawings and to have UL and NEC approval as being suitable protection for conductors under overload conditions.

1. All fuses to be of the same manufacturer.
2. No paralleling of fuses will be permitted.

B. Current limiting fuse manufacturers which may be incorporated in the Work include but not limited to Bussmann Fusetron, Dual Element time delay fuses, or Little Fuse; to be Underwriters' Laboratories listed Class "RK-5" fuses having an interrupting rating of 200,000 Amperes.

C. Fuses to be dual-element with a separate thermal element that will open at 280 degrees F or less; and to have time-delay such that they will hold 500 percent rated current for a minimum of ten seconds in all sizes.

D. The Contractor to check each motor nameplate data and provide proper fuses for motor running protection.

E. Spare fuses to be furnished in the ratio of ten percent of each size and type installed, but not less than three of each size and type. All fuses blown during construction to be replaced by the Contractor, and a complete supply of spare fuses to be turned over to the Authority upon completion of the Project.

F. Fuse manufacturers which may be incorporated in the Work include but not limited to s to be manufactured by Bussmann, LittleFuse or Mersen.

2.05 MOLDED CASE CIRCUIT BREAKERS

A. Molded case circuit breakers shall comply with UL 489, NEMA AB1,and NEMA AB3, with interrupting capacity to comply with available fault currents.

B. Thermal magnetic circuit breakers shall be inverse-time current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting shall be for circuit-breaker frame sizes 250A and larger.

C. Adjustable instantaneous break circuit breakers shall have magnetic trip element with front-mounted, field adjustable trip setting.

D. Electronic trip circuit breakers shall have 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 adjustments.
4. Ground-fault pickup level, time delay and I squared t response.

E. Current limiting circuit breakers shall be for frame sizes 400 ampere and smaller , and let thru ratings less than NEMA FU 1, RK-5..

F. Integrally fused circuit breakers shall be thermal magnetic trip element with integral-limiter style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

G. Ground fault circuit interrupter (GFCI) circuit breaker shall be single and two pole configurations with Class-A ground fault protection (6-Ma trip).

H. Ground fault equipment protection (GFEP) circuit breakers with Class-B ground fault protection (30-Ma trip).

2.06 CONTROL DEVICES

A. Pushbutton stations, selector switches, etc. shall be 30mm heavy duty oil tight type and UL approved and the enclosures to be NEMA rated for the area in which they are installed.

B. Manufacturers which may be incorporated in the Work include but not limited to Siemens, Eaton, or Allen Bradley.

2.07 DOOR (CONTACTS) SWITCHES

A. Provide security type magnetic door switches and associated wiring at each door and where shown on the Drawings.

B. Door switches shall be of the concealed type, 3/4 inch diameter, with plated Rhodium contacts. Door switches shall be GE 1078 series or Simplex 27760-9000 series.

C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

B. The Contractor to adjust the location of equipment to accommodate the work in accordance with field conditions encountered.

C. The equipment to be installed with workspace clearances required by the Code.

D. The equipment to be installed to permit maintenance and replacement of parts, and to be clear of all openings with swinging or moving doors, partitions or access panels.

E. Safety switches and circuit breakers to be installed 5 feet, 0 inches above finished floor unless shown otherwise on the Drawings.

F. The Contractor to provide a non-fused disconnect switch in accordance with the City of Chicago Electrical Code for each motor.

3.02 PERFORMANCE TESTING

A. The Contractor to test the complete local control installations to assure proper operation and correct sizing of all motor overload units and/or fuses.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of LOCAL CONTROL will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of LOCAL CONTROL must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 17 50

LOCAL CONTROL PANELS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This section specifies requirements for the furnishing and installing of local control panels.
2. The work under this section includes furnishing all labor, materials, tools, equipment and incidentals necessary to install the local control panels.
3. Furnish and install the local control panels as required by other Sections of these Specifications and as shown on the Drawings.

1.03 RELATED WORK

A. Local Control Panels specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261900 “Grounding”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor to prepare and submit to the Commissioner, for review, before fabrication and assembly of equipment, one electronic copy of CD ROM and one electronic PDF copy of each of the following:

1. Front and interior elevations to be provided as required to show all equipment for each control panel.
2. Drawings and section views to include all dimensions for rough in work at the site.

3. The shop drawings to show the details of connections, terminals, etc. including the complete terminal block arrangement and enclosure ground connections.
4. Single line diagrams where required to show equipment power distribution and control schematic diagrams to be provided.
5. Wiring Diagrams:

    a. Connection diagrams for the wiring of equipment in each local control panel to be provided.
    b. Interconnection diagrams to show the wiring to external equipment.
    c. The terminal block points to be clearly identified for the external wiring to be routed in or out of each local control. The wiring diagrams to provide adequate space at the terminal blocks for the addition of cable and wire designations.

6. Bills of material to include all items with catalog cuts describing the electrical and physical characteristics of each item.

B. The Contractor to submit, for record and distribution, prior to shipment of equipment, one electronic copy on CD ROM and five PDF electronic copies of each of the following for each local control panel.

1. All drawings to be as finally reviewed and to include any factory assembly modifications.
2. Recommended installation and storage instructions with any special instructions to be provided.

C. The Contractor to submit, for record and distribution, prior to shipment of equipment, five PDF electronic copies and ten hard copies of each of the following for each local control panel assembly.

1. Instruction manuals to include descriptive bulletins and operation leaflets for the control relays, switches, starters, and circuit breakers.

    a. Each instruction manual to be in a three ring hard binder with tabbed sections. The binder cover to have the project name and equipment name. The lettering to be block type and to be a minimum height of 1/2 inch.
    b. Each instruction manual to contain the "Record Document" drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
    c. The "Record Document" drawings larger than 8 1/2 by 11 inch to be fan folded.

2. Spare parts bulletins to be included with catalog cuts for each item.
3. For large projects, control panel instructions can be combined with other project material instructions.
4. Certified test reports to include all assembly and subassembly test and inspection reports.

D. The Contractor to submit one electronic copy in CD ROM and five PDF electronic copies and ten hard copies of any shop drawings and other data sheets that were revised or modified during installation. These will be inserted in the previously submitted instruction manuals.

E. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Local control panels furnished by the supplier of the equipment, and or the Contractor may be supplied as commercially available “Enclosed Control” as manufactured by Eaton, Square D, or Siemens, factory modified and to conform with the requirements specified herein.

B. Each commercially produced local control panel to be UL listed.

C. Each specialty local control panel to be UL and IBEW labeled.

D. In general, all commercially produced local control panels installed indoors to be NEMA Type 12 and NEMA Type 3R or NEMA Type 4X when installed in unheated, or outdoors, or in subway areas. Each specialty local control panel to be fabricated as specified below.

E. Specific site requirements may necessitate the use of different enclosure ratings or manufacturing techniques.

F. Specialty enclosures to be wall-mounted single-door, with back panels, similar to Hoffman Engineering Company Type A-12, as shown in the Contract Drawings, with the following additional requirements:

1. Enclosures for indoor locations to be formed of 12-gage galvaneal sheet steel minimum, seams continuously welded and ground smooth, without openings or knockouts, with external wall mounting brackets, and collar studs for mounting panel. Back panels to be formed from 12 gage galvaneal steel, with a rolled lip to be formed on all sides of the door opening. Size to be as shown on the Drawings.
2. Doors to be formed of 12 gage galvaneal sheet steel with rolled lip along top and sides to mate with the enclosure. The door to be fitted with a print pocket and a closed-cell neoprene gasket attached with oil-resistant adhesive and bonding stud.
3. Cabinet door to be equipped with a concealed full length, stainless steel continuous piano type hinge. Yale Company, Division of Eaton Security Products & Systems, Catalog Number S 1400, or Corbin Cabinet Lock Company Catalog Number 1000 vault handles with disc tumbler locks and three point latch to be provided on doors twenty-four inches or over in height. Yale Company, Division Eaton Security Product & Systems Catalog Number T 1403, or Corbin Cabinet Lock Company Catalog Number 1001 handles with disc tumbler locks and one point latch to be provided on doors under twenty-four inches in height.
4. Two keys to be furnished with each cabinet and lock. All cabinet locks to be provided to accept a CAT 60 Master Key (Corbin Lock or H. Hoffman Co.). Lock to be arranged to permit key removal in locked and unlocked positions.
5. For outdoor locations, enclosure including door and back panel to be stainless steel. The cabinet to be Type 304 stainless steel. Handle shall be provided as heavy duty padlockable stainless steel and three point latch suitable for outdoor installations.
6. Enclosures less than 24 inches can be constructed from 14 gage galvaneal steel or 304 stainless steel as applicable.
7. Specialty enclosures to bear UL-508 industrial control labels with respective UL enclosure ratings based on location of the installation and construction of the enclosure.

G. Each stainless steel enclosure located outdoors or in unheated areas, to have thermostatically controlled space heaters. Enclosures to also be supplied with breather drains.

H. Each panel to be provided with drip shield rain hood.

2.02 DISCONNECT SWITCHES AND CIRCUIT BREAKERS

A. Disconnect switches to be provided as horsepower rated, heavy duty type, fusible or non-fusible as indicated on the drawings. Non-fusible switches to be rated at 600 volts for 480 volt and 240 volt service. Fusible switches to be rated at 600 volt for 480 volt service and 250 volt for 240, 208 or 120 volt service. Fusible disconnects to be provided with rejection fuse clips. Fuses and spares to be provided as specified. External operator shall be provided. Disconnect switches to be heavy duty type, rated at 600 volts for 480 volt AC circuits and 250 volts for 208 volt AC and 120 volt AC circuits. Each disconnect switch to be horsepower rated.

B. Circuit breakers, to be rated at 600 volts for 480 volt AC circuits and 240 volts AC for 208 volts AC, and 120 volts AC circuits.

C. Circuit breakers to be the heavy duty industrial type. Circuit breakers for 480 volt and 277 volt service to have a minimum frame size of 100 Amperes and to be rated for 600 volts. The trip settings to be as shown on the Drawings. The breaker interrupting rating to be 65,000 Amperes, symmetrical at 480 volts AC. External operator shall be provided.

D. Circuit breakers for 120 volt and 208 volt service to be 240 volt rated. Industrial molded case style (miniature industrial breakers or panelboard style breakers are not acceptable) to be of the "bolt on" type and to have an interrupting rating of 65,000 Amperes at 240 volts AC. The trip settings shall be as required or as shown on the Drawings. External operator shall be provided.

E. Circuit breakers provided for motor circuit protection to be of the motor circuit protector type, sized to coordinate with the motor starter overloads and have an interrupting rating of 65,000 Amperes in combination with starter overloads. External operator shall be provided.

F. Disconnects and breakers to be provided with copper terminal lugs if available.

G. Circuit breaker and disconnect switch manufacturers which may be incorporated in the Work include but not limited to Square D, Eaton, or Siemens.

2.03 CONTACTORS AND STARTERS

A. Contactors and starters to be heavy duty type, NEMA style, rated 600 Volts AC, electrically held, minimum NEMA size 1 and with the number of poles shown on the Drawings. Contactors and starters to be supplied with 120 volt AC coils (unless otherwise noted) and two (2) normally open, two (2) normally closed spare auxiliary contacts over and above the auxiliary contacts required by the control circuit. Control relay contacts to be rated for a minimum continuous current of 10 amperes and a maximum voltage of 600 volts.

B. Starters shall be provided with solid state overload relays with external resets. . Overloads shall be provided with full load current adjustment dial, trip status indicator, operating mode LED, selectable trip class and phase balance protection, and ground fault protection.

C. Each starter, unless otherwise indicated on the Drawings, to be provided with a hand-off-auto selector switch and with push to test, transformer type red (on) and green (off) LED type indicating lights mounted on the door.

D. Each starter contractor shall be furnished with barrier type terminal blocks in accordance with the equipment manufactures UL listed components.

E. Spare contact kits and operating coils to be provided in the ratio of ten percent of each size installed, but not less than one of each size to be turned over to the Authority upon completion of the project.

F. Manufacturers for commercially available enclosed control shall be not limited to Square D, Eaton, or Siemens. Manufacturers for specialty enclosed control panels shall be Illinois Switchboard Corporation, Panatrol, or Gus Berthold Electric Company

2.04 CONTROL DEVICES

A. Pushbuttons, selector switches, indicating lights, etc. to be heavy duty oil-tight type 35MM, corrosion resistant if required by the application and UL approved. Enclosures to be NEMA rated for the area in which they are installed.

B. Pilot lights to be heavy duty, oil-tight, LED type with red (on), green (off) and amber (acknowledged) lenses. A push to test circuit to be provided when more than two lights are required. For alarm condition, green shall indicate normal condition, red shall indicate alarm condition, and amber shall indicate acknowledged condition.

C. Manufacturers which may be incorporated in the Work include but not limited to Square D, Siemens, or Eaton.

2.05 CONTROL CIRCUITS

A. Control circuits for motors to operate at 120 volt AC, unless otherwise shown on the drawings. Control circuits for single phase 120 volt motors shall be connected phase to neutral. Control circuits for 208, 240 or 480 volt motors shall be provided with a control power transformer within the enclosure with two (2) primary and one (1) secondary fuse unless otherwise shown on the drawings. One complete set of spare control fuses shall be supplied mounted within the assembly. Control power transformers shall be supplied with 50 VA extra capacity over and above the capacity shown for all devices powered by the control circuit.

2.06 CONTROL RELAYS

A. Logic Level control relays shall be 3 pole double throw, 120 volt AC, and octal style base with LED indicating light, test feature, matching socket with screw clamping terminals and hold down spring. Contacts shall be rated 1/3 HP at 120 volt AC, pilot duty class B300. Relays shall be Eaton Type D3PF or Square D type RPM.

B. Power control relays or relays used in circuits requiring more than three contacts shall be industrial grade, 120 volt AC operated, multi-contact, load voltage and current rated. Relays to be rated 600 volts AC and to have convertible, double-break silver alloy contacts with pressure wire connectors. Contacts to be provided with normally open or normally closed status indication, rated 600 volts 10 Ampere, class A600. Relay manufacturers shall be Eaton Type AR or D26, or Square D class 8501 type X.

C. Spare relays shall be provided in the ratio of ten percent of each type installed, but not less than one of each size to be mounted in the enclosure.

2.07 TIMING RELAYS

A. Pneumatic timing relays shall be “Off Delay” or “On Delay” type with an adjustable timing range as specified on the drawings with, instantaneous contacts if required by the application. Timers shall be rated for 120 volt 60 Hertz operation unless otherwise noted. Pneumatic timing relays shall be Agastat series 7000.

B. Solid state timing relays shall have the function specified with a fixed or adjustable timing range, plug in octal style base, matching socket with screw clamping terminals and hold down spring. Solid state timers to be Square D Class 9050 Type JCK or Eaton.

C. Spare solid state timers shall be provided in the ratio of ten percent of each type installed, but not less than one of each size to be mounted in the enclosure.

2.08 TIME CLOCKS

A. Time clocks shall be electromechanical 24 hour, with skip a day feature, contact configuration as shown. Suitable for operation at 120 volt AC, 60 Hertz. with mechanical spring reserve. Time clocks shall be Tork 7000 series.

2.09 NAMEPLATES

A. A nameplate to be provided on the exterior of each panel to describe the panel and equipment it serves.

B. The name of the driven equipment to appear on each starter and breaker.

C. Non-corrosive nameplates to be laminated plastic with 3/8 inch black letters on a white background and to be mechanically affixed to the front of each door with self-tapping stainless steel screws. This to not change the NEMA rating of the enclosure.

D. Component nameplates to be installed to designate the purpose of all switches, breakers, instruments, relays, fuses, etc.

2.10 FUSES

A. The Contractor shall furnish and install fuses for all fusible equipment provided on this Project regardless of which trade has provided such equipment. All fuses shall be provided in accordance with the indications of size and voltage ratings as required and shall have UL listing and NEC approval as being suitable protection for conductors under overload conditions.

1. All fuses shall be of the same manufacturer.
2. No paralleling of fuses must be permitted.

B. Fuses shall be UL listed, Class “RK-1” fuses having an interrupting rating of 200,000 Ampere.

C. Fuses shall be dual-element with a separate thermal element that will open at 280 degree F or less and shall have time-delay such that they must hold 500 percent rated current for a minimum of ten seconds in all sizes.

D. Control circuit fuses shall be time-delayed current limiting, 200,000 Ampere interrupting rating, UL listed Class “CC”.

E. The Contractor shall check each motor nameplate data and provide proper fuses for motor running protection.

F. Spare fuses shall be furnished in the ratio of ten percent of each size and type installed, but not less than three of each size and type. All fuses blown during construction shall be replaced by the Contractor and a complete supply of spare fuses must be turned over the CTA upon completion of the Project.

G. Manufacturers for the fuses which may be incorporated in the Work shall include but not limited to Bussmann, GEC Alstrom, Gould, or Littelfuse.

2.11 CABLE, TERMINATIONS, AND CABLE TAGGING

A. Where possible, compression type cable lugs for terminating cables and equipment within the panel and entering and leaving the panel to be furnished by the equipment manufacturer. Copper compression connectors to be crimp, type, long barrel tin plated closed end compression. All connectors to be copper. The barrel for each cable lug to be sized for the exact cable size specified. Copper type connectors and terminations to be furnished. Copper-Aluminum connectors are not acceptable. Connectors to be Burndy Type YA, Panduit Series LCB or LCC, Anderson Type VHCL, or T & B Series 54800 and 54900.

B. Cable lugs for terminations to bus bar, switch studs, terminal blocks, and other devices, for Number 22 AWG to Number 10 AWG wire to be 600 Volt, color coded nylon insulated ring tongue lugs. They to have a secondary metal sleeve around the wire barrel for insulation strain relief. Type to be Panduit Pan-Term PN series terminals. Locking fork- type lugs can be used for connections to devices provided with captive fasteners.

C. Cable lugs for terminations of Number 8 AWG to Number 1/0 AWG wire to be standard barrel, one hole high conductivity seamless copper lugs, with inspection holes to assure adequate wire insertion. The tongue to be stamped with wire size, UL & CSA logos and manufacturer. The base part number and stud size should also be stamped on the tongue to assure adequate identification in application. Barrels to contain color coded rings, die color code and/or number. Crimp locations to be indicated to assure correct installation. For further identification, the manufacturer shall also be included on the barrel. Type to be Panduit Series LCB or LCC Power Connectors or Burndy Type YA.

D. Cable lugs for terminations of Number 2/0 AWG and larger wire to be long barrel, two hole high conductivity seamless copper lugs. Barrels to contain color coded rings knurled markings indicating die color code, die index numbers, and crimp locations to assure correct usage and installation. For further identification, the manufacturer should also be included on the barrel. For Number 2/0 AWG to Number 600 KCMIL sizes, the tongue may be stamped with wire size, UL & CSA logos and manufacturer. The base part number and stud size shall also be stamped on the tongue to assure adequate identification in application. Type to be Panduit LCC series Power Connectors or Burndy Type YA.

E. Cable/wire markers to be installed on both ends of all conductors, both for internal and external cables. The cable/wire markers for external connections to comply with Section “261950” Identification. The cable/wire markers for internal wires and cables to be self-adhesive, self-laminating mechanically printed with a clear protective laminating over wrap or mechanically printed with a clear protective laminating over wrap or sleeve type tubing mechanically printed with permanent non smearing ink. Sleeve type wire markers to be properly sized for the conductor they are being installed on.

2.12 CONTROL DEVICES AND WIRING

A. Control devices, local instrument cables, and wiring required on the equipment to be furnished and installed at the factory.

B. All small wiring for control or accessory equipment to be installed in code approved wireways as necessary.

C. Control panel internal wiring to be Number 14 AWG, minimum, except for incidental wiring on mass produced pre-manufactured sub-assemblies or where larger size conductors are needed for current carrying requirements. The conductors to be stranded copper for fixed wiring and extra flexible copper for hinged wiring. The conductors to have 600 volts, 90 degrees C, polyvinyl chloride insulation with flameproof braid covering, Type TBS, or cross-linked polyethylene, Type SIS.

D. All control and instrument wiring, alarm leads, and instrument transformer secondaries, for connection to external cables, to be terminated at terminal blocks. Terminal blocks to be UL/CSA recognized, 94V-2 thermoplastic material, snap on rail mounted design, 30 Ampere 600 volt, with marking strip, with Number 6-32 terminal screws for use with crimp on ring style wire connectors. Cooper Bussmann (USD) type NSS3-WH, Eaton type TBAL30 or equal. A minimum of 10 percent spare terminals to be provided. Terminal blocks for current transformer secondaries to be shorting type Cooper Bussmann type KUSC or Marathon 1500SC series.

E. Compression, type (solderless) copper lugs to be furnished for each terminal block for external control and instrument wires. Minimum field wire size to be Number 12 AWG. Cable lugs for terminations to bus bar, switch studs, terminal blocks, and other devices, for Number 22 AWG to Number 10 AWG wire to be 600 Volt, color coded nylon insulated ring tongue lugs. They to have a secondary metal sleeve around the wire barrel for insulation strain relief. Type to be Panduit Pan-Term PN series terminals. Locking fork- type lugs can be used for connections to devices provided with captive fasteners.

F. Cable/wire markers to be installed on both ends of all conductors both for internal and external cables. Cable and wire markers to comply with this Specification.

G. Control cables to be neatly routed and supported in cable duct/wireway within the cabinet.

H. The assembled control equipment, wiring and connections to be insulated for a voltage of 600 volts and to be subjected to a one minute dielectric test AC phase to ground at the factory after fabrication and assembly is complete. Dielectric test value to be twice the rated voltage of the lowest rated device plus 1000 volts.

I. Spare fuses to be provided mounted in the assembly.

J. The specialty assembled control equipment shall be provided with UL 508 industrial control label with respective enclosure label or equal.

2.13 TESTING

A. The assembled control equipment, wiring and connections to be functionally tested for operation.

B. The assembled control equipment, wiring and connections to be insulated for a voltage of 600 volts and to be subjected to a one minute test of 2200 volts AC phase to ground at the factory, after fabrication and assembly is complete.

C. Copies of test reports to be provided with the documentation package.

2.14 PAINTING

A. All interior and exterior seams to be carefully filled and sanded smooth for neat appearance. The equipment manufacturer to remove oils and dirt and form a chemically and anodically neutral conversion coating, to improve the finish-to-metal bond, and to provide resistance to rust. All surfaces to be phosphatized before any of the protective coatings are applied. The final coat for non-stainless steel surfaces to be semi-gloss enamel to provide adhesion, resiliency, durability, color stability, and stain resistance.

B. The exterior surface of all non stainless steel structures to be thoroughly cleaned and given a coat of primer and a finish coat of the equipment manufacturer's standard of ANSI Standard light gray enamel color Number 61 for outside surface.

C. The interior surface of all non stainless steel surfaces to be given a primary coat and a finish coat of ANSI Standard light gray enamel color Number 61.

D. Sub pans to be painted white.

E. The equipment manufacturer to provide an adequate supply of touch-up paint in aerosol cans.

F. A packaged kit of refinishing materials, with complete instructions, to be included with each shipment for touch-up in the field.

2.15 MANUFACTURERS

A. Manufacturers which may manufacture and assemble the Local control panel Work shall include but not limited to Gus Berthold Electric Company, Illinois Switchboard Corporation, Panatrol, Perigon Systems, Inc., Siemens, or Eaton.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

B. The Contractor to adjust the location of equipment to accommodate the work in accordance with field conditions encountered.

C. The equipment to be installed with workspace clearances required by the Chicago Electrical Code.

D. The equipment to be installed to permit maintenance and replacement of parts, and to be clear of all openings with swinging or moving doors, partitions or access panels.

E. Mounting bases for floor mounted control panel:

1. The Contractor to install each floor mounted control panel on a 4 inch thick concrete housekeeping pad of sufficient size plus at least a 4 inch apron as specified in other specification sections within this division.
2. The panels shall be of such construction that when it is installed on the concrete pad there are no openings between the top of the pad and the bottom of the panels. Panels mounted in rooms with slabs on grade to have a non-conductive fiberglass mat installed between the panel and the concrete pad. Anchor bolts or fasteners to comply with the Commissioner's requirements for isolated connections.
3. The contractor shall chamfer the edges of the pad at a 45 degree angle.
4. Each foundation to be level, stable, and compacted to 95 percent Standard Proctor.
5. Conduit locations to be in accordance with equipment manufacturer's approved shop drawings.

F. Wall Mounted Control Panel:

1. Each wall mounted control panel to be supported and mounted away from the wall with "C" shaped channel. The channel to be fiberglass, when stray current control isolation is required. Hot dipped galvanized steel channel for normal applications when mounted in indoor electrical room when stray current isolation is not required, stainless steel channel when located outdoors or in the subway tubes. The minimum separation between the equipment and the wall to be one inch.
2. Each control panel to be mounted with the top a maximum of 6 feet 6 inches above the finished floor.

3.02 PERFORMANCE TESTING

A. The Contractor to test each complete local control panel installation to assure proper operation and correct sizing of all control fuses and motor overload units.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of LOCAL CONTROL PANELS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of LOCAL CONTROL PANELS to be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 19 00

GROUNDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This specifies grounding requirements for this project.
2. The Contractor to furnish and install complete a grounding system as required by the Drawings and as required by these Specifications.

1.03 RELATED WORK

A. Grounding specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261950 “Identification”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

B. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications shall be a Member company of NETA or an NRTL.

B. Testing Agency's Field Supervisor shall be Certified by NETA to supervise on-site testing.

C. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Contractor shall comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment

2.02 MATERIALS

A. Grounding conductors, other than bus bars, to be stranded copper wire, with type XHHW green 600 volt, rated insulation sized and installed in accordance with Code requirements, and as noted on the Drawings.

B. Ground rods shall be 3/4 inch minimum diameter, 10 foot long stainless steel type 304 rods, in 5 foot threaded sections.

C. Bare ground cable shall be bare Class A, stranded, annealed, high conductivity copper, no less than 97 percent International Annealed Copper Standard (IACS).

D. Ground bar shall be hard drawn, high conductivity rectangular copper bus bar, no less than 97.4 percent International Annealed Copper Standard (IACS) and shall meet requirements of ASTM SPEC B133 166 (latest edition for copper alloy 110).

E. Grounding bus shall be predrilled rectangular bars of annealed copper, 1/4 inch by 4 inches in cross section, with 9/32 inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 Volts and shall be Lexan or PVC, impulse tested at 5000 Volts.

F. Insulated grounding cable shall be 600 volt type "USE", stranded copper, 75C RHW insulation, and neoprene sheath.

G. Ground rod connectors, cable to cable connectors and cable to bar connectors shall be high copper alloy cast body with silicon bronze hardware, manufacturer and type as established by the Contractor.

H. Ground rods shall be complete with ground wells. The ground wells shall be high-density polyethylene type (HDPE). Manufacturers which may be incorporated in the Work shall include but not limited to series 1419-18 by Carson Industries.

2.03 GENERAL GROUNDING REQUIREMENTS

A. The equipment ground conductor shall be distinct and separate from the system neutral ground conductor and shall not be used as a load current carrying conductor. The equipment ground conductor shall be electrically and mechanically continuous from the transformer neutral ground to the equipment to be grounded. The equipment ground conductor shall provide a low impedance path for line to ground fault currents and bond all non-current carrying enclosures together including raceways, fixtures, receptacles, panels, controls, motors, disconnect switches, and exterior lighting standards.

B. Where building type conductors are installed in a raceway, the equipment ground conductor shall have a minimum size conductor of Number 10 AWG copper except for Number 12 AWG feeder. Where green insulation is not available, on large size cable, black insulation shall be used and shall be identified with green colored tape at each junction box, pull box, or device enclosure.

C. Wiring channels, cable trays, and all metallic conduit including rigid electrical metallic tubing and flexible conduits, shall be connected at each end to the equipment ground conductor utilizing a conduit grounding bushing. Manufacturers which may be incorporated in the Work shall include but not limited to O Z type BL.

D. Switchboards, panel boards, motor control centers, and panels shall be provided with an equipment ground bus (including lug or screw terminals) and shall be securely bonded to the enclosure. Junction boxes and other enclosures (sizes above 5 inches by 5 inches) shall utilize an equipment ground bus or lug as required to securely bond the equipment ground conductor to the enclosure.

E. Lighting fixtures shall be securely connected to the equipment ground conductor. A continuous row of fluorescent fixtures mechanically joined to provided good electrical contact may be considered as one fixture with the equipment ground conductor connected at only one point.

F. Motors shall be connected to the equipment ground conductor. Bolts, nuts, and washers shall be bronze, cadmium plated steel, or other noncorrosive material.

G. For elevated stations and Platform equipment/devices, the steel structure that supports the Rapid Transit ROW to serve as the Code required reference grounding electrode. Provide exothermic connection, where service ground conductor is connected to track structure.

H. Any metallic construction on the platform located less than 6 feet from the DC negative return shall be made electrically continuous with it. Where this is not possible, it shall be covered with an insulating protective barrier. This is to reduce the possibility of shock should a person contact the two potentials at the same time. DC negative returns are the running rails and anything electrically continuous with them including the RT Car and support structure for the track. Constructions that may be at other potentials are the elevator enclosure or station platform head house.

I. All light poles shall be grounded using a ¾ inch by x 10 foot long 304 stainless steel rod.

2.04 CONNECTORS

A. Each connector shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes and combinations of conductors and other items connected.

B. Bolted connectors for conductors and pipes shall be copper or copper alloy.

C. Welded connectors shall be exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar connectors shall be mechanical type, cast silicon bronze, solderless compression type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.05 TRANSFORMER GROUNDING

A. The 120 volt system and 277 volt system neutrals, for grounded transformers, shall be a white or gray insulated current carrying conductor over which unbalanced neutral load currents may flow. The neutral conductor shall originate at the grounded wye secondary of each transformer.

B. The wye connected secondary ground of each transformer shall be grounded directly to the electrical power system ground bus.

2.06 ELEVATED STATION REFERENCE GROUNDING ELECTRODES

A. Stations on CTA track structure shall use the traction power negative return as the Reference Grounding Electrode. Isolation transformers installed between the utility and station service shall have the secondary neutral bonded to the track structure using exothermic weld. All utility metallic underground services shall be isolated where they enter the station. Inside the station all utility service shall be bonded to the Reference Grounding Electrode.

B. All the conduits and cables referenced to the utility ground, shall be isolated from the CTA track structure, which has traction power negative reference.

C. Insulated mounting hardware, and fiberglass Unistrut's shall be used to isolate the ground. Isolated pads shall be used for floor mounted equipment.

D. For elevated stations, the steel structure that supports the Rapid Transit ROW to serve as the Code required reference grounding electrode. Provide exothermic connection, where service ground conductor is connected to track structure.

2.07 AT OR BELOW GRADE STATION REFERENCE GROUNDING ELECTRODES

A. Stations at or below grade shall use a ground field as the Reference Grounding Electrode. The ground field shall be installed using minimum three ¾ inch by 10 foot ground rods in triangular pattern at a distance of 10 feet between the rods. The rods shall be interconnected using Number 4/0 AWG bare copper conductors. The ground field is then connected to the nearest steel column, as well as the copper ground bus in the electrical or communication room using Number 4/0 AWG bare copper conductor.

B. All connections shall be exothermic weld.

C. Resistance to earth shall not exceed five ohms. All utilities shall be isolated where they enter the station. Inside the station, all utility services shall be bonded to the Reference Grounding Electrode.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors shall be installed and shall be solid conductor for Number 8 AWG and smaller, and stranded conductors for Number 6 AWG and larger.

B. Underground grounding conductor shall be installed and shall be Number 2/0 AWG minimum

1. Contractor shall bury at least 24 inches below grade
2. Duct bank grounding conductor shall be buried 12 inches above duct bank when required as part of duct bank installation.

C. Isolated grounding conductors shall be green-colored insulation with continuous yellow stripe. On feeder with isolated ground, grounding conductor shall be identified where visible to normal inspection, with alternation bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding bus shall be installed in electrical equipment rooms, in rooms housing service equipment.

1. Grounding bus shall be installed horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor.
2. Grounding bus shall be installed on both sides of doorways, routed bus up to top of door frame, across top of doorway, and down; shall connect to horizontal bus.

E. Conductor terminations and connections:

1. Pipe and equipment grounding conductor terminations shall be bolted connectors.
2. Underground connections shall be welded connectors except at test wells.
3. Connections to ground rods at test wells shall be bolted connectors.
4. Connections to structural steel shall be welded connectors.

3.02 GROUNDING SYSTEM

A. The intent is to set forth requirements for an effective ground system. The ground system to be installed so that the line-to-ground circuit has an impedance sufficiently low to limit the potential above ground to a level that to ensure freedom from dangerous electric shock-voltage exposure to the persons in the area, and to facilitate the operations of the overcurrent devices in the circuit.

B. The entire power and lighting systems to be permanently and effectively grounded in accordance with the latest issue of the city of Chicago Electrical Code. The items covered to include but not be limited to panels, motor frames, lighting fixtures and associated switches and other exposed, non-current carrying parts of the electrical equipment and as shown on the Drawings.

C. In general, the conduit systems to contain an equipment ground wire.

1. Continuity of ground to be maintained throughout the conduit systems, in particular the PVC conduit, as required by the City of Chicago Electrical Code.

2. Ground bushings and jumpers to be used wherever the normal metallic conduit termination does not insure continuity of ground.

D. Concealed or inaccessible grounding connections to be made with exothermic process.

1. Accessible grounding connections to be bolted or clamp type unless otherwise indicated.
2. Soldered connections will not be permitted in the grounding system.

E. Grounding conductors to be protected from mechanical damage, and to be supported in an approved manner.

F. Grounding connections made below grade to include the installation of waterproof tape.

G. Where ground conductors are run in conduit or other raceway, the ground conductor to be bonded to the conduit or raceway at each end.

3.03 TRANSFORMER GROUNDING

A. Control circuit transformers serving 120 volt control circuits shall have one side of the secondary grounded.

B. Transformers having neutral ground point shall be connected to the main service ground bus by means of a code size grounding conductor carried back to the source in the same conduit as the feeder conductors.

3.04 CONTINUOUS GROUND BUS

A. Switchboards, panelboards, and motor control centers to have a continuous ground bus within the enclosure, bonding all sections together.

B. The ground bus to be connected to the main service ground by means of a grounding conductor run in the same conduit or raceway as the feeder conductors.

C. When indicated on the contract drawings, a continuous ground bus 1/4 inch by 2 inches to be surface mounted 1 foot above floor level around the perimeter of the Electrical and Communications rooms. The ground bus in the Electrical room to be connected to the track structure by an insulated Number 4/0 AWG ground conductor, the ground bus in the Communications room to be connected to the ground bus in the Electrical room by a Number 4/0 AWG ground wire.

3.05 EQUIPMENT GROUNDING

A. Insulated equipment grounding conductors shall be installed with all feeders and branch circuits.

B. Insulated equipment grounding conductors shall be installed with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacles circuits.
4. Single-phase motor and appliance branch circuits.

5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway supply circuits shall be insulated equipment grounding conductor installed from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Air-Duct equipment circuits shall have insulated equipment grounding conductor installed to duct-mounted electrical devices operating at 120 Volts and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Conductor shall be bonded to each unit and to air duct and connected metallic piping.

D. Water heater, heat-tracing, and antifrost heating cables shall have separate insulated equipment grounding conductor installed to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated grounding receptacle circuits shall have an insulated equipment grounding conductor installed and connected to the receptacle grounding terminal. The conductor from raceway and from panelboard grounding terminals shall be isolated. Equipment grounding conductor terminal of applicable derived system or service should be terminated at the equipment.

F. Isolated equipment enclosure circuits shall be isolated for designated equipment supplied by a branch circuit or feeder, shall isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Fittings where raceway enters enclosure shall be installed and shall install a separate insulated equipment grounding conductor. Conductor from raceway and from panelboard grounding terminals shall be isolated. Equipment grounding conductor terminal of the applicable derived system ofr service shall be terminated.

G. Poles supporting outdoor lighting fixtures shall have grounding electrode and a separate insulated equipment grounding conductor installed in addition to grounding conductor installed with branch-circuit conductors.

H. Metallic fences shall comply with requirements of IEEE C2

1. Grounding conductor shall bare copper, not less than Number 8 AWG.
2. Gates shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed wire strands shall be bonded to the grounding conductor.

3.06 INSTALLATION

A. Grounding conductor shall be routed along shortest and straightest paths possible or required by Code. Obstructing access or placing conductors shall be avoided where they may be subjected to strain, impact, or damage.

B. Ground bonding common with lightning protection system shall comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Electrical power system ground shall be bonded directly to lighting protection system grounding conductor at closest point to electrical service grounding electrode. Bonding conductor sized shall be the same as system grounding electrode conductor and installed in conduit.

C. Ground rods shall have rods driven until tops are 2 inches below finished floor or final grade.

1. Ground rods shall be interconnected with grounding electrode conductor below grade. Connections shall be made without exposing steel or damaging coating if any.
2. For grounding electrode system, at least three rods shall be spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes and shall be connected to the service grounding electrode conductor.

D. Test wells shall be ground rod driven through drilled hole in the bottom of handhole and shall be at least 12 inches deep, with cover.

1. Test wells shall be installed at least one test well for each service. The ground rod shall be installed electrically closest to service entrance. The top of test well shall be flush with finished grade or floor.

E. Bonding straps and jumpers shall be installed in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to structure straps shall be bonded directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to equipment mounted on vibration isolation hangers and supports shall install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Exothermic welded connectors shall be used for outdoor locations; if a disconnect-type connection is required, bolted clamp shall be used.

F. Grounding and Bonding for Piping:

1. Metal water service pipe install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Grounding conductors shall connect to the main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed grounding conductor on street side of fitting shall be connected. Metal grounding conductor conduit or sleeve shall be bonded to conductor at each end.
2. Water meter piping shall use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Each above ground portion of gas piping system shall be bonded to downstream from equipment shutoff valve.

G. Bonding interior metal ducts shall be bonded metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Bonding jumper shall be installed to bond across flexible duct connections to achieve continuity.

H. Grounding for steel building structure shall have a driven ground rod installed at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground ring shall have a grounding conductor, electrically connected to each building structure ground rod and to each, installed and shall extend around the perimeter of building.

1. Tinned-copper conductor shall be not less than Number 2/0 AWG installed for ground ring and for taps to building steel.
2. The ground ring shall be buried not less than 24 inches from building's foundation.

3.07 GROUNDING SYSTEM FIELD TESTING

A. Ground system field testing shall be witnessed by the CTA's Testing Engineers.

B. The testing of grounding systems shall be done by an independent testing service employing the 3 point Fall-of-Potential method with a null balance instrument. Meter shall be such that lead resistance is rejected via null balance. Subtraction of lead resistance is not allowed (or necessary).

C. The test meter shall be Associated Research Vibro-ground test set with null balance. Manufacturers which may be incorporated in the Work shll include but not limited to James A. Biddle Megger Earth-Tester-Null Balance.

D. A graph of instrument readings versus potential electrode distance shall demonstrate a "flat" portion on the graph. Failure to achieve this will require larger electrode spacing or different test method. Reading obtained on flat or horizontal portion of graph is taken as resistance to earth of ground under test.

E. Ground grid shall be isolated from electrical supply neutral during test.

F. The ground test shall verify that the resistance to ground does not exceed 5 Ohms. If resistance is in excess of 5 Ohms, the Contractor shall install additional ground rods and cable, if directed by the CTA, until resistance is brought down to 5 Ohms or less. The ground resistance test data shall be posted on the CTA's project management web-site for the CTA's approval.

3.08 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test shall be performed for compliance with requirements.
2. Physical and mechanical condition shall be inspected. Tightness of accessible, bolted, electrical connections shall be verified with calibrated torque wrench according to manufacturer's written instructions.
3. Completed grounding system shall be tested at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Tests at ground rods shall be made before any conductors are connected.

    a. Ground resistance shall be measured no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Test shall be performed by fall-of—potential method according to IEEE 81

4. The Contractor shall prepare dimensioned drawing locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. The Contractor shall identify each by letter in alphabetical order, and key to the record of tests and observations. The Contractor shall include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. The Contractor shall describe measures taken to improve test results.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. The Contractor shall prepare test and inspection reports.

3.09 INSTALLATION OF GROUNDING SYSTEMS

A. Ground rods shall be installed in locations and to the depths as shown on the Contract Drawings. Round rod sections shall be connected using high strength bronze alloy couplings each tack welded to ground rod sections. Ground rods shall be installed by driving, not by drilling or jetting.

B. All connections below grade shall be made with exothermic welds and insulated with epoxy. All connections above grade shall be made with bolted connectors. All connectors shall be high copper alloy cast body with silicon bronze hardware, manufacturer and type as selected by the Contractor and approved by Engineer.

C. Connectors and lugs and their bolts, nuts or screws shall be furnished by the Contractor for connection to all equipment. The lugs, connectors and hardware shall be of material suitable for attachment of the copper ground system to the material to which it is being attached, without the possibility of attack by corrosive atmosphere or electrolytic action. Silver plate all bar and lug connections.

D. Bar to bar and lug to bar, bolted connections shall be made with silicon bronze bolts, nuts and washers. All connections shall be made electrically clean. Silver plate all bar and lug connections.

E. Use bonding jumpers and/or grounding bushing (set screw type) at all junction boxes, etc., to provide conduit ground continuity.

F. Permanently connect the ground terminal on each receptacle to the ground conductor or grounding bushing.

G. All grounding cable runs to equipment steel or tray device shall be securely fastened at intervals not to exceed 24 inches. All hardware for fastening shall be furnished and installed by Contractor.

H. After the entire grounding system has been installed, including ground rods and ground loop, the ground system shall be tested.

I. Ground grid and ground rod installations and resistance tests will be witnessed by the CTA. The Contractor shall inform the CTA three days in advance before the start of any of the above testing activities.

FORM 34 21 48-A

GROUND ROD RESISTANCE TO EARTH TEST RECORD

1. DATE _____

2. PROJECT NAME _____

3. LOCATION OF TEST _____

4. DRAWING NO. _____

5. GROUND ROD TYPE _____

   DIAMETER _____

   LENGTH _____

6. TEST METHOD _____

   INSTRUMENT TYPE _____

   SERIAL NO. _____

7. REQUIRED MAXIMUM RESISTANCE TO EARTH _____

8. MEASURED RESISTANCE TO EARTH ROD1 _____

   ROD2 _____

   ROD3 _____

TEST PERFORMED BY: _____
Signature

TEST WITNESSED BY: _____
Signature

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of GROUNDING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of GROUNDING must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 19 50

IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This Section specifies equipment, wire and conduit identification.

1.03 RELATED WORK

A. Identification specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261900 “Grounding”
10. Section 264700 “Panelboards”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the Sections of these Specifications for all the materials and construction referred to in this Section.

B. See Section 26 01 00, General Provisions Electrical for additional submittal requirements

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

A. After finish painting is completed, the Contractor to provide white with black core laminated phenolic nameplates with 3/8 inch lettering etched through the outer covering. Each nameplate to be fastened with stainless steel screws to each piece of equipment, in a way that will not void the NEMA rating for the enclosure.

1. All major electrical equipment to be identified which to include motor starters, disconnect switches, panelboards, transfer switches, transformers etc.
2. Disconnect switches serving feeders and overcurrent protective devices mounted in a switchboard to also be identified.

B. Embossed self-adhering plastic tape labels will not be accepted.

2.02 WIRE IDENTIFICATION

A. Cable/wire markers to be installed on both ends of all conductors.

B. All wire and feeder cables to be labeled with wire markers in all junction boxes pull boxes, control panels, motor control centers, panelboards, switchboards, etc.

C. Wire and cable markers to be self-adhesive, self-laminating mechanically printed with a clear protective laminating over wrap or mechanically printed with a clear protective laminating over wrap or mechanically printed heat shrink tubing.

D. Cable and wire markers to be approved by the Commissioner and to be attached to all cables where entering or leaving the conduit run. The cable designation and circuit use to appear on the tag.

E. Acceptable manufacturers shall be Brady, Panduit, 3-M, or Thomas and Betts.

PART 3 - EXECUTION

3.01 EQUIPMENT IDENTIFICATION

A. Each nameplate to include the equipment designation as shown on the Drawings, as approved by the Commissioner and other information as required in the Specifications.

B. The Contractor to provide the following identification markings on each individually mounted circuit breaker, disconnect switch, contactor, and motor starter:

1. Feeder name, number, voltage and phase.
2. Item of equipment controlled.

C. The Contractor to provide the following identification markings on each motor and other utilization equipment, except lighting fixtures:

1. Equipment tag designation.
2. Feeder number.

3. Voltage and phase.

D. The Contractor to provide the following identification markings on each transformer:

1. Equipment tag designation.
2. Feeder number.
3. Voltage and phase.
4. Name of lighting and/or power panels supplied by the secondary of the transformer.

E. The Contractor to provide a typewritten directory of circuits in lighting and power panels and provide panel identification in black alkyd paint stenciled inscriptions on the inside of the door, directly above the centerline of directory frame, or on vertical and horizontal centerline of doors without directory frames.

F. The Contractor to provide on device plates for local toggle switches, toggle switch type manual starters, pilot lights, and other electrical items whose function is not readily apparent, engraved suitable inscriptions on laminated phenolic nameplates describing the equipment controlled or indicated.

G. Each nameplate to be fastened with a minimum of two self- tapping stainless steel screws. This is to not change the NEMA rating of the enclosure.

H. The Contractor to provide the following alkyd paint stenciled inscription markings on the outside face and on the inside face of each feeder splice box, feeder junction box, and feeder pull box cover plate:

1. Designation shown on the Shop Drawings.
2. Feeder name.
3. Feeder number.
4. Voltage and phase.

3.02 CONDUIT, WIRE, CABLE AND BUS IDENTIFICATION

A. Each wire and each cable to be labeled at terminals and at all accessible points in equipment, panelboards, manholes, handholes, and pull boxes. Labels to be self-sticking wire markers.

B. Each cable run to be assigned a circuit number and to be recorded on a cable schedule showing from, to, purpose, number of conductors and length.

C. Cable and wire markers to be the wrap-around self-adhesive type, with factory or mechanical printed numbers, letters and symbols which to be used to identify all feeders, mains and branch circuit conductors.

D. All conductors to be tagged in cabinets at the time wires are pulled in and tested and markers to not be removed for any reason.

E. Phase identification letters, in readily visible locations, to be stamped into the main bus bars of switchboards and panelboards.

3.03 ROOM IDENTIFICATION

A. On each interior wall of each electrical room, the Contractor to provide a vitreous enameled metal sign or plastic sign, red on white, reading "Electrical Equipment Room - No Storage Permitted". Lettering of font size to be one inch. Signs to be mounted at clearly visible locations within the rooms or on the inside of doors where wall space within the room is not available.

B. Each sign manufacturer which may be incorporated in the Work include but not limited to Panduit.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of the IDENTIFICATION will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work for the IDENTIFICATION will be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. ELECTRICAL Work: 260000

END OF SECTION

SECTION 26 21 16

ELECTRICAL UTILITY SERVICE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specified the requirements for the accommodating ComEd service charges for this project and for contractor work related to electrical services. The Work under this Section to include all labor, materials, tools, equipment and incidentals necessary to provide complete new service entrance, including but not limited to conduit, cable, cable limiters, underground duct banks, grounding, fencing and foundations, penetration and sealing of ComEd manholes/vaults/facilities.

PART 2 - PRODUCTS

2.01 GENERAL

A. Contractor to provide two (2) new “cold sequence” services (Source 1 Service and Source 2 Service). Both services to be 120/208Y volt, 3 phase, 4 wire services, and 60 hertz. Services will be metered at 120/208Y volt, 3 phase, 4 wire.

B. Cable limiters to be provided at each end of the incoming service cables. Cable limiters to be furnished by the Contractor to ComEd for the cable end located in the ComEd Vault. The Contractor to install cable limiters located in the Electrical Room.

C. ComEd to install two duct banks, one for normal and one for reliable. Each ductbank to be 6-5” duct bank includes 1 spare. One spare duct to be routed to the service disconnect. The Contractor is responsible to coordinate the ductbank installation with ComEd.

D. The duct bank to be installed during ComEd Utility relocation work (under separate Contract) while ComEd has the street open for their relocation work

E. The Contractor to furnish the incoming service cable from the ComEd vault to the Electrical Room Service Disconnect. ComEd will assist in pulling into their vault and make connections in their vault. Contractor to install cable in the duct bank and make the connection at the service equipment in the Electrical Room.

F. Penetration and sealing for the duct bank at the vault will be provided by ComEd.

G. Contractor shall provide temporary electric service during construction from ComEd. The Contractor shall coordinate with ComEd and provide all necessary cable, conduit, and complete power panel for a 400A temporary electric service during construction. The temporary service will originate at the same location as Service 1.

2.02 SERVICE LOCATION

A. Normal Service and Reliable Service will be provided from existing ComEd Vault located east of State St on Lake St as shown on Contract Drawings. Coordinate the exact location with ComEd.

B. Normal Service: Contractor to provide new cables in conduit duct bank in location shown on the Contract Drawings. Contractor to provide sufficient cable slack for connections.

C. Reliable Service: Contractor to provide new cables in conduit duct bank in location shown on the Contract Drawings. Contractor to provide sufficient cable slack for connections.

D. Top of duct bank to be 36” below grade. Coordinate installation with existing and relocated utilities and make modifications as required. Street trenching and restoration to be completed by others under applicable sections of the Division 31.

E. ComEd to provide and install equipment in ComEd Vault as required to new service locations.

F. ComEd to be responsible for all permits to accomplish their work.

G. Contractor to connect service cables at point of service in Electrical Room.

H. All work to comply with the applicable requirements of ComEd.

2.03 METERING EQUIPMENT

A. ComEd to furnish and install meters in Contractor supplied meter sockets located in the meter closet.

PART 3 - EXECUTION

3.01 The Contractor to provide all materials and labor as required by this Contract and by ComEd service contract agreement being provided by ComEd to complete the services to the facility.

3.02 It to be the responsibility of the Contractor to contact the appropriate personnel within ComEd to determine the exact nature of the work involved. For information form ComEd, please contact Mr. Jose Favela, Jose.Favela@Comed.com at phone number (630) 473-5239.

3.03 The Contractor to coordinate all work with ComEd. All work to be installed in accordance with ComEd Standards and Requirements.

3.04 All work to be installed in accordance with the Chicago Electrical Code, and CTA requirements.

3.05 The Contractor to coordinate work of other Sections and with ComEd as required.

PART 4 - MEASURMENT AND PAYMENT

4.01 MEASUREMENT

A. No separate measurement will be made for ELECTRIC UTILITY SERVICE WORK.

4.02 PAYMENT

A. An allowance for payment for ELECTRICAL UTILITY SERVICE WORK has been included in the SCHEDULE OF PRICES.

B. The Contractor will pay ComEd for service directly, and then submit paid invoices from ComEd Company for payment. No mark-ups of any kind will be added.

C. Should the actual charges for ELECTRICAL UTILITY SERVICE WORK be less than the allowance, only the costs incurred will be paid, and the Contract will be reduced by the amount of the allowance not used.

D. Should the actual charges for ELECTRICAL UTILITY SERVICE WORK exceed the allowance, the whole allowance will be paid and the amount in excess of the allowance may be paid by contract modifications.

E. Payment for work covered under this SECTION not covered by the ELECTRICAL UTILITY SERVICE WORK and associated with electrical service will be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK and will be paid under 260000.

4.03 PAY ITEM ACCOUNT NUMBERS

A.	ELECTRICAL WORK	260000
B.	COMED SERVICE CHARGE ALLOWANCE	265000

END OF SECTION

SECTION 26 33 53

UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes Uninterruptible Power Supply for emergency lighting as well as appurtenances there to, required as part of this contact.

B. Related Sections:

1. Section 26 01 00 “General Provisions”
2. Section 26 05 00 “Raceways and Boxes”
3. Section 26 12 30 “Wires, Cables, Splices, Terminations”
4. Section 26 19 00 “Grounding”
5. Section 26 19 50 “Identification”
6. Section 26 95 00 “Electrical Testing”

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.03 REFERENCES

A. The battery inverter to be designed in accordance with the applicable sections of the current revision of the following documents:

1. ANSI C 62.41 Standard – IEEE 587 – Guide for Surge Voltages in Low-Voltage AC Power Circuits Rated up to 600v.
2. City of Chicago Electrical Code.
3. FCC Part 15, Subpart J, Class B.
4. ISO 9000.
5. NEMA PE-1 – Uninterruptible Power Systems.
6. OSHA – Life Safety Code.
7. IEEE 587 ANSI C 6241.
8. UL 924 – Standard for Safety for Emergency Lighting and Power Equipment.

1.04 QUALITY ASSURANCE

A. Contractor’s Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the work.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

C. Before shipment, the manufacture to fully and completely test the system to assure compliance with the specification.

1.05 SUBMITTALS

A. The manufacturer to supply documentation for the installation of the system, including wiring diagrams and cabinet outlines showing dimensions, weights, BTUs, input/output connection locations and required clearances. Product certificates, signed by the manufacturer of the system, are to be provided certifying that the product furnished complies with the requirement to be provided.

B. The Contractor to prepare and submit to the Commissioner for review before fabrication and assembly of equipment, 1 sepia and 6 prints of each of the following:

1. Shop drawing to show front elevation, rear elevation, section views, and mounting details.
2. The drawings to show the details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connection.
3. Single line diagram of equipment to be provided.
4. Wiring Diagrams:

a. Connection diagrams for the wiring of equipment to be included.
b. Interconnection diagrams to show the wiring to equipment. The terminal block points to be clearly identified for the external wiring that to be routed in or out of the cubicles. The wiring diagrams to provide adequate space for the addition of cable and wire designations for the external wiring to be routed in or out of the equipment at the terminal blocks.

5. Bill of material to include all items with catalog cuts describing the electrical and physical characteristics of each item.

C. The Contractor to submit for record and distribution, after installation of equipment, ten copies of each of the following for each UNINTERRUPTIBLE POWER SUPPLY.

1. All drawings to be as finally reviewed and to include any factory assembly modifications.
2. Recommended installation and storage instructions with any special instructions to be provided.

D. The Contractor to submit for record and distribution, after installation of equipment, ten copies of each of the following for each UNINTERRUPTIBLE POWER SUPPLY.

1. Instruction booklets to include descriptive bulletins and operation leaflets and maintenance procedures.
   a. Each instruction manual to be in a 3 ring hard binder, with tabbed sections. The binder cover is to have the project name and equipment name. The lettering is to be block type and to be a minimum height of ½ inch. The binder edge to have the project name and equipment name and to be visible when stacked on a shelf. The lettering is to be block type and to be in minimum height of ¼ inch.
   b. Each instruction manual to contain the “As Built” drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
   c. The “As Built” drawings larger than 8-1/2 inch by 11 inch to be fan folded.

2. Spare parts bulletins to be included with catalog cuts for each item.
3. Certified test reports to include all assembly and subassembly test and inspection reports.

E. The Contractor to submit 10 copies of any shop drawings and other data sheets that were revised or modified during installation. These will be inserted in the previously submitted instruction manuals.

F. Maintenance

1. Furnish complete operating and maintenance manuals describing the materials, devices and procedures to be followed in operating, cleaning and maintaining the Work. Include manufacturers' brochures and parts lists describing the actual materials used in the Work. Assemble manuals for component parts into single binders identified for each system. Include the following:

a. Instruction booklets must include descriptive bulletins and operation leaflets for the protective relays, control relays, operating switches and maintenance procedures for circuit breakers.
b. Each instruction manual must be in a three ring hard binder with tabbed sections. Binder cover must have the project name and equipment name. Lettering must be block type and must be a minimum height of 1/2".
c. Each instruction manual must contain the "as installed" drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
d. "As Installed" drawings larger than 8-1/2" by 11" must be fan-folded.
e. Spare parts bulletins with catalog cuts for each item.
f. Connection diagrams for external cabling.
g. Equipment internal wiring diagram.
h. Instruction manuals including as a minimum the following:
    1) Installation procedures.
    2) Operation procedures.
    3) Servicing procedures.
    4) Troubleshooting instructions.
    5) Construction Details.
    6) Service Supplement Manual covering all detail servicing requirements.

i. Certified copies of the final test report.

1.06 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type and grade. Store materials in a protected dry location off ground in accordance with the manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

1.07 MAINTENANCE

A. Maintenance and Operating Manuals: Submit for Commissioner's documentation complete manuals describing the materials, devices and procedures to be followed in operating, cleaning and maintaining the equipment.

B. Instructions: Prior to Commissioner's acceptance, establish with the Commissioner an instruction and training program for the Commissioner's personnel. Notify the Commissioner in writing, at least 7 days prior to commencement of the training program and furnish an outline of the instruction topics correlating with the Maintenance and Operating Manual(s). Provide a qualified

instructor and a 6-hour training period scheduled during a normal workday. Instruction and training to include, but not limited to, the following:

1. Use of the Maintenance and Operating Manual(s).
2. Commissioner's responsibilities for maintenance of the warranties.
3. Demonstrating operation in accordance with the Contract Documents.

1.08 WARRANTY

A. Special Warranties:

1. Furnish 3 year written warranty in form stipulated by Commissioner, signed by the Contractor and Installer, agreeing to repair or replace Work which has failed as a result of defects in materials or workmanship. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Commissioner.
2. Batteries to also have a 3 year full unconditional and a 7 year pro-rata limited warranty by the manufacturer that the batteries to operate at full rated capacity without maintenance or service under otherwise normal operating conditions. Warranty is to make such guarantee(s) to the effect that if any battery or cell fails to hold the full rated charge or requires maintenance or service; replace batteries to the satisfaction of the Commissioner.

1.09 TRAINING

A. Equipment manufacturer must provide the factory trained technicians at the job site to provide adequate training for the Authority's personnel in the proper operation and maintenance of the equipment.

B. Training classes must be done at on-site locations selected by the Authority. Equipment manufacturer must provide a "High Quality" training DVD.

C. Equipment manufacturer must provide all video equipment and a video recording of all training classes on a standard DVD. This DVD recording must be submitted to the Authority for review.

D. If the Authority determines that the DVD is not of "High Quality" for the future or refresher training, the equipment manufacturer must make another video recording of another training class at no cost to the City.

E. Equipment manufacturer must provide their service engineer for minimum of 24 man-hours of training which must be provided for each type and size of UPS system.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. UPS system to consist of a UPS module, storage batteries, and a batter disconnect breaker. AC output of the UPS module to be connected to the critical loads. Connect storage battery to the DC input of the UPS module through a battery disconnect breaker.

B. AC power must be connected to the normal source AC input of the UPS module. AC power to be connected to the alternate AC input of the UPS module to provide power to the critical loads during maintenance. Alternate AC input must match the UPS output in voltage, phasing and ampacity.

C. Critical loads are those loads which require regulated continuous AC power and which are connected to the output of the UPS module.

D. UPS system configuration to be a single UPS module rated to supply the full load for a minimum or 90 minutes. Oversizing the UPS to accomplish this rating is not accepted.

E. Equipment to be suitable for installation indoors with ambient temperature range of 0 to 40°C and relative humidity of 0 to 95%, non-condensing.

F. Power components to be sized with 30% or more safety margin to reduce components stress and increase the overall systems useful life.

2.02 SYSTEM DESIGN

A. The UPS to be a 20 year industrial design. System to use components of adequate rating to provide and expected service life of twenty years continuous duty and ten years without component replacement and a 150,000 hours MTBF (mean time between failures). System shall not contain continuously moving parts other than cooling fans which must have permanently lubricated bearing.

B. Provide provisions for testing the control circuits while the critical loads are bypassed to one of the power sources. Adjustments and tests to be possible with the use of a standard volt-ohm-milli-Ampere meter and oscilloscope. Test points and diagnostic lights to be provided to allow easy adjustment of the controls.

C. Control circuits to be mounted on etched circuit boards with plug-in connections for ease and speed or repairs. Printed circuit boards to be conformal coated prior to component mounting as to not inhibit replacement and/or thermal venting properties. As well as to protect against moisture, foreign particles and dust.

D. Cooling to be by natural convection or forced air by fans. If forced air fans are provided, small particulate air filters along with a low air pressure sensor with alarm contacts to be provided.

E. The UPS to be designed to work with a 10 to 20 year life battery

F. UPS to be able to discharge the battery to 90% of charge in 10 times the discharge

G. Strip heaters and fans to be included in enclosure to counter condensation

2.03 SYSTEM OPERATION

A. Under normal conditions the inverter is to supply AC power continuously to the critical loads through the static transfer switch. Inverter output to be synchronized with the alternate AC power source provided that the alternate AC power source is within the specified frequency range. Rectifier-charger to convert the normal AC input power to the DC power for the inverter and for float charging the storage batteries.

B. On loss of normal AC input power, the storage batteries to supply DC power to the inverter so that there is no interruption of AC power to the critical loads whenever the normal AC input power source of the UPS module deviates from the specified tolerances or fails completely. Batteries to continue to supply power to the inverter for the specified protection time.

C. On return of normal AC power source, the rectifier-charger to start and assume the DC load from the batteries. Rectifier-charger to then simultaneously supply the inverter with the DC power and recharge the storage batteries. This to be an automatic function and to not cause disturbance to the critical loads.

D. Transfer to the alternate source to occur when the static transfer switch senses and overload, an inverter shutdown signal, or degradation of the inverter output. Static transfer switch to automatically transfer the critical loads from the inverter output to the alternate AC power source without an interruption or power. If the alternate AC power source is below normal voltage limits, then the transfer to be inhibited.

E. Static transfer switch to automatically retransfer the load back to the inverter after the inverter has returned to normal voltage and stabilized for a period of time. Retransfer to not occur if the two sources are not in phase.

F. If batteries are taken out of service for maintenance, they to be disconnected from the rectifier-charger and inverter by the battery disconnect breaker. UPS to continue to function and meet all the performance criteria specified herein except for the battery reserve time capability

2.04 EQUIPMENT REQUIREMENTS

A. General:

1. UPS battery Inverter System must be UL 924 certified.
2. Enclosure: The UPS module shall be housed in a single free standing heavy-duty corrosion resistant NEMA 1 enclosure. Battery cabinet shall be designed to allow stacking to minimize the overall system's footprint. All equipment shall be front accessible. All components shall have a modular design and quick disconnect means to facilitate field service. The cabinet shall be powder coated (3mm minimum) with the manufacturers standard color. Cabinet doors shall be of heavy-duty construction and will be equipped with 3-point latches. Hardware shall include vault handles with CAT 60 key.
3. Ventilation: Provide as required to ensure that the components operate within their thermal and environmental ratings.
4. Internal Connections: Provide all copper bussing and/or cables.
5. Visual Displays: Provide as required to furnish the operator with instructions necessary to start or shut down the UPS battery Inverter System under both normal and emergency conditions.
6. Cooling of the UPS battery Inverter System shall be forced air in emergency mode with internally mounted fan to minimize audible noise. Fan shall not be required to operate in the battery charge/standby mode under normal conditions. Fan power shall be provided by the inverter system.
7. During normal conditions, the temperature compensated battery charger circuit supplier constant voltage and constant current to the batteries. Once the batteries have received a full recharge, a constant trickle charge maintains batteries at maximum level.
8. The charger shall be capable of producing battery charging current sufficient enough to recharge the fully discharge battery bank within a 24 hour period.

B. UPS Module:

1. UPS module contains the rectifier-charger, inverter, static transfer switch, maintenance bypass switch, controls, instruments and indicators.
2. UPS Input Module:

a. UPS module normal source input to be 208 VAC, three phase, 3 wire.
b. Voltage range to be +10% or -15% with equalizing capabilities.
c. The frequency to be 60 hertz +/- 5%.
d. Current walk-in to ramp up to full load in 15 seconds.
e. Magnetizing sub-cycle inrush current to not exceed four times the maximum peak current during recharge.
f. Current limit to not exceed 125% of full load input current.
g. Power factor to be 0.85 lagging at nominal input voltage Rectifier/Charger

3. UPS Module Alternate Input: 120/208 VAC, 3 phase, 4 wire, 60 hertz.
4. UPS Output Module:

a. UPS output module to be 120/208 VAC, 3 phase, 4 wire, 60 hertz.
b. Power rating to be kVA as shown on the Drawings at 1.0 or unity power factor.
c. Voltage regulation of +/-1% nominal for any of the following conditions:

1) No load to full load.
2) Lagging power factor from 1.0 to 0.8.
3) Minimum to Maximum DC input voltage.
4) Ambient temperature rate from 0 to 40°C

d. Voltage transient response to be 10% maximum deviation (average over 1/2 cycle) with recovery to within 5% after 1/2 cycle for 100% load application or removal.
e. Voltage adjustability to be +/-5%.
f. Voltage unbalance to be 5% maximum, line to line or line to neutral, with 100% load unbalance.
g. Phase separation of 120 degrees +/-5 degrees with 100% load unbalance.
h. Harmonic distortion of 5% total harmonic distortion (THD) maximum for proposed loads.
i. i. Frequency stability to be +/-0.1% free running.
j. j. Frequency slew rate to be 1.0 hertz per second maximum.
k. Frequency adjustability to be +/-2 hertz.
l. Overload capacity of the static bypass switch to be:
1) 125% continuous for 60 minutes.
2) 150% for 10 seconds.
3) 400% for 1 second.

C. Rectifier-Charger:

1. Rectifier-charger converts the normal source of AC input power to DC power for the inverter input and for charging the storage batteries. Rectifier-charger consists of an input circuit breaker, isolation transformer, surge suppressors, and a solid-state three phase rectifier with control circuitry to provide constant voltage-constant current regulation and a ramping current walk-in or start-up of the rectifier-charger.
2. Overcurrent Protection:

a. Rectifier-charger input to be protected by a circuit breaker. Breaker to be equipped with a non-automatic circuit wired to a set of terminal blocks.
b. Rectifier-charger output to be fused and electronically current limited to protect connections to the inverter input to prevent damage to the batteries.

3. Input Transformer:

a. Three phase isolation type with copper windings.
b. Transformer windings designed with extra leakage reactance to minimize notching of the input power lines due to SCR commutations.
c. Transformer core designed to limit subcycle magnetizing inrush currents to four times the maximum peak input currents during battery recharge.
d. Class F transformer winding insulation.
e. Provide surge suppressors on the secondary side of the input transformer to assure proper operation of the input module in the event spikes or surges are present in the normal input power source.

4. Control Circuitry:

a. Equip rectifier-charger with control circuitry to provide constant DC voltage regulation of +/-1% for +/-10% AC input voltage change, for +/-5% input frequency change, and for 10 to 100% load variations.
b. Control circuitry to electronically current limit the output of the rectifier-charger by dropping the DC voltage whenever the DC current exceeds a preset limit.
c. Whenever the AC power is applied to the rectifier-charger, the control circuitry to gradually ramp up the output current over a period of approximately 15 seconds to allow gradual loading of the normal input AC power source.
d. Control circuitry to automatically provide a boost (equalize) voltage after a failure of the normal input AC power. Provisions to be made to also manually initiate equalization. Duration of the equalize charge to be controlled by a 72-hour adjustable solid-state timing circuit.

5. Furnish output filtering within rectifier circuitry to limit ripple currents into the battery.

D. Inverter:

1. Inverter to convert DC power, from either the rectifier-charger or the storage battery, to regulated and filtered AC power which is supplied to the critical loads through the static transfer switch. Inverter to consist of DC filter capacitors, DC surge protection, solid state pulse width modulated (PWM) inverter, and control circuitry providing precise AC voltage regulation and electronically controlled current limiting.
2. Overcurrent Protection:

a. Protect inverter by fast acting fusing to prevent damage to solid-state devices in the inverter bridges.
b. Inverter outputs to be both fused and electronically current limited.

3. Inverter input to have banks of filter capacitors.
4. Inverter input to have DC surge protection to assure proper operation in the event that there are surges or spikes on the inverter input. Inverter input to be protected against a 4000 volt transient for 100 microseconds from a 40 ohm dynamic source impedance.
5. Inverter to be PWM type to minimize the number of power semi-conductors for increased reliability and to provide improved transient response.
6. Provide isolation type output transformer with copper windings and type F insulation.
7. Inverter to have a output filter to limit the total harmonic distortion (THD) of the output voltage to the specified limits.
8. Control Circuitry:

a. Provide control circuitry for constant AC voltage regulation as specified.
b. Control circuitry to electronically limit the output of the inverter by dropping the AC voltage when the output current exceeds a preset limit.

c. Circuitry to provide a low voltage initial start-up of the inverter and ramp up to full voltage in less than 5 seconds.
d. Control circuitry to automatically synchronize and phase lock the inverter output to the alternate power source as long as the source is within 60 +/-0.2 hertz. If alternate power source is not within these limits, then control circuitry to break synchronization and lock to an internal oscillator.
e. Control circuitry to interface with DC low voltage sensor and turn off the inverter at the 1.75 volts per cell level to prevent damage to the battery.
f. The inverter to shut down on a short to a battery.
g. Test points to be provided to facilitate adjustments and diagnosis.
h. Provisions to be made for easily testing logic circuitry without operating the power circuits.
i. Place light emitting diodes on the circuits for verification of operation.

E. Static Transfer Switch:

1. Static transfer switch to automatically transfer critical loads, without interruption, form the inverter output to the alternate AC power source and vice versa in the event of an overload or degradation of inverter performance.
2. Static transfer switch to consist of two pairs of Silicon Controlled Rectifiers (SCR's) per phase with each pair connected in inverse parallel (back to back). One set of SCR's to be connected to the inverter while the other set of SCR's is connected to the alternate, or bypass, power source. The outputs of the two sets of SCR's to be connected together and to furnish power to the critical loads.
3. If inverter is out of normal limits due to fast or slow under voltage or due to over voltages, the static transfer switch to turn on the alternate source of SCR's to provide power to the loads from the alternate power source. At the same time, the inverter power source to be turned off to prevent the alternated power source from back feeding power to the inverter. If the alternate power source is not within the normal voltage limits, then the transfer to be inhibited.
4. Static transfer switch to automatically retransfer the load back to the inverter after the inverter has returned to normal voltage and stabilized for a period of time. This function to be selected by a switch on the system panel. Retransfer to not occur, where initiated manually or automatically, if the two sources are not in phase.
5. If an overload is detected, the static transfer switch to operate.
6. Place fuses in the inverter and alternate sources of the static transfer switch.
7. Static transfer switch to have a surge protection on the alternate source side.
8. Static transfer switch to transfer from the inverter to the alternate power source for the following conditions:

a. Inverter under voltage, on any phase, to be 90% of nominal.
b. Inverter over voltage, on any phase, to be 110% of nominal.
c. Inverter over load to be on any phase.
d. Blown fuse in the inverter.
e. Manual signal.

9. Static transfer switch to inhibit transfer to the alternate source if the alternate source voltage is less than 80% of nominal on any phase.
10. System to automatically retransfer the load to the inverter provided all of the following conditions are met:

a. Inverter and the alternate source to be in phase.
b. Inverter voltage to be within +/-10% of nominal for more than five seconds on all phases.

11. Maximum transfer sensing time for loss of inverter voltage to be 1/4 cycle.

12. Maximum transfer time to switch from inverter to alternate power source to be 100 microseconds.

F. Maintenance Bypass Switch:

1. Maintenance bypass switch to connect the alternate AC power source to the critical loads while electrically isolating the static transfer switch and inverter for the maintenance purposes.
2. Provide a manually operated maintenance bypass switching arrangement which permits bypassing critical loads to the alternate AC power source without interruption of power to those loads, and at the time, electronically isolates the static transfer switch and inverter form the alternate power source.
3. Switch will not be able to be turned to bypass position unless the UPS is being fed from the alternate source.

G. Battery System:

1. Storage batteries to supply DC power to the inverter input when the normal AC input power to the UPS module fails or the rectifier-charger fails.
2. Battery voltage system to be as required by the inverter.
3. Size battery system to operate for 2 hours at 25°C at full inverter output rating.
4. Battery Enclosure:

a. Each battery cabinet to be sized to accommodate replacement batteries.
b. There is to be a minimum of a 9 inch clearance from the top of any battery terminal to the bottom of any shelf above.
c. Shelf width to be one more battery width than the battery quantity that is being installed.
d. Shelf depth to be one more battery depth than the battery quantity that is being installed.
e. Batteries to be housed in a separate enclosure from the UPS.
f. Battery shelves to be of the drawn out type to the width/depth of the shelf.

5. Batteries to be a 20 year rated lead calcium, non-hydrogen emitting, maintenance free, VRLA type rated at 2.25VPC with as many batteries as necessary to make up the DC buss voltage of the UPS.
6. Operate each battery in temperatures from 0°C to 40°C. Battery system to supply sufficient power to provide 90% of nominal specified inverter output performance while operating in 0°C ambient temperature. Battery to be able to safely operate from 0-40°C.
7. Battery voltages to be as follows:

a. Floating: 2.25 volts per cell.
b. Boost (equalize): 2.40 volts per cell.
c. End cell voltage to be no less than 1.75volts per cell.

8. Furnish storage batteries with racks connecting hardware, and standard service accessories. Deliver the batteries charged and filled, ready for service.
9. Battery Terminations:

a. Batteries to be interconnected using flexible jumper cables. Bus bar connections to not be allowed.
b. Batteries to have top mounted terminals. Terminals to be either 5/16 or 3/4 type terminal connection, flat top.

10. Verify that battery cabinet fits in the designated room.

H. Battery Disconnect: Battery disconnect to be a molded case circuit breaker used to electrically isolate the storage battery from the UPS module for maintenance purposes and to provide overcurrent protection at the storage battery output. The breaker to be equip0ped with a non-automatic circuit wired to a set of terminal blocks. The breaker to be integral to the UPS module.

2.05 CONTROLS

A. The following controls to be included in the UPS module cabinet for the Rectifier-Charger. Each pushbutton to be oil-tight, heavy duty.

1. Input non-automatic circuit beaker
2. DC Float voltage adjustment
3. DC boost (equalized) voltage and adjustment
4. Boost (equalized) voltage timer adjustment
5. Boost (equalized) voltage timer initiate pushbutton
6. Boost (equalized) voltage timer reset pushbutton

B. Inverter to have the following controls:

1. Inverter start pushbutton
2. Inverter stop pushbutton
3. DC input under voltage shutoff adjustment
4. Output AC voltage adjustment

C. Static transfer switch to have the following controls:

1. Test Transfer Switch
2. Transfer setting adjustment
3. Maintenance bypass switch

2.06 METERS

A. Analog Meters to have a minimum accuracy of 2% at full scale deflection. Measure the following parameters individually:

1. DC Voltage of the rectifier-charger.
2. DC Current of the rectifier-charger.
3. AC voltage:

a. Inverter
b. Alternate source
c. Load

4. AC Current of the load.
5. AC Frequency:

a. Inverter
b. Alternate Source
c. Load

2.07 STATUS AND ALARM INDICATORS.

A. Each indicating light to be of the light emitting diode (LED) type. A push to test pushbutton to be provided to test all the indicating lights. A complete mimic bus to be provided on the front of the panel. Monitor and display the following status and alarm functions on the front of the UPS module cabinet.

1. Status Indicators:

a. Synchronization monitor
b. Static transfer switch inverter position

2. Alarm Indications: Provide flashing displays for the following with latching memories which persist until manually reset by pushbutton after alarm has cleared.

a. On Battery
b. Low Battery
c. Over Temperature
d. DC Over Voltage
e. DC Ground
f. Sync Disconnect
g. Alternate Source Failure
h. Static Transfer Switch in Alternate Source Position
i. Air Filter Clogged
j. AC Input Power Failure
k. AC Output Power Failure
l. Inverter Failure Alarm.

2.08 ALARM FUNCTIONS

A. The following functions to have alarm contact 4-20 millamp rating available for connection to the remote alarm system. Alarms to latch until reset after the alarm condition has cleared.

1. “UPS” On Battery
2. “UPS” Low Battery
3. “UPS” Over Temperature
4. “UPS” Alternate Source Power Failure
5. “UPS” Common Trouble Alarm
6. “UPS” Air Filter Clogged
7. “UPS” AC Input Power Failure
8. “UPS” AC Output Power Failure
9. “UPS” Open/Short Battery
10. Inverter Failure Alarm
11. Static Switch Activated Alarm

2.09 ENCLOSURE CONSTRUCTION

A. Each enclosure to be a 14 gage steel enclosure with minimum 11 gauge welded steel frame construction NEMA Type 1 requiring access from the front only for all servicing adjustments and connections. Front access to be through a hinged door with a tumbler lock and 3-point latching

door handle. Enclosure door to be constructed of 12 gage steel. Rear -hinged doors to be provided for access to the rear.

B. Enclosure to be primed and painted inside and outside with semi-gloss enamel. Paint color to be manufacturer's standard. Enclosure to stand on lockable casters with removable side and back panels to provide flexibility of installation configuration.

C. UPS enclosure to be provided with a lining with sound deadening insulation.

D. Modules and subassemblies to be mounted in open construction style so that each may be easily replaced. Equipment to be constructed so that each power component can be replaced without a soldering iron or special tools.

E. Cable and conduit connections to be through the top of the cabinet.

F. Cooling to be by natural convection or forced air by fans. If forced air fans are provided, small particulate are filters along with a low air pressure sensor with alarm contacts to be provided

2.10 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Completely assemble, wire, adjust and test equipment at the factory. Rigid inspection before and after assembly to assure correctness of design and workmanship. After assembly, test each UPS system for operation under simulated conditions.
2. The main circuits to be given a dielectric test of 2200 volts AC for one minute between live parts and ground, and between opposite polarities. The working and control circuits to be given a dielectric test of 2200 volts AC for one minute between live parts and ground in accordance with ANSI C37.20.1.
3. Perform a complete set of tests at the factory. Tests include a manufacturer's standard and commercials test, and specific tests as specified, and a complete simulated operational test of the equipment to guarantee successful operation.

B. Factory Witness Testing:

1. Authority will witness test of this equipment at any time during manufacturing, assembling and/or testing. Provide advance notice of a minimum of six weeks prior to the schedule of factory testing to the Authority.
2. Include living, lodging, and transportation expenses for 4 representatives of the City of Chicago for witnessing factory tests. Living expenses to include meals, transportation, motel or hotel (similar or equal in quality to Holiday Inn Motels) for 2 nights, and a car when inspection facilities are out of the City of Chicago.

2.11 SPARE PARTS

A. Spare parts to be provided as listed in manufacturers spare parts recommended list.

2.12 MANUFACTURERS

A. Manufacturers which may be incorporated in the Work include but not limited to DSPM, Chloride, Cyberex, Controlled Power Co., Erickson Electric, or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine the areas to receive the equipment and the conditions under which the equipment to be installed. Contractor is to remedy conditions detrimental to the proper and timely completion of installation. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. The Contractor to install all equipment per the manufacturer's recommendations and the Contract Documents.

B. Verify measurements and dimensions at the project site and coordinate with the other trades. Install at locations shown on drawings. Use procedures that will prevent damaging or soiling the equipment during installation.

C. Install system components on concrete base. Anchor equipment to concrete base according to equipment manufacturer's written instructions.

D. Construct concrete base of dimension indicated, but not less than 4 inches (100mm) high and 4 inches (100mm) larger in both directions than supported unit.

E. Interconnect system components. Make connections to supply and load according to manufacturer's wiring diagrams, unless otherwise indicated.

F. 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 and UL 486B.

G. Ground equipment according to Section 261900 "Grounding and Bonding"

H. Final adjustments to the equipment to include verification of the proper mechanical operation, verification of the instrument operation and setting of the protective devices.

3.03 SERVICE ENGINEER

A. The equipment manufacturer to provide a qualified factory trained service engineer to provide technical direction for the installation and final adjustments of the equipment.

B. Furnish a signed field service report after equipment is operational.

C. Service engineer to certify that the equipment has been installed in accordance with the manufacturer's recommendations.

D. Service engineer to be available as long as his services are requested but in any case, he/she to be available for a minimum of four 8 hour working days for each UPS System.

3.04 FACTORY FIELD SERVICE

A. The equipment manufacturer to provide factory direct trained service engineers. Third party service not allowed.

B. Emergency on site response 2 hour maximum during the warranty period.

C. Spare parts to be stocked locally by the manufacturer within 50 miles of the job site.

D. Factory direct service engineer to certify that the equipment has been installed in accordance with the manufacturers recommendations.

3.05 FIELD QUALITY CONTROL

A. After UPS is installed and electrical circuitry has been energized, test for compliance with requirements.

B. Testing: Perform the following field quality-control according to manufacturer's written instructions and as listed below, to demonstrate condition and performance of each component of UNINTERRUPTIBLE POWER SUPPLY.

1. Site testing to be provided by the manufacturer's field service personnel. Site testing to consist of a complete test of the UPS system and associated accessories. A full load power test including a partial battery discharge test to be provided as part of the standard start-up procedure. This to be accomplished without disturbing existing wiring and completed prior to operation of the site critical load from the UPS output. Test results to be documented, signed and dated for future reference.
2. Conduct a megger test on the completed equipment grounding system at the system ground bus to endure that the ground resistance does not exceed 5 ohms without chemical treatment or other artificial means
3. Inspect interiors of enclosures for integrity of mechanical and electrical connections, components.
4. Test manual and automatic operational features and system protective and alarm functions.
5. Test communication of status and alarms to remote monitoring equipment.
6. Test communication of status and alarms to remote monitoring equipment.

C. Remove malfunctioning unit(s), replace with new unit(s), and retest as specified above.

3.06 ADJUSTING

A. Upon completion of the Work, replace Work which is damaged or fails to operate as specified. Replace fuses blown during construction.

3.07 CLEANING

A. Upon completion of the Work, remove unused materials, debris, containers and equipment from the project site. In addition to the initial cleaning procedure required, and not more than 2 days before occupancy by the Authority, clean the Work as recommended by the manufacturer.

3.08 PROTECTION

A. Protect the Work during the construction period so that it will be without any indication of use or damage at the time of acceptance.

3.09 TRAINING

A. Prior to CTA's acceptance, establish with the CTA an instruction and training program for the CTA's personnel. Notify the CTA in writing, at least 7 days prior to commencement of the training program and furnish an outline of the instruction of topics correlating with the maintenance and Operating Manual(s). Provide a qualified instructor and a minimum of 8 hour training period scheduled during a normal workday. Instruction and training to include, but not limited to, the following:

1. Use of the Maintenance and Operating Manual(s).
2. Commissioner's responsibilities for maintenance of the warranties.
3. Demonstrating operation in accordance with the Contract Documents.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of UNINTERRUPTIBLE POWER SUPPLY will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of UNINTERRUPTIBLE POWER SUPPLY is to be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 40 00

SERVICE EQUIPMENT - PASSENGER STATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This Section specifies the incoming electrical service equipment required under this Contract.

1.03 RELATED WORK

A. Service equipment – passenger stations specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260500 "Raceway and Boxes"
2. Section 261230 "Wires, Cables, Splices, Terminations."
3. Section 261950 "Identification"
4. Section 262116 "Electrical Utility Service"
5. Section 264600 "Dry Type Transformers"
6. Section 269500 "Electrical Testing"

1.04 REFERENCES

A. UL 489 Low-voltage power circuit breakers.

B. UL 891 Dead Front Switchboards.

C. UL 489 Molded Case Circuit Breakers

1.05 ELECTRICAL SERVICE CHARACTERISTICS

A. Two incoming services, designated "Source 1" and "Source 2", from two separate Commonwealth Edison Company (ComEd) sources are to be furnished.

B. The ComEd incoming service will be 120/208Y volt, 3 phase, 4 wire, grounded or as shown on the drawings for elevated stations.

C. The station distribution system voltage to be 120/208Y volt, 3 phase, 4 wire. The Service ground for elevated stations to be the elevated structure or as shown on the Contract Drawings. It is imperative that on elevated stations, to maintain stray current isolation, all necessary precautions must be taken to assure equipment grounding is isolated from earth ground. The service ground for grade level or below grade level stations to be earth ground as shown on the Drawings.

D. Available short circuit current to be obtained by the Contractor from ComEd and incorporated into the new service equipment as applicable.

1.06 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

B. The Contractor shall prepare and submit to the Commissioner, for review, before fabrication and assembly of equipment, shop drawings and other submittals including, but not limited to, the following:

1. Shop drawings showing the elevations, section views and mounting details of the equipment.
2. Shop drawings for the equipment showing components, fabrication and installation. All dimensions for rough in work at the site shall be provided. The drawings shall show the supports for the installation of the equipment which shall be provided as part of this Specification.
3. The shop drawings shall show the details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
4. Wiring Diagrams:

    a. Connection diagrams for the wiring of equipment shall be included.
    b. Interconnection diagrams shall show the wiring to equipment. The terminal block points shall be clearly identified for the external wiring which shall be routed in or out of the cubicles. The wiring diagrams shall provide adequate space at the terminal blocks for the addition of cable and wire designations for the external wiring to be routed in or out of the equipment.

5. Bills of material shall include all items with catalog cuts describing the electrical and physical characteristics of each item.
6. Contractor shall check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the specifications and drawings. This statement shall also list all exceptions to the specifications and drawings. Shop drawings not so checked and noted shall be returned.

7. The Commissioner's check shall be for conformance with the design concept of the project and compliance with the specifications and drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Contract Documents.
8. All dimensions shall be field verified at the project site and coordinated with the work of all other trades

C. The Contractor shall submit, for record and distribution in accordance with the Division 01 Sections, Project Closeout prior to shipment of the equipment, copies of Instruction, Operation and Maintenance manuals for the equipment.

1. Operation and Maintenance manuals shall include descriptive bulletins and operation leaflets for the equipment.

   a. Each Instruction, Operation and Maintenance manual shall be in a three ring hard binder with tabbed sections. The binder cover shall have the project name and equipment name. The lettering shall be block type and shall be a minimum height of 1/2 inch.
   b. Each Instruction, Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
   c. The "Record Document" Drawings larger than 8 1/2 inches by 11 inches shall be fan folded.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

D. The Contractor shall submit shop drawings and other data sheets that were revised or modified during installation; in accordance with Division 01 Sections, Project Closeout. These will be inserted in the previously submitted instruction manuals.

E. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.07 QUALITY ASSURANCE

A. Contractor is solely responsible for quality control of the Work.

B. Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State, and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

C. The switchboard must bear a UL 891 label. Certified copies of production test reports must be supplied demonstrating compliance with these standards.

D. The switchboard must comply with latest edition of the Chicago Electrical Code.

1.08 QUALIFICATIONS

A. The manufacturer of this equipment must have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Authority, and acceptable list of installations with similar equipment must be provided demonstrating compliance with this requirement.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instruction. Do not open packaging nor remove labels until time for installation.

B. Any areas or facilities used by the Contractor for storage of materials for deliveries to the CTA shall be climate controlled, and secured dry locations off the ground. Relative humidity shall not exceed 70 percent.

C. All materials shall be delivered to the location specified by the Authority. The Contractor shall provide all labor, tools, and material handling of equipment needed to safely deliver the equipment to Commissioner's location.

D. The Contractor shall follow manufactures guidelines for delivery and storage of equipment. Care shall be taken to not damage any of the equipment or components. Contractor shall provide all packaging required to protect the equipment during delivery and storage.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Each low voltage switchboard assembly shall consist of circuit breakers, necessary bus, metering and associated equipment specified and installed where shown on the Drawings.

B. The Contractor shall contact the Commonwealth Edison Company (COMED) and shall comply with the current COMED standards and methods of installation.

C. It shall be the Contractor's responsibility to contact the appropriate personnel within COMED to determine the exact nature of work involved. See Specification Section 26 21 16 for COMED contact information.

D. The Contractor shall coordinate and arrange for COMED service, arrange for permits and shall install all necessary equipment as required, to provide electrical power. The Contractor shall submit the required shop drawings to COMED.

E. The Contractor shall obtain the approval of the City of Chicago Bureau of Electrical Inspection and COMED for the switchboard assembly. This shall be obtained at the same time the shop drawings are submitted to the Commissioner for review.

2.02 GENERAL

A. The Contractor to provide the Commonwealth Edison Company metering CT switchboard, metering sockets, and interconnecting conduit as indicated on the Drawings.

B. Each switchboard must consist of breakers, copper bus, and accessories, as shown on the Drawings, mounted on metal frames, complete with all electrical connections and completely enclosed within sheet metal housings.

C. The arrangement of the breakers must be the equipment manufacturer's standard arrangements.

D. The main current carrying parts, insulators, supports and housings must have sufficient mechanical strength to withstand, without incurring damage, the effect of any momentary current resulting from a three-phase, line-to-line or line-to-ground short circuit.

E. The front and rear of each unit of each switchboard must be in continuous alignment.

F. Each switchboard must be provided adequate lifting means on the top of the shipping assemblies for lifting or moving the equipment into the final installation position and bolted directly to the channel iron bases. Provision must not necessitate disassembly of the equipment.

G. The Contractor shall include an allowance for ComEd fees in the Base Bid for these items as specified in Division 1 and the proposal of the specifications under the title ComEd Service Charge Allowance.

2.03 SWITCHBOARD

A. The Contractor to provide, for the "Source 1" Service, a free-standing dead-front type, front accessible, low voltage metering switchboard with a incoming service main breaker, and barriered CT compartment as required. Unmetered sub feed breaker with separate meter fitting for concession service maybe included. This breaker is to be fed from the Source 1 service conductors. (Line side of main breaker).

B. Incoming services shall consist of hot sequence service ComEd approved. Final location of ComEd current transformers will be as shown on the Contract Drawings. ComEd equipment is to be located in the station electrical room accessible by authorized personnel only.

C. Source 1 and Source 2 incoming service main breakers shall have microprocessor based tripping system, auxiliary contacts and trip alarm contact as specified herein.

D. Source 1 and Source 2 services shall be provided with 208/120 Volt three phase voltage monitoring relay and ground fault protection. Relay shall be solid state control with isolated contact outputs, and with adjustable pick up and drop out voltage settings. Relay to drop out on under-voltage or phase loss conditions and be self-resetting upon return to normal voltage conditions. Voltage sensing

connections to be provided with current limiting control fuses and be connected to line side of service breaker. Indicating contact to be connected to station alarm and interface terminal compartment to indicate utility under voltage or phase loss condition.

1. One complete set of spare control fuses to be included, identified and mounted within the enclosure.

E. Each switchboard must be dead front type, completely metal enclosed, self-supporting structure independent of wall supports. It must consist of the required number of vertical sections bolted together to form one rigid switchboard. The sides must be covered with removable screw-on plates. All edges of front covers or hinged front panels and rear hinged doors must be formed.

F. Each switchboard must comply with the latest applicable standards for dead front switchboard and must be UL labeled, and must meet City of Chicago Code Requirements.

G. Supporting frames with sheet metal enclosures must be designed and fabricated to form rigid self-supporting structures that will withstand, without damage, the installation and service conditions for which the equipment is specified.

H. The following must be included for each switchboard incoming line.

1. Three current transformers for metering must be provided with the primary ratio equal to the main bus ampacity.
2. One microprocessor metering-protection unit must be provided.
3. Control Power transformer with primary disconnect and primary and secondary overcurrent protection.
4. Potential transformers must be provided for additional devices, must be front accessible, and must have adequate capacity for the loads. They must be protected by fused disconnect of a design that interrupts all phases at the same time.

I. Each 600 Volt secondary switchboard must have the following ratings.

1. The rated nominal voltage must be 120/208 Volts.
2. The rated maximum voltage must be 600 Volts.
3. The rated frequency must be 60 Hertz.
4. The breaker Ratings on a Symmetrical Basis at 480 Volts AC must be as follows:

    a. Each breaker must have an interrupting rating of 100,000 symmetrical Amperes. This must be accomplished without current limiters. Each circuit breaker must fully clear faults within its current limiting range in less than one cycle, and reduce the peak let through current to a value less than the prospective available.

5. Bus Rating (Main and Neutral):

    a. The rated continuous current must be as shown on the Drawings.
    b. Momentary current (Amperes RMS symmetrical) of 100,000.
    c. The temperature rise at rated current, above outside ambient

temperature of 40 degrees C, must conform to UL 891.

6. The control bus must be 120 Volts AC.
7. The current transformer minimum mechanical limit must match the switchboard UL short circuit rating.
8. The neutral bus must be full capacity, must be the full length of the switchboard, and must be solidly grounded with rigid copper ground bus and provided with a neutral disconnect link.
9. The bus material must be copper.
10. All structures must have top cable entrance accommodations. All cables that enter from the top and bottom must have a removable cover section for drilling in the field.
11. Bottom plates must be provided.
12. Switchboard must be service equipment rated.
13. All wires must be installed in such a manner that will not interfere racking in and out of the breakers.
14. Control wires installed vertically must be installed in a vertical chase, separate from the breaker compartment. Control wires must be free and clear of racking area of the breaker.
15. A mimic bus nameplate must be screw mounted to the front of the switchboard.
16. The electrical distribution single line diagram shall be embossed on 24″ by 36″ plastic and mounted to Main Electrical Room wall. Provide multiple panels as needed to clearly show all of the distribution single line.

J. Construction

1. Each switchboard must be complete with low voltage insulated case circuit breakers. The entire assembly must be suitable for 600 Volts maximum AC service.
2. Current transformers for feeder instrumentation or relays must be located within the appropriate breaker cells.
3. The stationary part of the primary disconnecting devices for each insulated case circuit breaker must consist of a set of contacts extending to the rear through a glass polyester insulating support barrier.
4. Corresponding moving finger contacts suitably spaced must be furnished on the power circuit breaker studs which engage in only the connected position.
5. The assembly must provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit breaker must include the necessary 3 phase bus connections between the section bus and the breaker line side studs.
6. The secondary disconnecting devices must consist of floating fingers mounted on the removable unit and engaging flat contact segments at the front of the compartment. The secondary disconnecting devices must be silver-plated and of the sliding contact engagement type. They must be maintained in the "connected" and "test" positions.
7. The removable power circuit breaker element must be equipped with disconnecting contacts, wheels and interlocks for draw-out application. It must have four positions, "connected", "test", "disconnected" and "removed", all of which permit closing the compartment door. The breaker draw-out element must contain a worm gear levering "in" and "out"

mechanism with removable lever crank. Mechanical interlocking must be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell.

8. An automatic insulated shutter system must be provided to close off the energized line side stationary stabs when the breaker is not in the connected position.
9. A glass polyester full height and depth barrier between adjacent vertical structures in the bus compartment with appropriate slots for the main bus must be provided.
10. Supports must be provided for all power cables. Supports must be arranged so that any cable is supported every 4 feet or less.
11. All cable must enter from the top or bottom. Provisions to support incoming leads and sufficient room to terminate must be provided.

K. Enclosure

1. Each enclosure must be of indoor construction.
2. Space heaters with suitable thermostats and humidistats must be installed in each enclosure to provide protection against the effects of moisture and low temperatures. The space heaters must be rated to operate on 120 Volts.
3. The space heaters must be controlled from an "ON-OFF" switch, thermostat, and humidistat, all wired in parallel. The thermostats must have a 35 degrees F minimum setting. The humidistats range must be 20 percent to 80 percent, 3 percent differential.
4. Temporary power for the space heaters must be wired to separate terminal blocks for an external source. A maximum of 1200 Watts must be provided for each circuit. Heaters must be energized during the construction period only. After room space heaters have been energized and operating, temporary power must be removed. No permanent 120 volt power for space heaters is required.

L. Bus and Insulators

1. The size, material and arrangement of the bus bars, connections, conductor insulators and supports will be reviewed as part of the shop drawings before fabrication.
2. Main bus and conductors must be copper, ASTM B 187, 98 percent conductivity with maximum current density of 1,000 Amperes per inch. The bus must be capable of carrying the maximum load continuously.
3. All bus connections and joints must have a minimum of two bolts for copper bus bar sizes 3 1/2 inches and smaller. A minimum of four bolt connections must be provided for copper bus bar sizes 4 inches and larger.
4. All copper bus bar joints and connections must be full lapped or have been UL witness tested and approved by the City of Chicago Bureau of Electrical Inspection as equivalent of full lapped joints. All nuts, bolts, studs, and washers must be yellow zinc DI-Chromate plated. A Belleville washer must be used on each bolt or stud. Copper bus bars must be silver plated at all joints.
5. Bolted bus bar joints and all main and auxiliary contacts must be silver plated.

6. Insulators and supports must be braced to prevent displacement due to stresses incident to short circuits. All bus bars must be insulated. Insulation must be minimum hygroscopic.
7. Connections for cables to outgoing services must be extended to allow for accessibility with the switchboard energized. The necessary conductor details and supports must be provided.
8. The bus must be protected against damage from expansion and contraction due to load and temperature changes when the housings are assembled in groups.
9. A ground bus must be installed in each structure and bolted to each section of it. The ground bus must be capable of carrying short circuit current of a magnitude and duration corresponding to the short time rating of the largest circuit breaker in the switchboard, but the ground bus dimensions must in no case be less than 0.25 inch by 2 inch copper. Grounding devices must be provided which effectively ground the frames of all switches and other removable devices. Mechanical cable connector must be provided at two locations within the switchboard for grounding. Provide disconnecting link in the grounded conductor on the line side of the service main circuit breaker per CEC Art. 384.11.g.
10. Provisions for future bus extensions at the end of the assembly must be closed with both an exterior panel and an internally secured barrier.
11. A full capacity neutral bus must be provided.

M. Circuit Breakers for Mains and Tie - 600 Volt

1. All protective devices must be low voltage insulated case circuit breakers. Frame ratings must be as shown on the Drawings. All breakers must be 100 percent rated.
2. Each circuit breaker must be a three-pole, single throw, air break, supported on a frame and designed to be rigidly connected to the housing in the operating position. Each breaker must be removable from the front of the compartment. It must be possible to close a door with its associated breaker in the connected and disconnect positions. There must be provisions for padlocking each breaker in the tripped position and disconnect position.
3. Branch breakers must be manually operated (M.O.). Main breakers and tie breaker must be electrically operated (E.O.) as shown on the Drawings.
4. Each circuit breaker must have an operations counter and an over current trip switch (OTS). Each OTS contact must be Form C and must be wired to terminal blocks.
5. Electrically Operated Breakers

    a. Each service entrance breaker and tie breaker must be electrically operated.
    b. Each electrically operated breaker must be complete with control switch and with red and green indicating lights to indicate the breaker contact position. Each E.O. breaker must have a set of cell switches to by-pass the control circuits when the breaker is removed.
    c. Each electrically operated circuit breaker must be equipped with the following:

        (1) The control relay, which must be the trip-free type, must be

connected so that the closing circuit must be de-energized after the breaker is closed regardless of the position of the control switch. The closing circuit must not be de-energized until the circuit breaker has had ample time to complete the operation of closing. It must be impossible to again energize the closing circuit until the breaker switch has been moved to the neutral position.

(2) Truck operated cell (TOC) switches must be provided to automatically by- pass the circuit breaker interlocking such as (anti-paralleling) only when the circuit breaker is in the test position.

(3) A rotary type auxiliary switch must be included.

(4) A lamp indicator or a target must be located so that the position of the breaker, open or closed, must be indicated without opening the compartment door.

(5) Each circuit breaker control circuit must have two main fused circuits. One fused circuit must be for the circuit breaker closing operation and the other must be for the circuit breaker tripping operation.

6. Each insulated case circuit breaker will be equipped with a solid-state microprocessor-based tripping system consisting of three current sensors, solid-state microprocessor trip device and flux-transfer shunt trip. The tripping system for each breaker must have the following specified features.

   a. Each trip unit must use microprocessor-based technology to provide the basic adjustable time-current protection functions. True RMS sensing circuit protection must analyze the secondary current signals received from the circuit breaker current sensors and must initiate trip signals to the circuit breaker trip actuator when predetermined trip levels and time delay settings are reached. All power from the tripping function must be taken directly from the load or fault current. Interchangeable rating plugs must establish the continuous trip ratings of each circuit breaker.

   b. Each trip unit must have an information system that provides LED's to indicate mode of trip following an automatic trip operation.

   c. Each trip unit must provide a series of energy-monitoring parameters including peak demand, and energy consumption values.

   d. Each trip unit must be provided with a display panel that indicates the protection function settings. The unit must be continuously self-checking and must provide a visual indication that the internal circuitry is being monitoring and is fully operational.

7. Each circuit breaker mechanism must absorb any shock incident to the operation of the breaker with a minimum of vibration and noise.

8. The following individually adjustable solid-state elements must be provided as an integral part of each solid-state trip device.

   a. All breakers must have long time delay current pick-up from 0.5 to 1.0 times the rating plug value. Long time delay must be from 2 to 24 seconds at 6 times the rating plug value.

   b. Each feeder breaker must have instantaneous pick-up from 2 to 6

times the rating plug value and two variable settings depending on the rating plug size.

c. Each breaker must have short time delay pick-up from 2 to 6 times the rating plug value with two variable settings depending on the rating plug size, and short time delay having flat response settings of 0.2, 0.4, and 0.5 seconds and I2T setting 0.1 and 0.3 seconds.

d. Each breaker shall be equipment with ground fault relay.

e. LED's must be provided for indication of which function, overload, short delay, instantaneous or ground fault caused a trip operation. Rating plus must include a 40 hour rated lithium battery with push to test button and battery check LED to provide power for indicating LEDs.

9. When the adjustable instantaneous setting is omitted, the trip unit must be provided with discriminator or making-current release circuit to prevent closing the circuit breaker on a faulted system. The circuit must be armed for approximately eight cycles and must operate for all fault levels above eleven times the ampere value of the sensor.

10. The trip unit system must have the following additional features:

    a. A four digit alpha-numeric display must be provided as part of the trip unit and must indicate the instantaneous value of maximum phase and ground current, the approximate level of fault current that initiated an automatic trip operation, and the energy monitoring parameters including peak demand, present demand, and energy consumption.

    b. Each trip unit must contain an integral means to conduct circuit breaker tests. A potentiometer must be provided to enable the operator to select the values of these currents within the range of available settings. The basic protection functions must not be affected during test operations. The test must be selectable between "TRIP" and "NO TRIP" test positions. An auxiliary power module must be provided for testing the trip unit in the breaker "Disconnected" or "Withdrawn" positions.

    c. An automatic trip/demand relay must be provided. This device must provide alarm, lockout and demand relay contacts.

    d. A potential transformer module must be supplied to provide control power for operating the display, internally mounted signal relays and LEDs.

    e. Each trip unit must be equipped with a product interface card to permit communication through a network twisted pair for remote monitoring and control.

11. Contact devices must be provided on the breaker mechanisms and housings such that when a breaker is placed in either the operating or test position in the housing, all control circuits on the breaker must be connected.

12. Provisions must be made for manual operation of circuit breakers from the front of the housing without opening the breaker compartment. Electrically operated circuit breakers must be manually operated by a "lockout-open-close" switch. This switch must only be functional when the "Automatic-

manual" switch is in the "manual" position. These switches are described below.

13. In the case of "stored energy" breakers, anti-pumping or tripping arrangements must not prevent the immediate restoration of the "stored energy" after a closing operation. In some cases, automatic control may call for "close" at the time when manual control initiates a "trip". Breaker must then immediately reclose upon release of the trip circuit.
14. All manually operated circuit breakers must be equipped with a "stored energy" type of closing mechanism.
15. One microprocessor-based, panel-mounted Assembly Electronic Monitor (AEM) must be mounted on the switchboard group and must be wired to each breaker with twisted pair wire.

    a. The AEM must be capable of displaying the following parameters for each individual breaker selected by means of "Address" step up and step down buttons:

        (1) Circuit breaker status.
        (2) AC current for each phase and grounds.
        (3) Cause of circuit breaker trip.
        (4) High load condition when current through the circuit breaker exceeds 85 percent of the long time delay setting for at least 40 seconds.

    b. The AEM must be capable of storing cyclically the following parameters for 3 alarmed breakers:

        (1) Circuit breaker address.
        (2) Circuit breaker status.
        (3) Cause of trip, if tripped.
        (4) Phase with a value of current that caused the trip, if tripped.

    c. Each AEM must include a separate Form C, normally open/normally closed, contact for remote alarm along with an Acknowledge/Reset pushbutton to acknowledge the alarm. The contact rating must be 10 amperes resistive as 120 volt AC. All contacts must be wired to terminal blocks.

        (1) The pushbutton must de-energize the alarm relay to silence the remote alarm.
        (2) The pushbutton must change the alarm LED from flashing to steady on.
        (3) The pushbutton must stop cycling the alarmed breakers.

    d. In addition to the above indicated displayed parameters, the following additional parameters must all be capable of being transmitted through a twisted pair wire to a standard IBM compatible remote computer:

        (1) Circuit breaker type.
        (2) Current rating of circuit breaker rating trip plug.
        (3) Power in megawatts.
        (4) Peak power demand.

(5) Energy used in megawatt hours.
(6) Breaker trip unit in test mode.
(7) Long delay pick-up - overload in progress.
(8) Missing or defective rating plug.
(9) Unit failed RAM check.
(10) Unit failed ROM check.
(11) Negative power.
(12) The remote computer must also be capable of opening any circuit breaker on the network.

16. Each Circuit breaker must be equipped with normally open and normally closed contacts as required to monitor the open, closed, status to SCADA and controls.
17. Power circuit breaker must be Eaton Cutler Hammer type Magnum MDSX, Siemens Type WL, or equal.

N. Circuit Breakers for Distribution - 600 Volt

1. Circuit breakers shall be of the bolt-in type, industrial heavy-duty, quick-make, quick-break, single or multi-pole of the type specified herein and shown on the Drawings.
2. Circuit breakers shall be thermal magnetic type with common handle for a multiple pole circuit breakers. Circuit breakers shall be a minimum 100 ampere frame and through 100 ampere trip sizes shall take up the same pole spacing. Single pole circuit breakers rated at 15 and 20 amp shall be UL listed as type SWD for lighting circuits.
3. Molded case circuit breakers shall provide circuit overprotection with inverse time and instantaneous tripping characteristics. Ground fault protection shall be provided where shown on the Drawings.
4. Circuit breakers shall be operated by a toggle-type handle and shall have a quick- make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by the handle position.
5. Contacts shall be nonwelding silver alloy, and arc extinction shall be accomplished by means of DE-ION arc chutes.
6. Circuit breakers shall have the minimum symmetrical interrupting rating capacity as shown on the Drawings.
7. Each breaker shall be connected to the main bus with copper bus bar. Insulated cable is not acceptable.
8. Breakers shall be full size E or F frame 480 volt as required.
9. Each Circuit breaker must be equipped with normally closed contacts to monitor the open, closed, status to SCADA.
10. The generator feed circuit breaker must be equipped with "cause of trip" display unit.
11. Circuit breakers shall be Cutler-Hammer, Siemens, General Electric, or approved equal.

O. Utility Metering

1. Where shown on the Drawings, a separate barriered-off Utility Metering Compartment complete with hinged sealable door must be provided. The bus work must include provisions for mounting Commonwealth Edison

Company (COMED) current transformers and potential transformers or potential taps as required by COMED.

2. A Service Entrance Label and necessary applicable service entrance features must be provided in accordance with the Chicago Electrical Code.
3. The ground wire must be terminated in the ComEd Meter fitting per ComEd standards.

P. Painting

1. All interior and exterior seams must be carefully filled and sanded smooth for neat appearance. The equipment manufacturer must remove oils and dirt to form a chemically and anodically neutral conversion coating, to improve the finish-to-metal bond, and to provide resistance to rust. All surfaces must be phosphatized before any of the protective coatings are applied. The final cost must be based semi-gloss enamel to provide adhesion, resiliency, durability, color stability, and stain resistance.
2. The exterior surface of all structures must be thoroughly cleaned and given a coat of primer and a finish coat of the equipment manufacturer's Standard of ANSI Standard light gray color Number 61.
3. The interior surface must be given a primary coat and a finish coat of ANSI Standard light gray color Number 61.
4. The equipment manufacturer must provide an adequate supply of touch-up paint in aerosol cans.
5. A packaged kit of refinishing materials, with complete instructions, must be included with each shipment for touch-up in the field.

Q. Instrument Transformers

1. Meter potential coils must be 120 volts, 60 Hz. All current coils must be 5 amperes.
2. Instrument transformers must be insulated for a test voltage corresponding to the insulation level of the switchboard.
3. Current transformers must have 5 ampere secondary windings. The necessary auxiliary transformers must be provided for the AC status trip devices on each breaker.
4. Secondary windings must be terminated at barrier type terminal blocks suitable for connection to external cables.
5. Current transformers must have a minimum mechanical limit as defined by ANSI Standards and as specified.
6. Current transformers must have accuracy in accordance with ANSI C37.20-4-7.1.
7. Current transformers whose secondaries are connected to terminal blocks must be provided with temporary jumpers at the terminal blocks to prevent an open circuit if the switchboard is energized. These temporary jumpers must be tagged and indicated on the wiring diagrams.
8. Potential transformers must have ANSI 0.3, W, X, T and 1.2 Z accuracy.
9. The primary and secondary of each potential transformer must be fused.
10. One set of spare fuses shall be provided.
11. All instrument transformers, control transformers, and power transformers must be grounded directly to the ground bus, not to the housing. Each ground wire must be green insulated.

R. Microprocessor Metering and Protection

1. The metering must be provided by a single microprocessor based unit, capable of monitoring and displaying the functions and the accuracies listed. The unit must provide auto range between units, kilounits and megaunits.
2. Each unit must provide the adjustable protection functions with the capability to communicate data through a twisted pair wire network.
3. Each unit must be UL and CSA listed and must conform to ANSI C37.90.
4. The direct meter readings must be as follows:

    a. Current readings must be in amperes for each phase and must have a plus or minus 0.2 percent accuracy of the read value.
    b. Voltage readings must be in volts for all phases to phases and all phases to neutral. The accuracy must be plus or minus 0.2 percent of full scale.
    c. Watt readings must be provided and must have a 0.4 percent accuracy of full scale.
    d. Var readings must be provided and must have a 0.4 percent accuracy of full scale.
    e. Power factor readings must be provided and must have 0.8 percent accuracy of full scale.
    f. The frequency reading must be provided and must have a plus or minus 0.04 percent accuracy of full scale.
    g. Watt demand reading must be provided with programmable intervals of 5, 10, 15 and 30, 45, and 60 minutes and must have a plus or minus 0.4 percent accuracy of full scale.
    h. Watt hour reading must be provided and must have a 0.5 percent accuracy of full scale.
    i. VA reading must be provided and must have a plus or minus 0.4 percent accuracy of full scale.
    j. VAR hours must be provided and must have a plus or minus 1 percent accuracy of reading.
    k. VA hours must be provided and must have a plus or minus 0.5 percent accuracy of reading.
    l. Percent THD must be provided thru the 50th harmonic for voltage and current.

5. The following protective adjustable functions must be provided and must function as stated below.

    a. Voltage phase loss must operate if any phase RMS voltage is less than 50 percent of the nominal line voltage.
    b. Current phase loss must operate if the smallest phase value is less than 1/16 of the largest phase value.
    c. Phase unbalance must operate when the deviation between any two phases exceeds the amount of unbalance as a percent of the nominal line voltage. The range must be from 5 percent to 40 percent in 5 percent increments.
    d. Voltage phase reversal protection must be provided.
    e. Overvoltage protection must be provided and must have adjustable set points from 105 percent to 140 percent in 5 percent increments.
    f. Undervoltage protection must be provided and must have adjustable set points from 95 percent to 60 percent in 5 percent

increments.

g. Adjustable time delay setting must be provided from 0 seconds to 20 seconds in 1 second increments for each overvoltage, undervoltage and phase unbalance trip and alarm setting.

h. Each of 3 relays must be programmable for alarm and trip and either latched or unlatched and energized or de-energized when an event occurs.

6. The current input ranges of the unit must accommodate externally mounted current transformers with ratios from 100/5 to 5000/5 amperes.

7. The potential input must be self-contained with fused primary and secondary for voltages up to 600 volts. The voltage module must be mounted on the interior panel of the metering compartment and must be connected to the microprocessor by means of an extended ribbon connector.

8. A synchronous pulse input from the utility company must be accepted and when activated must override the preset watt demand interval. The utility must control the demand window.

9. Each output must have a separate set of trip contacts and must have a separate set of alarm contacts. Each contact must be Form C, normally open/normally closed. Each contact must have an interrupting rating at 120/240 volt AC of 10 amperes and must have an interrupting rating at 30 volt DC resistive rating of 10 amperes.

10. Each alarm contact must be connected to terminal blocks in the rear compartment for external alarm connections. The connections must be made with Number 12 AWG insulated cable.

11. A separate Form C contact, normally open/normally closed must be provided for watt hour pulse rate output which must be field programmable.

12. The display face must be a membrane type and must be suitable for NEMA Type 3R and NEMA Type 12 mounting. The microprocessor must have a durable 6-digit LED display screen. The display screen and LEDs must indicate both trip and alarm conditions. The cause of a trip of alarm must be indicated in the display window.

13. Control power must be drawn from the monitored incoming AC line terminal connections. No separate AC supply input must be required. Terminal provisions for external 120-volt AC control power supply must be furnished. Each microprocessor must have non-volatile memory and not require battery back-up. In the event of a power failure, the device must retain all pre-set parameters, data at time of power loss, and cause of trip must be stored. Each microprocessor must have an operating temperature range from 0 degrees C to 70 degrees C, and from 0 to 95 percent relative humidity non-condensing.

    a. Each microprocessor must allow the operator to disable undesired values/functions and to later reactivate them if required. A neutral terminal must be provided and wired for 4 wire, grounded systems. The 600 volt and below voltage power module must be detachable from the chassis. Three in-line fuses must protect the unit from current overloads.

    b. In the event of a trip or alarm condition, a built-in reset button must allow a manual reset of the microprocessor. Each

microprocessor must also be capable of being remotely reset through its communication port. Each microprocessor must have the capability for resetting both watt hours and watt demand.

14. Provide an addressable communication card capable of transmitting all data, including trip data over a compatible two wire local area network to a central personal computer for storage and/or printout. The network must also be capable of transmitting data in RS232c format through a translator module.
15. A set of DIP switches must be provided for setting each current and voltage transformer ration input and for setting each protective function trip and alarm condition.

S. Meters and Instruments

1. Indicating instruments, other then the microprocessor metering, must be approximately 4-1/2 inches square with long scale (approx. 250 degrees) white dials with black markings. They must be accurate within one percent at full scale deflection, must have an external zero adjustment. Acceptable manufacturers:

   a. Siemens,
   b. Crompton Type K-241, or equal.

2. Instrument transfer switches must have an off position. Acceptable manufacturers:

   a. Siemens
   b. Electroswitch Type W2 or equal.

T. Control Devices and Wiring

1. Control devices, local instrument cables, and wiring required on the equipment must be furnished and installed at the factory. All LED indicating and push to test lights must be fed from the switchboards UPS system.
2. All small wiring for control or accessory equipment must be installed in wire way. All small wiring enclosures must be grounded.
3. Control wiring must be Number 12 AWG, except where larger size conductors are needed for current carrying requirements or smaller wiring on mass produced pre-manufactured sub-assemblies. The conductor must be stranded copper for fixed wiring and extra flexible copper for hinged wiring. The conductors must have 600 volts, 90 degrees C, polyvinylchloride insulation with flame-proof braid covering, Type TBS, or cross-linked polyethylene, Type SIS.
4. All control and instrument wiring, alarm leads, and instrument transformer secondaries, for connection to external cables, must be terminated at terminal blocks. A maximum of two wires must be connected to each terminal.
5. Terminal blocks must be molded blocks, 600 volt and 30 ampere rated, screw type, with washer head screws which must be provided for terminating all small wiring. Acceptable manufacturers:

a. Marathon,
b. Cutler-Hammer,
c. Buchannan, or equal meeting the specified ratings.

6. Compression type solderless copper lugs must be furnished for each terminal block for external control and instrument wires. All control wires must be terminated utilizing insulated ring type connectors. Acceptable manufacturers:

   a. Burndy Catalog Number YAEV 10-L36,
   b. Thomas & Betts Company, Catalog Number C1 insulated, or equal.

7. Cable/wire markers must be installed on both ends of all conductors both for internal and external cables. Markers must comply as specified in applicable section under these specifications.
8. Wiring between auxiliary switches and terminal blocks must be completed for all switch points, whether they are used or not.
9. The assembled control equipment and wiring connections must be insulated for a voltage of 600 volts and must be subjected to a one minute test of 2200 volts AC phase to ground at the factory, after fabrication and assembly is complete.
10. Use the following color coding for all LED lamps used for push-to-test indicating lights.

a.	Source 1 Available	- Red
b.	Source 2 Available	- Red
c.	Source 1 Breaker Closed	- Red
d.	Source 2 Breaker Closed	- Red
e.	Source 1 Breaker Open	- Green
f.	Source 2 Breaker Open	- Green
g.	Tie Breaker Open	- Red
h.	Tie Breaker Closed	- Green
i.	PLC Auto Mode	- Red
j.	PLC Manual Mode	-Amber
k.	PLC Auto Mode Failure	- Green

U. Nameplates

1. Nameplates of laminated phenolic material with engraved letters must be installed to designate the purpose of all switches, breakers, instruments, meters, relays and fuses, etc.
2. The minimum height of letters used must be 3/16 inch. The main titles, such as for circuit or cubicle designations, must be in letters 3/8 inch in height. Letters must be block type and square cut. The wording must be furnished on the shop drawings. The nameplates must be black phenolic material with white engraved letters.
3. Nameplates must be fastened to the equipment with self-tapping stainless steel screws. This must not change the enclosure NEMA type rating.

V. Cable Terminations and Tagging

1. Compression type cable lugs for terminating cables and equipment within each switchboard entering and leaving the enclosed structures must be

furnished and installed by the equipment manufacturer. Copper type connectors and terminations must be furnished. Aluminum-copper type is not acceptable. Copper compression connectors must be two-hole long barrel, tin plated, closed end compression type. The barrel for each cable lug must be sized for the exact cable size specified.

2. Cable lugs must be Anderson Type VHCL, Burndy Type YA, Panduit Series LCB or LCC, Thomas & Betts Series 54800 and 54900, or equal.
3. Supports must be provided for all power and control cables.
4. The Contractor must furnish 600 volt copper cable limiters with heat shrinkable plastic sleeves for all service entrance cables within the switchboard, if required by ComEd.
5. All cable, primary and secondary, must enter from the top or bottom. Provisions to support incoming leads and sufficient room to terminate must be provided.
6. Cable/wire markers must be installed on both ends of all conductors, both for internal and external cables.
7. Terminal blocks must come with mylar terminal strips for terminal point identification. Terminal mylar strips must be fastened to terminal blocks using screws.

W. Programmable Logic Controller (PLC)

1. All electrically operated circuit breakers must operate under the control of a PLC with the sequence of operation described in these Specifications.
2. All electrically operated circuit breakers must be provided with both a "manual-automatic" switch with a knurled operating handle and a "lockout -open-close" switch with a pistol grip operating handle to allow breaker control in the manual position. The "lockout-open-close" switch must not be functional when the "manual-automatic" switch is in the "automatic" position even if the switch is operated to the "lockout" position.
3. When the "manual-automatic" switch is in the "manual" position and the "lockout-open-close" switch has been operated to the "lockout" position, the breaker cannot be controlled by the PLC even if the "manual-automatic" switch is restored to the "automatic" position.
4. The "lockout-open-close" switch must be a spring loaded return to center switch for the "open" and "close" functions which must occur at approximately 45 degrees left and right of center, respectively. The lockout function must be achieved by moving the operating handle to the "open" position, pulling the handle out and moving the handle to the "lockout" position where it will be held in place.
5. To restore the breaker, the handle must be pulled out and moved to the open position where it will be released and will "spring return" to the center position.

X. Hard wired interlocking must be provided to prevent the paralleling of the two ComEd sources with each other during manual operation or during a PLC failure.

Y. The time delay logic required to override transient voltage dips in the ComEd lines must be programmed in the PLC.

Z. A pair of normally open isolated contacts from the PLC must be provided for each indication function of the electrically operated breakers as follows:

1. The status of the PLC unit and the power supply,
2. The status of both ComEd lines,
3. The status of the CPT's,
4. The status of the main, and tie, breakers,
5. The position of the "manual-automatic" switch for each breaker,
6. The "lockout" position of the "lockout-open-close" switch for each breaker,

AA. All PLC status and alarm functions must be monitored and displayed at the switchboard. In addition, all functions must be capable of being transmitted through a twisted pair wire to a standard IBM compatible remote computer.

BB. The switchboard must contain a programmable logic controller (PLC) and an uninterruptable power supply system (UPS).

1. The PLC must have discrete input/output (I/O) racks as required to meet all I/O conditions of the control system. There must be a minimum of 4 spare I/O slots. There must be a minimum of one spare I/O module for each catalog number used in each enclosure.
2. The PLC must receive discrete and analog inputs and control discrete and analog outputs in a manner dictated by the user specified logic called Relay Ladder Logic.
3. The PLC must also perform data handling operations and communicate with external devices.
4. The PLC system design must accommodate the replacement of assemblies without having to disconnect field wiring. Whenever possible, removable connectors must be used to connect field wiring to the individual circuit board assemblies.
5. All major assemblies and subassemblies, circuit boards, and devices must be identified using permanent labels or markings each of which indicates the manufacturer's catalog number, product manufacturing date code, U.L. and CSA certifications.
6. PLC Power Supply

    a. The PLC power supply must be an AC/DC Supply, a wide range supply operating from a voltage source in the range of 83 to 254 volts AC and 100 to 125 volts DC.
    b. The PLC power supply must provide 24 watts at an isolated 24 volts DC output.
    c. The Central Processing Unit (CPU) must contain a built-in serial communication port which can be used to connect the programmer for IBM compatible programming software, connect the Hand-Held Programmer to the PLC and connect to one of the wide variety of third-party operator interfaces utilizing an open architecture software protocol.
    d. The serial port must provide RS-485 compatibility. The characteristics of this port must be software configurable and must be modem compatible.
    e. The power supply must be modular in design, separate from the CPU and baseplate for easy replacement in the unlikely event of failure.
    f. The power supply must be universal in design, compatible with main CPU racks, as well as the expansion racks.
    g. There must also be a super capacitor that provides a minimum of

two hour batteryless backup power for CPU RAM memory.

7. Central Processing Unit (CPU)

   a. The CPU must read the inputs, perform all system logic, conduct on-line diagnostics, and control the outputs. Diagnostics must include memory check sum and scan time monitoring. If a fault is detected, the processor must stop and turn off the outputs.
   b. Indicating lights must indicate the operating mode of the controller (RUN or STOP).
   c. A minimum of 2K words (16-bit) of internal RAM memory must be provided for storage of the control program. The full memory of the CPU must be usable for program or data storage. Additional memory must be provided where required to perform the functions shown on the Drawings and specified herein.
   d. Program backup must be on nonvolatile EPROM memory cartridges, which can be loaded from the CPU without additional equipment.
   e. Program functions must include contacts, coils, timers (range 0 to 9990 seconds), counters (range 0 to 999), math functions (add, subtract, multiply, divide), shift registers, bit and word operations.
   f. The CPU must include an integral real-time clock which can be accessed from the control program. The clock must include functions for time of day (year, month, day of month, day of week, hour, minute, second), alarm, and operations hours counter.
   g. The CPU must contain an integral PID loop control function for execution of closed loop control.
   h. The CPU must be capable of floating-point math calculations including integer-to-floating point conversion, floating-point to integer conversion, add, subtract, multiply, divide, and compare.
   i. The CPU must permit changing ladder program or data values while running.
   j. The CPU must be capable of being networked to other programmable controllers or a host computer up to 12,000 feet away.
   k. The modular CPU must be capable of controlling up to 17 I/O slots per chain.

8. Memory Capacity

   a. Each PLC must supply a modular design CPU that contains at least the following:

      (1) Either 8192 (8K) or 40,960 (40K) 16-bit words for application programming.
      (2) Either 2048 (2K) or 9,999 16-bit registers for register and data usage.
      (3) 1280 global references.
      (4) 1024 control relays.
      (5) 400 bits for discrete inputs (minimum).
      (6) 400 bits for discrete outputs (minimum).

   b. The PLC must have either 64 or 256 16-bit registers for analog outputs.

9. Operator Interface

a. The programming port and its protocol must be open in architecture. The protocols of this communication port must be published such that the City may develop its own operator interface device, software or hardware, to access Register, I/O status, I/O override and system diagnostic memory data.
b. Through an open nature of this communications protocol, a wide variety of operator interface must be made available. These may be manufacturer's own brand or they may be manufactured by third party suppliers.

10. Discrete I/O

a. Interface between the PLC and user supplied input and output field devices must be provided by rack type I/O modules.
b. Configuration

(1) An expandable I/O system must be supported by a single slot modular CPU and must accommodate up to two total racks or 17 I/O slots up to a total distance of 0.5 meters with the standard expansion racks and 1000 meters with the remote expansion racks.
(2) Expansion I/O racks must be connected to the CPU rack via a high speed serial interface cable. The receiver must be contained within the expansion baseplates eliminating the requirement for additional communication modules.

c. Construction

(1) All field wiring must be to screw connectors attached to the I/O mounting rack. It must be possible to remove and replace any I/O module without disturbing field wiring or any other I/O modules.
(2) All modules must be enclosed in rugged plastic housings. There must be no user access to the circuit board components.
(3) Input and output modules must have faceplates which must be marked or labeled in accordance with the system shop drawings.
(4) The label must have color coding for quick identification of the module as high voltage (red), low voltage (blue), or signal level (gray) type.

d. I/O modules must be designed for 1500 volt isolation between the field wiring and the system backplane.
e. The 120 volt AC input module must accommodate an input voltage range from 0 to 132 volts.
f. There must be a minimum of 16 points per module for 120 volt AC inputs for each discrete input module.
g. Output Specifications

(1) Each discrete AC output must be provided with an RC

snubber to protect against transient electrical noise on the power line.

(2) Discrete AC outputs must be suitable for controlling a wide range of inductive and incandescent loads by providing a high degree of inrush current (10 times the rated current).

h. As a minimum, there must be 120 to 249 volt AC-isolated, 2 ampere output modules and discrete relays.

(1) Each discrete 120 to 249-volt AC-isolated, 2 ampere output module must have 16 points for each module.

(2) Each discrete relay, normally open, 2 ampere (2 groups), output module must have 16 points for each module.

i. As a minimum, each 120-volt AC input, relay discrete output module must have 16 input points and 16 output points per module.

j. The conversion of analog to digital and digital to analog must be by an application of analog modules.

(1) Each current analog input must have 4 channels for each module.

(2) Each voltage analog input must have 4 channels for each module.

(3) Each current analog output must have 2 channels for each module.

(4) Each voltage analog output must have 2 channels for each module.

k. Peer/Peer Communications

(1) A specialized option module must be available that will allow the PLC to communicate on a token passing peer-to-peer, noise immune network providing high-speed transfer to control data.

(2) The specialized communication module must be configurable to broadcast data to and receive data from up to 31 other devices on a network automatically and repeatedly from a shared and dedicated database in RAM memory.

(3) The communication medium for this specialized network must be a high energy and noise immune signal shielded twisted pair cable transmitting data at an adjustable rate of up to 5M Baud. The distance of the communication must be up to 7500 feet at a lower baud rate.

(4) One PLC programming device, complete, for use in maintaining and troubleshooting the PLC equipment and program. One PLC programming device must be provided for this Project.

CC. The UPS must be rated a minimum of 3000 VA and must be sized to provide power for the PLC and each I/O rack for a minimum of two hours on loss of AC power.

The UPS must be energized at all times. The UPS input must be connected to a 120 volt source of power.

DD. A control power transformer must be provided for the 120 volt AC power to the UPS.

EE. All interposing relays must be electro-mechanical type with convertible contacts. Cartridges must have a 600-volt rating with 10 amperes continuous current rating.

FF. Control Logic

1. The normal operating condition must be with the first source main service breaker 52-M1 closed, the second source main service breaker 52-M2 closed, and the tie breaker 52-T12 open.
2. Loss of ComEd power must be defined as:

    a. Voltage on any phase falls to 80 percent of nominal for one second.
    b. Frequency falls below 95 percent of rated frequency.

3. A bus fault must be defined as a condition which causes a main or bus tie breaker to trip in either the instantaneous, short time, or long time fault mode.
4. Upon loss of COMED power to first source main service breaker 52-M1, and a time delay of 2 seconds (adjustable), the main service breaker 52-M1 must open, and the tie breaker 52-T12 must close. Second service 52-M2 must remain closed throughout this sequence.
5. Upon return of COMED normal source of power with uninterrupted availability for 3 continuous minutes, the tie breaker 52-T12 must open and the normal service breaker 52-M1 must close.
6. Upon loss of COMED power to second source main service breaker 52-M2, and a time delay of 2 seconds (adjustable), the main service breaker 52-M2 must open, and the tie breaker 52-T12 must close. First service 52-M1 must remain closed throughout this sequence.
7. Upon return of COMED normal source of power with uninterrupted availability for 3 continuous minutes, the tie breaker 52-T12 must open and the second service breaker 52-M2 must close.
8. During a normal operating condition (52-M1 closed, 52-M2 closed, 52-T12 open):

    a. Should a fault occur on N1 bus, the normal service breaker 52-M1 must trip and lock out and the tie breaker 52-T12 will remain open and must lock out. The 52-M2 service breaker must remain closed throughout the sequence. Neither the bus tie 52-T12 nor the 52-M1 service breaker will operate until they are manually reset. This condition will remain in effect even if there is a loss of ComEd power to normal service breaker 52-M2.
    b. Should a fault occur on N2 bus, the normal service breaker 52-M2 must trip and lock out and the tie breaker 52-T12 will remain open and must lock out. The 52-M1 service breaker must remain closed throughout the sequence. Neither the bus tie 52-T12 nor the 52-M2 service breaker will operate until they are manually reset. This condition will remain in effect even if there is a loss of ComEd power to normal service breaker 52-M1.

9. During a condition where there has been a loss of normal ComEd power to source N1 (52-M1 open, 52-M2 closed, 52-T12 closed)

    a. Should a fault occur on N1 bus, the tie breaker 52-T12 must trip and lock out. It must remain locked out until manually reset. When the normal ComEd power source N1 becomes available, the normal service breaker 52-M1 must not automatically close.
    b. Should a fault occur on N2 bus, both the normal service breaker 52-M2 must open and must lock out and the tie breaker 52-T12 must trip and lock out. The normal service 52-M2 and bus tie 52-T12 breakers must remain locked out until manually reset even if there is a loss of ComEd N2 service power. When the normal ComEd power source N1 becomes available, the normal service breaker 52-M1 must automatically close.

10. During a condition where there has been a loss of normal ComEd power to source N2 (52-M1 closed, 52-M2 open, 52-T12 closed)

    a. Should a fault occur on N2 bus, the tie breaker 52-T12 must trip and lock out. It must remain locked out until manually reset. When the normal ComEd power source N2 becomes available, the normal service breaker 52-M2 must not automatically close.
    b. Should a fault occur on N1 bus, both the normal service breaker 52-M1 must open and must lock out and the tie breaker 52-T12 must trip and lock out. The normal service 52-M1and bus tie 52-T12 breakers must remain locked out until manually reset even if there is a loss of ComEd N1 service power. When the normal ComEd power source N2 becomes available, the normal service breaker 52-M2 must automatically close.

11. Provide following as part of the ATC scheme:

    a. A "Manual" – "Automatic" system Master mode selector switch 43-1.
    b. A "Manual"-Automatic" Return to Normal mode select switch 43-2.
    c. Provide PLC relay type output cards and where required because of breaker coil current/voltage ratings auxiliary relays, to open and close each electrically operated main and tie breakers.

12. The following sequence of operation must be provided by combination of PLC and ANSI 43 selector switches:

    a. With the "Manual"-"Automatic" master selector switch 43-1 in the "Manual" position, the operator must be capable of opening and closing either main or tie breaker through their associated local Open-Close Control Switches as long as anti-paralleling and lock-out interlocking is not being violated. In the manual mode, hard wired interlocking as well as PLC programming must be provided to prevent Automatic Operation of the Breakers.
    b. With the "Manual"-Automatic" master selector switch 43-1 in the "Automatic" position, hard wired interlocking must prevent operation of the local manual Open-Close Control switches. With 43-1 in the "Automatic" position, the following sequence of events

must occur automatically:

(1) Normal Operating Condition with voltage available on both incoming lines must be Main 1 and Main 2 Closed, Tie Breaker open.

(2) Should 1) voltage be lost on either of the connected lines as detected by its' ANSI 27 relay, and 2) after an adjustable programmable time delay of (0-60 seconds) and 3) with voltage available on the alternate line determined by its' ANSI 27 relay, then 4) the failed line main breaker must open, 5) an adjustable programmable time delay neutral relay (0-10 seconds) must be energized, and after it has timed out, then 6) the tie breaker must close.

(3) With the return to normal selector switch 43-2 in the "Manual" position, should voltage return to the previously failed line, the system must not return to normal operating condition. Return to normal operating condition must occur by the operator changing the master "Manual"-"Automatic" selector switch 43-1 to the "Manual" position and utilizing the associated breaker control switches to open and/or close the breakers. The operator must not be capable of violating the anti-paralleling and overcurrent/fault lock-out interlocking. If the voltage should return to the originally failed line, and then the line which the loads are presently connected should fail, the automatic control scheme must open the failed source main breaker and re-close the returned line main breaker thus, energizing both buses from the returned line through the closed tie breaker.

(4) With the return to normal selector switch 43-2 in the "Automatic" position, should voltage return to the previously failed line after an adjustable programmable time delay of (0-30 minutes), normal operating conditions must be restored by open transition retransfer with the previously programmed time delay neutral between opening closing of breakers.

13. The switchboard must provide three phase undervoltage relays for the first source main service breaker (52-M1) and the second source service breaker (52-M2).
14. Provide auxiliary contacts on the main circuit service breaker (52-M1) and the main service breaker (52-M2) for remote indication.
15. Provide interlocks to prevent closure of tie circuit breaker into a faulted bus or unless one main circuit breaker is open. Trip the tie circuit breaker whenever both main circuit breakers are closed.
16. PLC must provide an adjustable range of 1 to 30 minutes, factory set at 3 minutes, for establishing the availability of ComEd power.

GG. Switchboard Accessories

1. Channel iron bases must be furnished for the switchboard. These bases must be suitable for embedding in the concrete pad or welded to the structural steel. All openings at the ends of the bases must be closed flush to the top of pad.

2. A metal document pocket must be provided on each secondary switchboard group and must be large enough to hold the "As Built" drawings and instruction manuals.
3. The Contractor shall provide ribbed rubber mats having a dielectric strength of 30,000 volts, 1/4-inch thick, 36 inches wide, extending the full length of each switchboard, front and back. Mat must be black and meet ASTM D-178 requirements.
4. One test kit, for use with solid-state trip device for checking and calibration, operating from standard 20 ampere, single phase 120 volt, 60 Hz outlet must be provided for each switchboard group. Each test kit must include jack and receptacle to connect to solid state trip device, ammeter, second counter and test switches to enable testing of all tripping functions.
5. One spare fully programmed PLC, 1 of each type of Input Card, and 1 of each type of Output card must be provided. If ATC is provided, one fully programmed ATC must be provided.
6. Ladder logic used for programming with descriptions written above each rung with all input output descriptions must be provided.
7. Software used to program all HMI and PLC must be provided with 2 licenses registered to the Commissioner.
8. All cables to connect to PLC or HMI unit from a laptop must be provided.

HH. Factory Test

1. Each secondary switchboard must be completely assembled wire, adjusted and tested at the factory. After assembly, the complete switchboard must be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment.
2. The main circuits must be given a dielectric test of 2200 volts AC for one minute between live parts and ground, and between opposite polarities. The working and control circuits must be given a dielectric test of 2200 volts AC for one minute between live parts and ground in accordance with ANSI C37.20.1.

2.04 MANUFACTURERS

A. Service equipment manufacturers which may be incorporated in the Work include but not limited to the following:

1. Eaton
2. Illinois Switchboard Corp.
3. Erickson Electrical Equipment Co.
4. Gus Berthold Electric Co.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawing and the equipment manufacturer's instructions.

B. Each surface mounted cabinet to be supported and mounted away from the wall with "C" shaped channel. The channel to be fiberglass, when stray current control isolation is required, and stainless steel for other applications. The minimum separation between the equipment and the wall to be 1 inch.

C. The equipment to be installed with work space clearances as required by the Code.

D. The equipment to be installed to permit maintenance and replacement of parts, and to be clear of all openings with swinging or moving doors, partitions or access panels.

E. Final adjustments to the equipment must include verification of the proper mechanical operation, verification of the instrument operation and setting of the circuit breakers, protective relays and devices in accordance with the coordination study. The final settings and calibration of the circuit breakers must be witnessed by the Commissioner.

F. Service Engineer

1. The equipment manufacturer must provide a qualified factory trained service manager to provide technical direction for the installation and final adjustments of the equipment.
2. The service engineer must certify that the equipment has been installed in accordance with the manufacturer's recommendations.
3. The service engineer must be available as long as his services are requested, but in any case, he must be required for a minimum of one full 8-hour working day.

G. The Contractor must install the switchboard on a 4-inch thick reinforced concrete housekeeping pad of sufficient size plus at least a 4 inch apron. The equipment must be of such construction that when it is installed on the concrete pad, there are no openings between the top of the pad and the bottom of the switchboard. Contractor to install 6-inch by 6-inch wire mesh in pad.

H. Power for Space Heaters

1. The Contractor must energize the space heaters furnished with the equipment as soon as it is delivered to the site or storage facility.
2. Power for the space heaters at the site must be obtained from the temporary power system.
3. After the permanent power from the building to the room space heaters is energized, the Contractor must disconnect the space heaters.
4. The expenses to provide power to the space heaters must be paid for by the Contractor.

I. Entryway or conduit locations shall be in accordance with equipment manufacturer's approved shop drawings.

J. Mounting Bases - Concrete:

1. The Contractor to install the floor mounted switchboard on a 4 inch thick concrete housekeeping pad of sufficient size plus at least a 4 inch apron.

2. The equipment shall be of such construction that when it is installed on the concrete pad, there are no openings between the top of the pad and the bottom of the equipment.
3. The Contractor shall include a 6 inch by 6 inch wire mesh in the pad.
4. The Contractor shall chamfer the edges of the pad at 45 degree angle.
5. Each foundation to be level, stable, and compacted to 95 percent Standard Proctor.
6. Switchboards and service equipment installed in electrical rooms located on grade to be electrically isolated from the concrete pad when stray current control isolation is required by the use of isolating pads, sleeves, and washers as specified elsewhere in these Specifications.
7. Entryway or conduit locations to be in accordance with equipment manufacturer's approved shop drawings.

3.02 FIELD QUALITY CONTROL

A. Field Test Plan and Documentation

1. The Contractor must submit a field test plan 120 days after award, with accompanying documentation in the form of test data recording sheets and list of proposed test equipment.
2. The Contractor must not proceed with testing until plan and documentation are approved.
3. The Contractor must indicate, in scope of test plan how equipment will be tested to ensure safe and orderly transition from installation, through initial energizing, to specified field testing.
4. The accompanying documentation must include standard data recording sheets as used in manufacturer's in-plant testing of equipment and devices or as used by major utilities or large industrial users of specified equipment.
5. The Contractor must submit certified copies of test data, within two weeks after completion of testing.

B. Field Testing and Inspection

1. The Contractor must conduct field testing and inspection to ensure proper operation of equipment provided.
2. Prior to field testing, the Contractor must check equipment installation in accordance with manufacturer's recommendations and in accordance with IEEE requirements.
3. Field Testing.

    a. The Contractor must furnish equipment required to perform tests.
    b. The Contractor must provide services of manufacturer's Commissioning representative and supporting field crew. The Contractor must conduct the tests in the presence of the Commissioner. For each item, submit for approval and perform approved tests including, but not limited to, those specified.
    c. The Contractor must perform insulation resistance test of 60-second duration in accordance with the following requirements:

        (1) The test voltage must be 1000 volts.
        (2) The Contractor must perform a megger test for each phase-to-

phase and phase-to-ground circuits as recommended by the manufacturer.

(3) The Contractor must test operation of each circuit and control in accordance with the approved sequence.

(4) The Contractor must test interlock system to make closure attempt on locked open devices and make opening attempt on locked closed devices.

(5) The Contractor must perform functional tests on control, interlocking, blocking and supervisory circuits, including verification of interconnections between equipment and interface points. The Contractor must provide verification of these tests in the form of lined-in schematics and signed by the Contractor and the Commissioner.

d. Bus Bars

(1) Where directed, the Contractor must test resistance of bus bar connections. Resistance not to exceed value recommended by manufacturer.

(2) The Contractor must test insulation resistance to ground and between insulated bus bar.

e. Proof of Compliance

(1) If testing indicates failure to comply with specified requirements, the Contractor must replace, correct or modify equipment so that it does comply.

(2) The Contractor must conduct additional tests witnessed by the Commissioner to prove compliance with specified requirements.

C. The Contractor must submit certified test reports

D. All field test must be witnessed by the Commissioner.

3.03 TRAINING

A. The equipment manufacturer shall provide factory trained technicians at the Project site to provide adequate training for the Commissioner/CTA's personnel in the proper operation and maintenance of the equipment.

B. The training classes shall be done at on-site locations selected by the Authority.

C. The equipment manufacturer or the Contractor shall provide all video equipment and DVDs necessary for the recording of all training classes. These DVDs shall be submitted to the Authority for review.

D. If the Authority determines that the DVDs are not of "High Quality" for future refresher training, the equipment manufacturer shall make another DVD recording of another training class at no cost to the CTA.

E. The Contractor shall provide one 21 inch color television, one DVD player, and one cabinet with capacity to store the television, DVD player, and 48 DVDs.

F. The equipment manufacturer shall provide professionally made DVD filmed in the equipment manufacturer's factory plant or a controlled environment depicting operations, maintenance, safety training, and procedures of the equipment.

G. A minimum of 24 man-hours shall be provided for the training classes.

H. Arc flash awareness and safety training shall be incorporated into all training and DVD recordings required in this Specification.

3.04 FACTORY TESTING

A. The equipment must be completely assembled, wired, adjusted and tested at the factory. Rigid inspection before and after assembly must assure correctness of design and workmanship. After assembly, each switchboard assembly must be tested for operation under simulated conditions.

B. A complete set of tests must be performed at the factory. The tests must include the manufacturer's standard and commercial tests, and specified tests, as specified, and a complete simulated operational test of the equipment to guarantee successful operation.

3.05 FACTORY WITNESS TESTING

A. The Commissioner, as a part of the Contract, will witness tests of all equipment covered by these Specifications at any time during manufacturing, assembling and/or testing. The Contractor must provide the Commissioner with advance notice of a minimum of two weeks prior to the schedule of factory testing.

B. The Contractor must pay the cost for four (4) persons from the Commissioner's office or representative to travel to manufacturer's assembly facility, appropriate overnight accommodations and meals, where required, and car rental to witness the testing of the switchboard and inspect it prior to shipment.

3.06 COORDINATION STUDY

A. A complete coordination study, including the switchboard as shown on the Drawings, must be provided. The study must be performed, signed and sealed by a qualified Registered Professional Engineer who is registered in the State of Illinois. The Registered Professional Engineer must have a minimum of 5 years relay coordination experience. The Registered Professional Engineer used must be subject to the Commissioner's approval. The study system must be subject to the Commissioner's approval.

B. The study system must be inclusive of the complete high voltage distribution system, from the line terminals of Commonwealth Edison Company to the 120/208 volt bus of the switchboard and panelboards.

C. The Coordination study must provide carefully prepared graphic representations of the protective elements coordinating for overloads and short circuits for each service, including transformers, motors, etc., as supplied by the electrical system.

Each set of curves must contain a single line segment of that part of the total distribution system represented. Each set of curves must also contain identification of the actual equipment or future equipment ratings.

D. The coordination study must also provide a tabulation of the breaker settings. The tabulation must include the service identification; service loading; current transformer ratios; relay types; circuit breaker short time, instantaneous, long time delay ground fault time and pick-up settings with the ranges for each set point must be provided.

E. The coordination curves, breaker data and relay data will form the basis of the Commissioner's review of the breakers and relays to be provided by the equipment manufacturer.

F. The data required on the foreign equipment, ancillary equipment, fuses, etc., for the preparation of the coordination curves, breaker data and relay data must be provided by the Contractor.

G. The equipment manufacturer must tabulate all data utilized as available short circuit currents, full load operating current, equipment ratings (current and withstand) as well as transformer, cable and motor characteristics.

H. Coordination study must be in accordance with section 26 05 73 of these specifications.

I. The Circuit breakers and protective devices must not be set or tested until the coordination study has been submitted and approved.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of the SERVICE EQUIPMENT PASSENGER STATIONS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work for the SERVICE EQUIPMENT PASSENGER STATIONS will be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 46 00

DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. This Section specifies the furnishing and installing of dry type transformers.
2. The Contractor to furnish and install dry type transformers as shown on the Drawings.

1.03 RELATED WORK

A. Dry type transformers specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “Basic Electrical Requirements”
2. Section 260500 “Raceways and Boxes”
3. Section 260600 “Grounding and Bonding”
4. Section 261950 “Electrical Identification”
5. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

B. The Contractor shall prepare and submit to the Commissioner, for review, before fabrication and assembly of equipment, one electronic copy on CD ROM and one electronic PDF copy of each shop drawing and other submittals including, but not limited to, the following:

1. Shop drawings showing the elevations, section views and mounting details of the equipment.
2. Shop drawings for the equipment showing components, fabrication and installation. All dimensions for rough in work at the site shall be provided. The drawings shall show the supports for the installation of the equipment which shall be provided as part of this Specification.

3. The shop drawings shall show the details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
4. Wiring Diagrams:

    a. Connection diagrams for the wiring of equipment shall be included.
    b. Interconnection diagrams shall show the wiring to equipment. The terminal block points shall be clearly identified for the external wiring which shall be routed in or out of the cubicles. The wiring diagrams shall provide adequate space at the terminal blocks for the addition of cable and wire designations for the external wiring to be routed in or out of the equipment.

5. Bills of material shall include all items with catalog cuts describing the electrical and physical characteristics of each item.
6. Contractor shall check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the specifications and drawings. This statement shall also list all exceptions to the specifications and drawings. Shop drawings not so checked and noted shall be returned.
7. The Commissioner's check shall be for conformance with the design concept of the project and compliance with the specifications and drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Contract Documents.
8. All dimensions shall be field verified at the project site and coordinated with the work of all other trades.

C. The Contractor shall submit, for record and distribution in accordance with the Division 01 Sections, Project Closeout, prior to shipment of the equipment, copies of Instruction, Operation and Maintenance manuals for the equipment.

1. Operation and Maintenance manuals shall include descriptive bulletins and operational leaflets for the equipment.

    a. Each Instruction, Operation and Maintenance manual shall be in a three-ring hard binder with tabbed sections. The binder cover shall have the project name and equipment name. The lettering shall be block type and shall be a minimum height of 1/2 inch.
    b. Each Instruction, Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
    c. The "Record Document" Drawings larger than 8 1/2 inches by 11 inches shall be fan folded.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

D. The Contractor shall submit one electronic CD ROM copy, five PDF electronic copies and ten hard shop drawings and other data sheets that were revised or modified during installation; in accordance with Division 01 Sections, Project Closeout. These will be inserted in the previously submitted instruction manuals.

E. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.05 QUALITY ASSURANCE

A. The design, manufacture and testing of dry type transformers and the methods of conducting tests and preparing reports to be in accordance with NEMA Standards Publication for Specialty Transformers, No. ST-20 and UL 1561.

B. Dry type transformers shall be energy efficient designs Department of Energy compliant in accordance with Department of Energy 2016 (D.O.E. 10 CFR Part 431) as of January 1, 2016 or as amended.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Dry Type Transformers:

1. Each dry type transformer to be ventilated and to be designed for continuous operation at rated KVA without exceeding 115 degrees C. temperature rise above a 40 degree C. ambient. All insulating materials to be in accordance with NEMA ST-20 standards for a 220 degree C. component recognized insulating system.
2. Transformer core to be constructed with high-grade, nonaging, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities to be substantially below the saturation point. The transformer core volume to allow efficient transformer operation at 10 percent above the highest tap voltage. The core laminations to be tightly clamped and compressed.
3. Transformers rated 15 KVA and below to have the core and coil assembly completely encapsulated in a proportioned mixture of resin and aggregate to provide a moistureproof, shock resistant seal. The core and coil encapsulation system to be NEMA and UL rated for a maximum temperature of 180 degrees C. and designed to minimize the sound level. Two 5 percent below normal and one 5 percent above normal taps to be provided. Station or infrastructure design may require encapsulated transformers larger than 15 KVA.
4. All ventilated dry type transformers rated 30 KVA and larger to have a core and coil assembly impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly to be installed on vibration absorbing pads. 2 1/2 percent taps, two above and four below normal to be provided. Station or infrastructure design may require ventilated dry type transformers smaller than 30 KVA.
5. Both high voltage and low voltage windings to be of copper conductors. Aluminum conductors are not acceptable.
6. Sound levels to be in accordance with NEMA-ANSI standards.
7. Transformer enclosure designs are dependent on equipment locations and transformer type:

    a. Enclosures for ventilated dry type transformers located in equipment rooms or in protected areas to be painted sheet steel, self- bracing, drip proof type, solid bottom plates for increased rodent protection, complete with lifting lugs as required. Each transformer to have an electrical ground connecting the core to the enclosure with a flexible ground strap. Ventilating openings to be in accordance with NEMA and UL standards for ventilated enclosures. Bases of large transformers consisting of structural steel members to permit skidding or rolling.

b. Enclosures for ventilated dry type transformers located in outdoor areas, unprotected equipment areas, or passenger accessible areas to be Type 304 stainless steel, self-bracing, weather-resistant type, with solid bottom plates for increased rodent protection, complete with lifting lugs as required. Ventilating openings to be provided with Barbara-Coleman style grills (standard weather shields are not acceptable). Additionally, transformers located in passenger accessible areas or outdoor locations to be provided with stainless steel tamper-resistant cover hardware.

c. Encapsulated transformers located in equipment rooms or in protected areas to be painted sheet steel, NEMA Type 3R. Encapsulated transformers located outdoors, unprotected equipment areas, or in the subway tunnels to be Type 304 stainless steel. Encapsulated transformers to be mounted in a way that maintains the NEMA 3R equipment rating.

8. Each transformer to have coils of continuous winding construction. High voltage leads and connections to be insulated, equal to the voltage class of the winding.
9. Each dry type transformer to be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections and side or bottom conduit entrance. Transformers having ratings not exceeding 25 KVA to be provided with terminal leads equipped with Contractor installed connectors arranged and supported in workmanlike manner. Ventilated dry type transformers with terminal boards to be supplied with provisions for NEMA two hole lugs for Contractor installed compression type connectors as specified in the appropriate Specification Section. Contractor to mount terminal lugs with zinc plated Grade 5 hardware complete with conical washers.
10. The terminal compartment temperature to not exceed 75 degrees Celsius when the transformer is operating continuously at rated load with an ambient temperature of 40 degrees Celsius. Transformers having ratings not exceeding 10 KVA to be UL listed for operation with connecting cables rated for use at 75 degrees Celsius.
11. Ratings to be as shown on the Drawings.

B. Shielded Isolation Transformers

1. All cores to be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities to be kept well below the saturation point. The laminations to be clamped together securely with heavy gage steel angles.
2. The core of the transformer to be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC Standards.
3. Each transformer to comply with the DOE Efficiency Standards for Transformers (latest edition).
4. Each transformer enclosure to be of the heavy gage, sheet steel, weather resistant, tamperproof, self-bracing, drip proof type complete with lifting lugs. Base of structural steel members to permit skidding or rolling.
5. Ventilating openings to be provided and to be in accordance with NEMA and NEC standards for ventilated enclosures.
6. The entire enclosure to be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to ensure uniform coating of all edges and surfaces. The coating to be UL listed for outdoor use. The coating color to be ANSI 49.
7. The maximum temperature of the top of enclosure to not exceed 115 degree C rise above 40 degree C ambient.

8. Effective primary to secondary capacitance to not exceed 33 Pico-farads over a frequency range of 20 Hertz to 1 Megahertz in order to attenuate all common mode transients to acceptable levels.
9. Ratings to be as shown on the Drawings

2.02 MANUFACTURERS

A. Dry type transformers manufacturers which may be incorporated in the Work include but not limited to the following:

1. Hammond Power Solutions.
2. Olsun Electronics.
3. ABB
4. Square D

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawings, the equipment manufacturer's recommendations and the contract documents.

B. Mounting Bases - Concrete:

1. Concrete pads to be 4 inches high, unless otherwise indicated on the Drawings, complete with steel reinforcing and necessary bolts, anchors, etc. Where concrete pad is set directly on concrete floor, dowels in floor to tie base to floor to be provided. These pads to be extended at least 4 inches beyond the equipment outlined on all four sides, unless otherwise indicated on the Drawings.
2. Each foundation to be level, stable, and compacted to 95 percent Standard Proctor.
3. Transformers installed in Electrical rooms located on grade to be electrically isolated from the concrete pad by the use of insulating pads, sleeves, and washers.
4. Entryways or conduit locations to be in accordance with manufacturers approved shop drawings.

C. Dry type transformers, if not supplied with internal vibration and noise isolating and dampening supports where the core mounts to the frame, to be provided with approved external vibration and noise isolating and dampening pads. The Contractor to make all conduit connections to transformers with flexible liquid tight metal conduit, not less than 18 or more than 36 inches in length, or with approved vibration isolating connections.

D. Encapsulated transformers to be mounted to maintain NEMA 3R equipment rating.

E. The Contractor to ground enclosure and neutral conductors as shown on the Drawings.

F. Transformers feeding Platform equipment area to be isolating type and to be mounted on electrically isolating pads.

G. The Contractor to terminate primary and secondary conductors in accordance with manufacturer's instructions.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of the DRY TYPE TRANSFORMERS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work for the DRY TYPE TRANSFORMERS will be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 47 00

PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. The panelboards, circuit breakers as well as appurtenances thereto required under this contract.

1.03 RELATED WORK

A. Panelboards specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261900 “Grounding”
10. Section 261950 “Identification”
11. Section 265010 “Lighting Fixtures”
12. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

B. The Contractor shall prepare and submit to the Commissioner, for review, before fabrication and assembly of equipment, one electronic copy of CD ROM and one electronic PDF copy of shop drawings and other submittals including, but not limited to, the following:

1. Shop drawings showing the elevations, section views and mounting details of the equipment.
2. Shop drawings for the equipment showing components, fabrication and installation. All dimensions for rough in work at the site shall be provided. The drawings shall show the supports for the installation of the equipment which shall be provided as part of this Specification.
3. The shop drawings shall show the details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
4. Wiring Diagrams:
    a. Connection diagrams for the wiring of equipment shall be included.
    b. Interconnection diagrams shall show the wiring to equipment. The terminal block points shall be clearly identified for the external wiring which shall be routed in or out of the cubicles. The wiring diagrams shall provide adequate space at the terminal blocks for the addition of cable and wire designations for the external wiring to be routed in or out of the equipment.

5. Bills of material shall include all items with catalog cuts describing the electrical and physical characteristics of each item.
6. Contractor shall check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the specifications and drawings. This statement shall also list all exceptions to the specifications and drawings. Shop drawings not so checked and noted shall be returned.
7. The Commissioner’s check shall be for conformance with the design concept of the project and compliance with the specifications and drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Contract Documents.
8. All dimensions shall be field verified at the project site and coordinated with the work of all other trades.

C. Provide product overview data, applicable standards and certifications, catalog number order information, product selection information, technical data and specifications and installation support hardware information. Provide data with respect to approved use in classified hazardous locations. Contractor shall submit proposed product data for approval by the Commissioner.

D. The Contractor shall submit, for record and distribution in accordance with the Division 01 Sections, Project Closeout, prior to shipment of the equipment, one electronic copy on CD ROM and five PDF electronic copies and ten hard copies of Instruction, Operation and Maintenance manuals for the equipment.

1. Operation and Maintenance manuals shall include descriptive bulletins and operation leaflets for the equipment.
    a. Each Instruction, Operation and Maintenance manual shall be in a three-ring hard binder with tabbed sections. The binder cover shall have the project name and equipment name. The lettering shall be block type and shall be a minimum height of 1/2 inch.
    b. Each Instruction, Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
    c. The "Record Document" Drawings larger than 8 1/2 inches by 11 inches shall be fan folded.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

E. The Contractor shall submit shop drawings and other data sheets that were revised or modified during installation; in accordance with Division 01 Sections, Project Closeout. The Contractor to submit one electronic copy in CD ROM and five PDF electronic copies and ten hard copies of any shop drawings and other data sheets that were revised or modified during installation. These paper hard copies shall be inserted in the previously submitted instruction manuals.

F. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.05 QUALITY ASSURANCE:

A. Assembled panelboard to be UL and IBEW labeled.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Panelboards to be of the circuit breaker, plug fuse, or fusible switch type, of dead front construction, with the voltage characteristics, bus size, main lugs only or main protective device, and number and size of branch circuits as shown on the Drawings.
2. Panelboards to be recessed or surface mounted as shown on the Drawings, enclosed in a 12-gauge minimum steel cabinet with steel trim, and door with concealed continuous stainless steel piano hinges and cylinder type locks.
3. Panelboards shall be a minimum of 24 inches in width.
4. Panelboards to be fully rated, labeled with their UL short circuit rating, and to have a Service entrance label when required by the application.
5. Circuit breakers to be of the industrial, bolt-on type, of the number of poles and rating as shown on the Drawings.
6. Fusible switch units for sizes 30 Amperes through 400 Amperes to be quick- make, quick-break design, with rejection type fuse clips. Switch units 600 Amperes and larger to be of the bolted pressure type with Class L fuses.
7. Panelboards to be designed for sequence phase connection of branch circuit devices to allow for the complete flexibility of circuit arrangement to evenly balance the electrical load on each phase.

B. Cabinets:

1. Cabinets to be fabricated from a minimum of 12 gauge stretcher level galvanealed steel and to provide not less than 6 inches clear space for wiring gutters at top, bottom and sides, as measured from the panel edge or breaker whichever is greater.
2. The seams for each cabinet to be continuously welded at the outside and to be ground smooth, and the cabinet thoroughly cleaned.
3. All free-standing cabinets to be securely and adequately supported by approved angle iron and channel type frame work.

4. Doors and trim to be each of one piece, constructed of Number 12 gage galvanealed steel and be designed so that doors will close against a gasketed rabbet. Trims to be fastened with machine screws or bolts fastening to permanently affixed nuts on the cabinet. Self-tapping screws or self-adjusting clamps are not acceptable. Doors and trims to be gasketed.
5. Cabinet door to be equipped with a concealed full length, stainless steel continuous piano type hinge. Yale Company, Division of Eaton Security Products & Systems, Catalog Number S 1400, or Corbin Cabinet Lock Company Catalog Number 1000 vault handles with disc tumbler locks and three point latch to be provided on doors twenty-four inches or over in height. Yale Company, Division Eaton Security Product & Systems Catalog Number T 1403, or Corbin Cabinet Lock Company Catalog Number 1001 handles with disc tumbler locks and one point latch to be provided on doors under twenty-four inches in height.
6. A full size typewritten directory with frame and glass face to be furnished and installed on the inside of the door of each cabinet. The directory frame to be secured to the door without the use of screws or holes.
7. Two keys to be furnished with each cabinet and lock. All cabinet locks to be provided to accept a CTA CAT 60 Master Key (Corbin Lock or H. Hoffman Co.). Lock to be arranged to permit key removal in locked and unlocked positions.
8. Panels associated with fare control equipment to be provided with an additional padlock hasp.
9. Site conditions may dictate other construction.
10. Panelboards located in non-temperature controlled environments, outdoors or in subway areas to be NEMA Type 3R or 4X fabricated from 12 gauge type 304 stainless steel, continuously welded seams ground smooth and provided with drip shield and wall mounting brackets, gasketed formed door that closes against formed external return flanges of the enclosure body, continuous stainless steel hinge, heavy duty padlockable stainless steel handle with 3 point catch, 120 volt thermostatically controlled strip heater with barrier. In addition, panels located in subway areas to be provided with a breather drain as manufactured by Crouse Hinds catalog number ECD18 or approved equal.
11. Each panel to be provided with drip shield rain hood.

C. Circuit Breakers:

1. Circuit breakers to be of the bolt-in type, industrial heavy-duty, quick-make, quick-break, single or multi-pole of the type specified herein and shown on the Drawings.
2. Circuit breakers to be thermal magnetic type with common handle for a multiple pole circuit breakers. Circuit breakers to be a minimum 100 Ampere frame and through 100 Ampere trip sizes to take up the same pole spacing. Single pole circuit breakers rated at 15 and 20 Amperes to be UL listed as type SWD for lighting circuits.
3. Circuit breakers for larger than No 10 AWG wire termination to be provided with circuit breaker wire terminal that excepts the larger wire size.
4. Molded case circuit breakers to provide circuit overprotection with inverse time and instantaneous tripping characteristics. Ground fault protection to be provided where shown on the Drawings.
5. Circuit breakers to be operated by a toggle-type handle and to have a quick- make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker to be clearly indicated by the handle position.
6. Contacts to be non-welding silver alloy, and arc extinction to be accomplished by means of “DE-ION” arc chutes.
7. Circuit breakers to have the minimum symmetrical interrupting rating capacity as shown on the Drawings.

8. Each panelboard breaker to be connected to the main bus with copper bus bar. Insulated cable is not acceptable.
9. Circuit breakers to be Eaton, Siemens, or General Electric.
10. Breakers for Distribution Panels to be full size E or F frame 240 or 480 volt as required. Circuit breakers for lighting and receptacle panels to be 480/277 volt rated Eaton Type GHB or Siemens Type BQD.

D. Lighting Contactors:

1. Photo-Cell controlled lighting contactors to be installed within the respective lighting panels for both normal and reliable platform and station lighting circuits as shown on the contract drawings.
2. Lighting Contactors to be located at the lower portion of the respective panels and be provided with a separate removable trim and door.
3. Lighting contactors shall be electrically held, 30 Ampere with the number of contacts and number of lighting contactors as determined by the number of circuits to be controlled. There shall be 25 percent spare and a minimum of two spare contacts in each panel. A maximum of four lighting contactors shall be provided in each panel. Additional contactor cabinet shall be provided if more than 4 contactors are required. Lighting contactors to be Square D Class 8903 Type LO or Eaton Type CN35.
4. Lighting contactors shall have a maximum of eight normally closed contacts with the control circuit controlled by a remote photocell and arranged for fail safe operation where a failure of any control component will turn the controlled lighting on.
5. Control circuit to be powered from a 15 Ampere 1 pole breaker in the reliable panel.
6. If only one or two sets of lighting panelboards require lighting contactors the interposing control relays may be located within the Reliable lighting panel. Control relays to be 3 pole double throw, 120 Volt AC, and Octal style base with LED indicating light, test feature, matching socket with screw clamping terminals and hold down spring. Contacts to be rated 1/3 HP at 120 volt AC, pilot duty Class B 300. Relays to be Eaton Type D3PF or Square D Type RUM. Test-Auto switch to be located on the contactor door.
7. If more than two sets of lighting panels requiring lighting contactors are required separate wall mounted specialty local control panel as specified in specified in section 26 17 50 Local Control Panels shall be supplied.

E. Fusible Switches:

1. Fusible switch units, 30 Ampere through 400 Amperes to be quick-make, quick- break design, rated not less than 200 KAIC with rejection type fuse clips. Switch units 600 amperes and larger to be of the bolted pressure type rated 200 KAIC with Class L fuses.

F. Transient Voltage Surge Suppressors (TVSS)

1. The Contractor to provide Transient Voltage Surge Suppressor (TVSS) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the Contract Drawings.
2. Each TVSS to be remote mounted as shown on the Contract Drawings.
3. TVSS units and all components to be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).
4. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
5. Maximum Continuous Operating Voltage (MCOV) – The MCOV not to be less than 115% of the nominal system operating voltage.

6. The suppression system to incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system not to utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
7. Protection Modes – The TVSS must protect all modes of the electrical system being utilized.
8. Nominal Discharge Current (In) – All TVSS' applied to the distribution system to have a 160kA In rating regardless of their TVSS Type (includes Types 1 and 2) or operating voltage. TVSS' having an In less than 20kA to be rejected.
9. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device not to exceed the following:
10. Maintenance Free Design – The TVSS to be maintenance free and not to be requiring any user intervention throughout its life. TVSS' containing items such as replaceable modules, replaceable fuses, or replaceable batteries not to be accepted. TVSS' requiring any maintenance of any sort such as periodic tightening of connections not to be accepted. TVSS' requiring user intervention to test the unit via a diagnostic test kit or similar device not to be accepted.
11. Balanced Suppression Platform – The surge current to be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable TVSS modules not to be accepted.
12. Electrical Noise Filter – Each unit to include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise to be up to 50 dB from 10 kHz to 100 MHz using the MIL-TVSS-220A insertion loss test method. Products unable able to meet this specification not to be accepted.
13. Internal Connections – No plug-in component modules or printed circuit boards to be used as surge current conductors. All internal components to be soldered, hardwired with connections utilizing low impedance conductors.
14. Monitoring Diagnostics – Each TVSS to provide the following integral monitoring options:
    a. Protection Status Indicators - Each unit to have a green / red solid-state indicator light that reports the status of the protection on each phase.
        i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units to also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. TVSS' that indicate only the status of the L-N and L-G modes not to be accepted.
        ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
        iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase will not to be accepted.

    b. Remote Status Monitor – The TVSS must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts to change state under any fault condition.

c. Audible Alarm and Silence Button – The TVSS to contain an audible alarm that will be activated under any fault condition. There to also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The TVSS to be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter to trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton to also be standard, allowing the surge counter to be zeroed. The reset button to contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button to be depressed for a minimum of 2 seconds in order to clear the surge count total.

    i. The ongoing surge count to be stored in non-volatile memory. If power to the TVSS is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption to be stored in non-volatile memory and displayed after power is restored. The surge counter's memory not to require a backup battery in order to achieve this functionality.

15. Overcurrent Protection

    a. The unit to contain thermally protected MOVs. These thermally protected MOVs to have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element to disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

16. Fully Integrated Component Design – All of the TVSS' components and diagnostics to be contained within one discrete assembly. TVSS' or individual TVSS modules that must be ganged together in order to achieve higher surge current ratings or other functionality not to be accepted.

17. Safety Requirements

    a. The TVSS to minimize potential arc flash hazards by containing no user serviceable / replaceable parts and to be maintenance free. TVSS' containing items such as replaceable modules, replaceable fuses, or replaceable batteries will not to be accepted. TVSS' requiring any maintenance of any sort such as periodic tightening of connections will not to be accepted. TVSS' requiring user intervention to test the unit via a diagnostic test kit or similar device will not to be accepted.

    b. TVSS' designed to interface with the electrical assembly via conductors to require no user contact with the inside of the unit. Such units to have any required conductors be factory installed.

    c. Side mount TVSS' to be factory sealed in order to prevent access to the inside of the unit. Side mount TVSS' to have factory installed phase, neutral, ground and remote status contact conductors factory installed and to have a pigtail of conductors protruding outside of the enclosure for field installation.

18. Lead length between the breaker and suppressor to be kept as short as possible to ensure optimum performance. Any excess conductor length to be trimmed in order to minimize let-through voltage. The installer to comply with the manufacturer's recommended installation and wiring practices.

19. All enclosed equipment to have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated in these specifications and as shown on the drawings.

20. TVSS Manufacturers which may be incorporated in the Work include but not limited to Eaton / Cutler-Hammer or Siemens.

G. Interiors:

1. Interiors to be completely factory assembled with bolt on devices. The interior to be so designed that circuit breakers can be added or replaced without disturbing adjacent units and without removing main bus connectors, and to be so designed that circuits may be changed without additional machining, drilling, or tapping. Spaces for future breakers to have bussing provided, of the required capacity, for the maximum device that can be fitted into them.
2. All bus to be hard drawn electrolytic copper, having 98 percent conductivity and sized on a basis of 1000 Amperes, maximum, per square inch of cross sectional area.
3. Neutrals, where called for, to be grouped and arranged on a common bus.
4. Each panelboard to be furnished with a full-length ground bus drilled and tapped to accommodate a ground cable for each circuit breaker. Cable terminals to be provided.
5. Compression type cable lugs for terminating cables and equipment within the panel and entering and leaving the panel to be furnished by the equipment manufacturer. Copper compression connectors to be crimp, type, long barrel tin plated closed end compression. All connectors to be copper. The barrel for each cable lug to be sized for the exact cable size specified. Copper type connectors and terminations to be furnished. Copper-Aluminum connectors are not acceptable. Connectors to be Burndy Type YA, Panduit Series LCB or LCC, Anderson Type VHCL, T & B Series 54800 and 54900 as specified in another section of this division.
6. Breaker terminal lugs to be suitable for copper only cable, if available.

H. Emergency Lighting Panel (Fuse Type or Lockable Circuit Breaker Type)

1. Circuit breaker type emergency lighting panel may be provided with lockable circuit breaker handles. Circuit breaker type panel shall comply with panel construction stated elsewhere in this Specification.
2. Each emergency lighting fuse type panel shall be of the one compartment, safety dead front, plug fuse type, with the rating shown on the Drawings. Branches shall be 120 volt, single phase.
3. Each fuse position shall be provided with a numerical designation strip.
4. All branch circuit fuses shall be UL, Edison base plug fuse, Type T, of required capacity, rated at 125 volts AC in accordance with this section and as required. Fuses shall capable of interrupting the maximum short circuit current available at their load terminals.
5. Plug fuse shells shall be back connected to bus bars with studs. Bus bars, as minimum, shall be rated at full fuse loads, plus twenty-five percent for demand factor.

2.02 MANUFACTURERS

A. Manufacturers which may be incorporated in the Work include but not limited to Eaton, Illinois Switchboard Corporation, Chicago Switchboard, Berthold Electric Co, Eaton Corporation, or Erickson Electric, Square D, or Siemens.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawing and the equipment manufacturer's instructions.

B. Each surface mounted panelboard to be supported and mounted away from the wall with "C" shaped channel. The channel to be fiberglass, when stray current control isolation is required, and hot dipped galvanized steel for normal applications. The minimum separation between the equipment and the wall to be one inch. For exterior or subway locations mounting channel to be stainless steel.

C. The equipment to be installed with work space clearances required by the City of Chicago Electrical Code.

D. The equipment to be installed to permit maintenance and replacement of parts, and to be clear of all openings with swinging or moving doors, partitions or access panels.

E. Each panelboard to be mounted with the top a maximum of 6 feet, 6 inches above the finished floor unless shown otherwise shown on the Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of the PANELBOARDS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work for the PANELBOARDS will be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. ELECTRICAL Work: 260000

END OF SECTION

SECTION 26 49 00

GENERATOR TAP BOX

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. The furnishing and installing of generator tap box as well as required appurtenances.
2. This Contractor to furnish and install the generator tap box as shown on the Drawings.

1.03 RELATED WORK

A. The Generator Tap Box to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 261000 “Basic Electrical Materials and Methods”
3. Section 261230 “Wires, Cables, Splices, Terminations”
4. Section 261900 “Grounding”
5. Section 261950 “Identification”
6. Section 269500 “Electrical Testing”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, shop drawings, conduit layouts, installation drawings, diagrams, schedules and samples in accordance with Division 01 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this section.

B. The Contractor shall prepare and submit to the Commissioner, for review, before fabrication and assembly of equipment, one electronic copy of CD ROM and one electronic PDF copy of shop drawings and other submittals including, but not limited to, the following:

1. Shop drawings showing the elevations, section views and mounting details of the equipment.
2. Shop drawings for the equipment showing components, fabrication and installation. All dimensions for rough in work at the site shall be provided. The drawings shall show the

supports for the installation of the equipment which shall be provided as part of this Specification.

3. The shop drawings shall show the details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
4. Wiring Diagrams:
    a. Connection diagrams for the wiring of equipment shall be included.
    b. Interconnection diagrams shall show the wiring to equipment. The terminal block points shall be clearly identified for the external wiring which shall be routed in or out of the cubicles. The wiring diagrams shall provide adequate space at the terminal blocks for the addition of cable and wire designations for the external wiring to be routed in or out of the equipment.

5. Bills of material shall include all items with catalog cuts describing the electrical and physical characteristics of each item.
6. Contractor shall check shop drawings for accuracy and contract requirements prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to the specifications and drawings. This statement shall also list all exceptions to the specifications and drawings. Shop drawings not so checked and noted shall be returned.
7. The Commissioner’s check shall be for conformance with the design concept of the project and compliance with the specifications and drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Contract Documents.
8. All dimensions shall be field verified at the project site and coordinated with the work of all other trades.

C. Provide product overview data, applicable standards and certifications, catalog number order information, product selection information, technical data and specifications and installation support hardware information. Provide data with respect to approved use in classified hazardous locations. Contractor shall submit proposed product data for approval by the Commissioner.

D. The Contractor shall submit, for record and distribution in accordance with the Division 01 Sections, Project Closeout, prior to shipment of the equipment, one electronic copy on CD ROM and five PDF electronic copies and ten hard copies of Instruction, Operation and Maintenance manuals for the equipment.

1. Operation and Maintenance manuals shall include descriptive bulletins and operation leaflets for the equipment.
    a. Each Instruction, Operation and Maintenance manual shall be in a three-ring hard binder with tabbed sections. The binder cover shall have the project name and equipment name. The lettering shall be block type and shall be a minimum height of 1/2 inch.
    b. Each Instruction, Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
    c. The "Record Document" Drawings larger than 8 1/2 inches by 11 inches shall be fan folded.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

E. The Contractor shall submit shop drawings and other data sheets that were revised or modified during installation; in accordance with Division 01 Sections, Project Closeout. The Contractor to submit one electronic copy in CD ROM and five PDF electronic copies and ten hard copies of any shop drawings and other data sheets that were revised or modified during installation. These paper hard copies shall be inserted in the previously submitted instruction manuals.

F. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Generator Tap Box to be fabricated in accordance with the details contained in the Contract Documents, and to provide adequate and proper space for all wires, connections, terminations, and taps.

B. Cabinet to be provided in a stainless steel type 304 enclosure:

1. The cabinet to be fabricated from a minimum Number 10 U.S. gage stainless steel continuously welded outside of seams, ground smooth and thoroughly cleaned.
2. The cabinet to be equipped with mounting lugs, continuous stainless steel piano hinged overlapped double doors on the front, continuous stainless steel piano hinged drop down door on the bottom for temporary generator cable entrance. Doors to be equipped with stainless steel Corbin 1000 lever handle cabinet locks with CAT 60 key and three-point latching. Doors to also be provided with stainless steel padlocking provisions.
3. The cabinet to be a rated NEMA Type 3R enclosure.
4. Specific site requirements may necessitate the addition of floor stands constructed of 10 gage Type 304 Stainless Steel. When permanent conduit connections are to be made through the bottom of the enclosure the enclosure to be designed with extra width for integrated side gutter.

C. Bus Work:

1. Bus bars to be hard drawn silver plated electrolytic copper of 98 percent conductivity, rated at a minimum current density of 1000 Amperes per square inch and to be installed as shown on the Drawings.
2. Insulators to be provided as required and as shown on the Contract Drawings. Standoff insulators for bus bars to be 600 volt rated. Enclosure to be provided with a one inch thick insulated back pan size as shown on the Drawings.
3. Load side lugs for permanent connection to the station distribution system to be provided for cable sizes as shown on the contract drawings and to be provided as long barrel 2 hole for phase and neutral connections and long or short barrel 1 hole for ground connection. Lugs to be copper compression type in accordance with specification. Lugs for temporary connections of generator cables to be current rated specifically designed and approved for use with extra flexible copper emergency cables.

2.02 MANUFACTURERS

A. Manufacturers which may be incorporated in the Work include but not limited to Illinois Switchboard Corporation, Berthold Electric Company, or Hoffman.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment to be installed as shown on the Drawings.

B. Unless otherwise indicated conduit openings as required for the installation of conduits indicated on the Drawings to be provided by the installing Contractor. Conduit connections to be made with weatherproof conduit hubs.

C. Cabinets to be supported and mounted as shown on the Drawings with stainless steel channels. The minimum separation between the equipment and wall to be one inch.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of the GENERATOR TAP BOX will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work for the GENERATOR TAP BOX will be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. ELECTRICAL Work: 260000

END OF SECTION

SECTION 26 50 10

LIGHTING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This specifies the methods of construction and installation that apply to lighting fixtures, exit lights, emergency lights, motion sensor switches and accessories required for a complete interior and exterior lighting system at rapid transit stations.

B. The Contractor to furnish and install all lighting fixtures as shown on the Drawings and indicated on the light fixture schedule.

C. The Contractor shall provide custom wireways with Platform and Platform Exit Stair luminaires. The custom shall be complete with custom mounting brackets. The wireway shall be provided by the approved manufacture so that all material and finishes match.

D. All fixtures to have UL label, CSA label, ETL label and/or other National Recognized Testing Laboratory (NRTL).

E. Fixture catalog numbers specify the standard of quality and appearance required and to represent the basic fixture of that type. Substitutions to the listed acceptable manufactures will not be accepted until the Contractor has complied with the requirements of the Related Documents, Submittal Procedures.

F. Lamps, mounting brackets and mounting hardware for all fixtures to be supplied by the Contractor.

G. LED light sources and power supplies to be supplied by the approved manufacturer.

1.03 RELATED WORK

A. LIGHTING FIXTURES specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 26 01 00 “General Provisions”
2. Section 26 03 00 “Electrical Demolition”
3. Section 26 05 00 “Raceways and Boxes”
4. Section 26 10 00 “Basic Electrical Materials and Methods”
5. Section 26 12 30 “Wires, Cables, Splices, Terminations”

6. Section 26 14 10 “Wiring Devices”
7. Section 26 17 00 “Local Control”
8. Section 26 17 50 “Local Control Panels”
9. Section 26 19 00 “Grounding”
10. Section 26 19 50 “Identification”
11. Section 26 47 00 “Panelboards”
12. Section 26 50 30 “Cable and Light Tray Enclosure”
13. Section 26 95 00 “Electrical Testing”

1.04 SUBMITTALS

A. Contractor shall provide submittals for luminaires as indicated in the “Lighting Fixture Schedule.”

B. Excess delivery times shall not be an acceptable cause for substitution of specified luminaires. Notify Architect/Engineer of any long lead luminaires that may impact project schedule within two weeks of contract award. Beyond two weeks the contractor is responsible for any costs associated with expediting the manufacturing process of the specified luminaire and/or cost associated with an approved substitute luminaire is allowed by Architect/Engineer.

C. The Contractor shall prepare and submit one electronic copy of CD ROM and one electronic PDF copy to the Commissioner for review before fabrication according to the requirements of the general conditions and Division 1, submittal Section of these Specifications of each of the following:

1. Product Data for each fixture type, each lamp type, accessories, brackets and poles. The Contractor shall submit catalog literature for each luminaire specified in booklet form with index and a separate sheet for each luminaire, assembled in luminaire “type” alphabetical order, with specified luminaire data as required below.
2. Include data on features, accessories, finishes, and the following:

    a. Physical description of luminaire including dimensions.
    b. Emergency lighting units including battery and charger.
    c. LED driver.
    d. Energy-efficiency data.
    e. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
    f. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
    g. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    h. LED compliance testing documentation in accordance with IESNA LM-79 and LM-80 and the DOE CALiPER testing documentation for all solid-state luminaires.
    i. Vibration test reports for each fixture type demonstrating compliance to 3G level vibration testing.

D. Shop Drawings: For nonstandard or custom luminaires. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

E. Furnish quality control testing and inspection reports for the specified Quality Control inspections and tests.

F. Furnish statement of application in form stipulated by Commissioner, signed by the Contractor and Installer, stating that the Work was provided in compliance with the Contract Documents and that the installation was proper for the conditions of application and use.

G. Furnish record drawings annotated with the changes made during installation of the Work so as to be a complete set of “as installed” drawings and wiring diagrams.

H. Furnish point by point calculations for all areas illuminated by submitted fixtures. Calculations must be performed using CTA standard maintenance factor. Calculations to comply with latest revision of the CTA Electrical, Infrastructure Design Criteria Manual.

I. Samples: For each luminaire indicated in the “Lighting Fixture Schedule.” Each Sample shall include the following:

1. Full assembly
2. Lamps and drivers, installed.
3. Cords and plugs.
4. Pendant support system.
5. Turn over samples to Commissioner as additional spare parts.

J. Point by Point Calculations

1. Furnish point by point calculations for all areas illuminated by submitted fixtures. Calculations shall be performed using 0.70 overall light loss factor (LLF) for Platform and outdoor locations and 0.85 overall LLF for Station indoor locations. Contractor shall coordinate in the event area is being illuminated by more than one type of fixtures. Calculations shall be in compliance with CTA design criteria illumination levels.
2. Minimum illumination 2 feet from edge of platform shall be 20-foot candles.
3. Maximum or minimum foot candles shall be within 25 percent of targeted foot candles listed in the CTA’s Design Criteria.

K. See Section 26 01 00, General Provisions Electrical for additional submittal requirements.

1.05 INSTALLATION INSTRUCTIONS

A. The Contractor shall submit, for record and distribution in accordance with the Division 01 Sections, Project Closeout, prior to shipment of the equipment, two electronic copies on CD ROM, five electronic PDF copies and ten hard copies of Instruction, Operation and Maintenance manuals for all electrical fixtures and related items.

1. Operation and Maintenance manuals shall include descriptive bulletins and operation leaflets for the equipment.

a. Each Instruction, Operation and Maintenance manual shall be in a three-ring hard binder with tabbed sections. The binder cover shall have the project name and equipment name. The lettering shall be block type and shall be a minimum height of 1/2 inch.
b. Each Instruction, Operation and Maintenance manual shall contain the "Record Document" Drawings, complete operating and instruction manuals, spare parts lists, certified test documents, and other special data required for this equipment.
c. The "Record Document" Drawings larger than 8 1/2 inches by 11 inches shall be fan folded.

2. Spare parts bulletins shall be included with catalog cuts for each item.
3. Certified test reports shall include all assembly and subassembly test and inspection reports.

B. The Contractor shall submit two electronic copies on CD ROM, five electronic PDF copies and ten hard copies of shop drawings and other data sheets that were revised or modified during installation; in accordance with Division 01 Sections, Project Closeout. These hard copies will be inserted in the previously submitted instruction manuals.

1.06 QUALITY ASSURANCE

A. Equivalency of luminaires is determined by Engineer and includes the following data for comparative purposes.

1. Efficiency.
2. Efficacy.
3. Distribution.
4. Construction.
5. Design compatibility.
6. Manufacturer reliability based upon past performances.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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 location and application.

D. Luminaires to be compliant with UL Standards, CEC, and RoHS.

1.07 COORDINATION

A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. Pre-Installation meeting: Approximately two weeks before the scheduled commencement of work on the site, convene a meeting to review site conditions, access to installation areas, and

coordination with other trades. Do not proceed with installation until proper conditions for installation are verified.

1.08 WARRANTY

A. Warranty Requirements for All Fixtures:

1. The fixture and all its components to be warranted by the fixture manufacturer to be free from defects in material and workmanship for a period of three (3) years from the date of installation.
2. The Contractor to agree to promptly correct by repair or replacement any defect or failure of compliance that may develop within one (1) year of the date of substantial completion. Any part or material replaced under this warranty to be warranted for additional one (1) year period from the date of replacement.
3. The Contractor's obligation to include reimbursement to the City for any labor, material, transportation or reinstallation costs incurred by the City in making any correction assented to by the Contractor.

B. Additional Warranty Requirements for LED Fixtures:

1. The LED and driver components to be additionally warranted by the manufacturer for a total period of ten (10) years from date of substantial completion against defects in materials and workmanship that result in a fixture lumen depreciation of 30 percent or greater. The maximum allowed lumen depreciation annually is 3 percent.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor to furnish and install all lighting fixtures in strict accordance with the Lighting Fixture Schedule or Lighting Fixture Details as described hereunder or on the Drawings. Fixtures to be complete with all necessary accessories and related work including lamp holders, lamps, ballasts/LED power supplies, starters, LED light sources, prismatic style lens, frames, support, wiring and all connections. The Contractor to provide supports from framework where no finished ceiling occurs.

1. The Contractor shall provide and install poles and all accessories for pole mounted light fixtures.

B. The Contractor to provide auxiliary supports for mounting fixtures in areas without ceilings (i.e. exposed beams and joists) as may be required for proper installation of fixtures. Such supports to span a minimum of 2 joists for each individual fixture, and to be securely and suitable anchored to same. Fixtures not to be supported from underside of roof deck or built tees except as specifically noted otherwise on the Drawings, the detail to be followed.

C. Fixtures to bear the Underwriter's Laboratories and shall be purchased, wired and installed in accordance with regulations applicable to the CEC.

D. The Contractor to provide adequate protection for fixtures and at completion of the work they to be clean and free of foreign material. Replace all burned out or defective lamps, starters, etc., until such time as the Commissioner/CTA takes complete occupancy of the facility.

E. All material furnished under this contract to be new and of the best quality practicable for the application.

F. All fixtures to be constructed to be sturdy and rigid. Fixtures located in public areas at a mounting height of ten feet or less to be designed to be vandal resistant.

G. Fixtures and all components to be constructed, assembled and fastened for maximum endurance to the vibration (3G vibration test at 100,000 cycles) present on CTA platforms.

H. Fixtures to have simple lines and a clean uncluttered appearance. There to be a minimum of exposed hardware.

I. The fixture to be so constructed, hinged and latched that driver/transformer replacement, power supply replacement, and LED light source component replacement can be performed safely by one individual from a centrally located ladder, without requiring relocation of the ladder.

J. Fixtures to be designed and tested to maintain the temperature of all interior components (LED modules, drivers/transformers, gaskets, diffusers, etc.) below their respective manufacturers recommended normal operating temperature, for any predictable electrical or environmental operating condition.

K. Each fixture to be assembled from material components in a careful manner by persons experienced in their line of work. Forming, assembly and subassembly to be accomplished such that all parts come together in the fixture to form a complete, well fitted integrated assembly.

L. Conduit and wire entries to the fixture shall be through knock-outs provided by the fixture manufacturer on the top or end plate of the chassis. Entry shall be flush with the top of the fixture. All penetrations to the fixture shall be properly sealed. Field drilled holes shall be sealed with manufacturer supplied gasket.

M. The entire lens area of the fixture (exclusive of door frame members) to be uniformly illuminated. There to be no black or unlit areas including those areas where drivers/transformers, power supplies, or mounting hardware are located.

N. Fixtures and luminaires primarily made of steel must be manufactured in the United States and adhere to the ARRA Buy American Compliance Act on all Federally funded projects.

O. Exterior Light Poles

1. The Contractor shall provide and install poles and all accessories for pole mounted light fixtures.
2. If light poles are required for platform lighting, provide 4 inch diameter tubular steel luminaire support poles. Poles shall be of sufficient length to provide a nominal height of ten feet above the platform when resting on the platform support beams. Poles shall be designed for a maximum wind loading of 100 MPH, with the specified fixture. Provide plates, supports, and hand holes.

3. All welds shall be ground smooth and the poles shall be given a shop coat of primer, and made ready for field painting as indicated in specification 26 10 00 Basic Electrical Materials and Methods.
4. The ingress protection (IP) rating of the pole mounted light fixture shall be IP-66.

2.02 POWER DISCONNECT FOR LED DRIVER

A. Provide a power disconnect in the conductors supplying the fixture LED engine.

B. Disconnect to be self-aligning (polarized) snap in type and to contain three wires, one each for the hot, neutral and equipment ground conductor.

C. Disconnect to facilitate easy removal of the LED engine for maintenance and to be prewired by the fixture manufacturer.

D. Male side of disconnect to be connected to the LED engine power lead-in wires so that exposed contacts are dead in the disconnected position.

E. Disconnect to be UL listed. The dielectric strength of the connector to be 1500 volt minimum.

2.03 WIRING FOR FIXTURES

A. Wire inside fixtures to be copper conductor of ampacity required plus twenty-five percent for continuous load.

B. Insulation to be rated for 1000 volt AC and to be rated for operation at a minimum 200 degrees Celsius in dry locations.

C. Provide type FF glass braid insulation.

D. All connections inside the fixtures to be made with wire nuts rated for a minimum of plus 90 degrees C.

2.04 ON/OFF TOGGLE SWITCH FOR FIXTURES

A. Provide a toggle switch or quick disconnect in the conductors feeding lamps or LED boards from the ballast or LED engine.

B. Toggle switch to contain all wires and equipment ground conductor. Toggle Switch to facilitate easy removal of the power supply for maintenance and to be prewired by the fixture manufacturer.

C. Toggle switch to be UL recognized and CSA approved. The dielectric strength of the connector to be 1000 volt minimum.

D. Toggle Switch to be installed next to power supply.

2.05 FUSE HOLDER AND FUSE FOR FIXTURES

A. Fuse holder to have compact through-panel design and facilitate easy replacement of fuse.

B. Fuse Holder to be rated for 30 Ampere, 600VAC.

C. Fuse Holder to be UL recognized and CSA approved.

D. Fuse shall be replaceable type and shall be properly rated to protect the fixture, minimum 5 Ampere replaceable fuse.

2.06 LED LIGHT SOURCE FIXTURES

A. General:

1. Manufacturers shall have at least (5) years experience manufacturing LED fixtures.
2. LED Light Source Fixtures to be of the type called for on the light fixture schedule.
3. Available Manufacturers as listed in the Lighting Fixture Schedule on the Drawings.
4. The LED light source shall have a color temperature of 4000 Kelvin as shown on the Drawings and color rendering index (CRI) of 80 minimum.
5. Lumen depreciation shall be measured according to IESNA LM-80. Reported lumen maintenance shall be reported and calculated according to IESNA TM-21. Luminaire manufacturer shall report all lumen maintenance values using the EnergyStar TM-21 calculator. All photometric data shall be obtained from a ILAC Accredited facility using IESNA LM-79.
6. Life/lumen maintenance shall provide greater than or equal to 70 percent of the initial lumens L70 at 100,000 hours. The maximum allowed lumen depreciation annually is 3 percent.
7. The fixtures shall be rated for operations at minus 30 to plus 40 degrees Celsius.
8. The fixture efficacy shall not be less than 85 lumens/watt delivered.
9. The LED boards and driver shall not be mounted directly to the fixture housing and shall be mounted with standard available hardware.
10. The LED chips used shall be manufactured by Samsung, Cree, Philips-Lumiled, or Nichia.
11. The fixture shall be Design Lights consortium (DLC) listed, and RoHS compliant.
12. Fixture shall have integral over-temperature protection which does not result in the fixture turning off but rather the reduction of drive current through dimming.
13. LED lighting components shall be nominal length as required to completely and uniformly fill the luminous opening of the fixture.
14. Fixtures shall have a minimum IP 65 rating or UL wet listed label.

B. LED Light Source Fixture Sub-Assembly:

1. Each LED Light Source Fixture to consist of one complete sub-assembly designed for field installation. Sub-assembly to consist of the following:

    a. LED board.
    b. Heat sink/chassis.
    c. Mounting plate.
    d. Power supply.
    e. Internal ON/OFF toggle switch.

f. Fuse.

2. LED light source sub-assemblies will be built to UL8750 for LED Lighting Equipment and to UL1598C for Luminaire standards.
3. The LED light fixture to consume zero (0) watts in the off-state, excluding any control devices.
4. Installation and maintenance instructions for all LED light source sub-assemblies to be provided by the manufacturer.
5. LED Light Sources shall have a minimum CRI of 80 with a minimum CCT of 4000K unless otherwise stated on the Drawings.

C. LED Power Supply:

1. Power supply to be Class 2 rated for a nominal input voltage of 120 to 277VAC with a voltage range of 108 to 305 VAC and a constant output voltage of 24VDC with an input frequency of 50/60 Hz, Nominal current of 2 Ampere, Current range of 1 Ampere to 2 Ampere, Current overshoot less than 20 percent, Ripple current less than 5 percent, and output voltage range of 18 to 24 VDC.
2. Power Supply to be securely fixed to mounting plate so that it is not affected by vibrations.
3. Power supply to carry UL and CE labels.
4. Power supply to be rated for temperatures ranging from minus 30 to plus 40 degrees C. The power supply to be suitable for use in dry and damp locations. The Total Harmonic Distortion (THD) to be less than 20 percent. The power supply to have a power factor greater than 95 percent. The power supply to have an audible noise rating of Class A or better.
5. Power supply line transient harmonics to comply with EN 61003-2 and EMC immunity to comply with IED 640004-4. Surge protection to comply with combination wave test procedures per IED 610004-5 and ANSI C62.41.
6. The power supply to be long-life (100,000 hours) and carry a ten (10) year warranty.
7. Manufacturer to be a full line power supply manufacturer with a ten (10) year history of producing power supplies for the North American Market.
8. The power supply to conform to FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).
9. The electronic power supply to be Philips Advance, MeanWell, Thomas Research Product, or approved equal.

D. Lumen Depreciation:

1. Lumen depreciation per IESNA LM-80 is compared to the published lumen output of the product per IESNA LM-79 testing and reporting standards.
2. Normal accumulation of particles on the optical surfaces to not be factored into the lumen depreciation.
3. A Coloring Rendering Index (CRI) of 85 or higher to apply to all LED lamps.

E. Light Engine Wattage:

1. Light engine wattage will vary by light fixture type.
2. Life/lumen maintenance to provide greater than or equal to 70 percent of the initial lumens at 100,000 hours.

2.07 RECESSED FIXTURES

A. Recessed fixtures to be of type suitable for mounting in the type of ceiling as scheduled on the Fixture Schedule. Variations to catalog numbers indicated on the Fixture Schedule to be made by the Contractor prior to placing order for the fixtures to insure proper mounting arrangement.

2.08 EXTERIOR LIGHTING

A. The Contractor to furnish labor and install all material necessary to provide exterior lighting as indicated on the Drawings.

1. Fixtures to be suitable for outdoor surface and suspended mountings.
2. Fixtures to be of the enclosed and gasketed type suitable for wet locations.
3. Ends and body to be one piece or to be made one piece by continuous (Heliarc) welding all seams, grinding them smooth and finishing to match the various parts.
4. Fixtures shall be IP-66 rating unless shown otherwise on the “Lighting Fixture Schedule”.

B. Chassis Construction:

1. Chassis of exposed fixtures to be constructed of Number 316 stainless steel.
2. All seams in the chassis to be externally welded shut, ground smooth and finished to make a watertight enclosure. Welding to be continuous of the Heliarc type.
3. Strength:

    a. Fixture chassis to be designed with sufficient rigidity and strength to protect the components inside from damage and withstand without fracture or excessive permanent distortion due to weather or moderately determined acts of vandalism.
    b. Fixture to withstand without damage 100 MPH winds and ice loads.
    c. Fixture to withstand without excessive or permanent distortion a two hundred pound weight suspended from one end when it is supported from one point, 6 inches in from the fixture ends on its central axis for the 4 foot fixture.

4. Chassis to be shaped to enhance structural rigidity and to provide a seat on which the door frame and its gasket to seal.

C. Finishes:

1. Stainless steel fixtures to have a natural satin Number 4 finish.
2. Seam welds on all chassis to be ground smooth and finished to match surrounding metal.

D. Diffuser (Door) Frame:

1. Frame to rigidly and totally enclose and support the perimeter of the fixture diffuser and to mate with the fixture chassis to form a weather tight seal.
2. Frame to be constructed of minimum 12 gage angle iron. Corner to be mitered and seams fully welded and ground smooth. Frame material to be the same as chassis.
3. Frame members and joints between members to have sufficient rigidity as a unit to prevent distortion during re-lamping.

4. Frame to be fully hinged along the long axis of the fixture with a continuous hinge. Door frame to be attached to hinge at every six inches with stainless screws.
5. Door frame to be so constructed and latched that the sealing gasket interface between the chassis and frame is compressed along its entire length.
6. Frame to be constructed to permit removal of lens for replacement without demounting the fixture or removal of the door. Removal to be accomplished without breaking or distorting the frame.
7. Frame to securely enclose the diffuser but to provide adequate clearance for differential thermal expansion and contraction and to permit diffuser to deform when it accepts impact.

E. Gaskets:

1. Gasketing to be continuous on both sides and ends of the fixture between the hinged door and the upper housing (chassis) and between the diffuser and its supporting frame fixture body.
2. Gasketing material to be close cell sponge neoprene, soft or medium density, evenly textured with high resistance to aging, heat, ultra-violet light, water, oils, weathering and setting.
3. Gaskets to be cemented to the various components with resilient neoprene sealing compound. Compound to be compatible with the finish to which it is applied.
4. Gasket to not exhibit any noticeable stiffening at temperatures down to 0 degree F and to be satisfactory for long life in summer and winter temperatures in Chicago.
5. Water and aqueous solutions to not cause swelling nor be absorbed by the gaskets.
6. Gasket to be self-extinguishing and flame resistant.

F. Mechanical Components:

1. Hinges for external fixture components.

    a. Hinges to be continuous and designed to prevent accidental disconnection of connected fixture components while being hinged down and in the open position.
    b. Hinge to be fabricated from the same material as the pieces connected thereby and to be sufficiently rigid to prevent distortion in service.
    c. Hinges where not an integral part of connected components to be affixed to the pieces connected thereby with a continuous weld or other approved means to prevent distortion in service.

2. Hinges for internal fixture components:

    a. Hinges for reflector and other internal fixture components to be suitable for the weight suspended and the service requirements.
    b. Hinges to be firmly affixed to the pieces they connect and to not bend or distort in service.
    c. Hinges to be fabricated from the same or galvanically compatible materials as the pieces connected thereby.
    d. Hinges to be designed to prevent accidental disconnection of fixture components connected thereby while being hinged down and in the open position but to be capable of ready disconnection for removal or replacement of parts.

3. Locking Devices:

a. All locking devices that must be activated for maintenance or relamping to be stainless steel with positive lock-up that will not disengage due to vibration caused by the trains.
b. All locking devices to be of the captive design. Only stainless retainers to be used to retain the screws in place.
c. External locking devices to be tamper resistant screws.
d. Internal locking devices to be quarter turn fasteners thumb operated type.

4. Fasteners:

a. All threaded fasteners to be made of the same material as the piece into which they are threaded. No aluminum fasteners will be permitted.
b. All fasteners to have a thread sealant applied to prevent vibration from loosening same.

G. Illumination Components:

1. Lamps:

a. LED
1) LED lighting components to be nominal length as required to completely fill the length of the fixture.
2) LED color 4000K

2. Reflectors:

a. Reflectors to be formed from stainless steel and to extend the full width and length of fixture.
b. Reflector to fasten into position with 1/4 turn fasteners and to lock- up tight to prevent noise during vibration of fixture.
c. Reflectors to be finished with high reflectivity glass white enamel, baked on after the reflector has been degreased and phosphatized. Minimum reflectivity to be eighty-seven percent.
d. Reflector mounting to be such that the reflector can be easily removed for ballast changing by one man unaided.
e. Reflector to be prevented from falling out of the fixture when it is unlatched. Provide safety chains, hinges or other approved means of sufficient number and so located as to prevent reflector from swinging down and causing injury.
f. Reflector to be "V" shaped in the middle to give better lighting distribution and increase the efficiency of the fixture.

3. Diffuser:

a. Diffuser to be fabricated from 0.187 inch thick prismatic clear polycarbonate.
b. Diffuser to effectively obscure the outline of the source during fixture operation and to as far as practical maintain an even surface brightness across the diffuser.
c. Lens/diffuser to be fully enclosed and mechanically held in a completely gasketed, rigid door frame.
d. The combination of lens/diffuser to have all edges sealed to keep out dust, dirt and moisture.
e. Provide prismatic and clear polycarbonate lens manufactured from General Electric "Lexan" or Rohm and Haas "Tuffac".

f. The light transmittance rating of the lens to be 0.86 inch minimum.

H. UTILITY POLES:

1. Provide tubular steel support poles as shown on the Drawings. Poles to be of sufficient length to provide a nominal height of ten feet above the platform when resting on the platform support beams.
2. Poles to be designed for a maximum wind loading of 100 MPH, with the specified fixture.
3. Provide plates, supports, and handholes as shown on the Drawings.
4. All welds to be ground smooth and the poles to be given a shop coat of primer and made ready for field painting as indicated in Specification 261000. “Basic Electrical Materials and Methods”

2.09 LIGHT CONTROL

A. Provide local switching for all employee, maintenance, equipment and storage spaces.

B. All platform lighting shall be controlled from a single photocell, and panelboard mounted electrically held contactor, as shown on the Drawings.

C. Provide local switching or occupancy/vacancy sensors for all employee, maintenance, equipment and storage spaces. All other individual circuit switching shall be done at the panel board.

D. Bridge Level lighting to be controlled by the single photocell and dimmer control system to allow for automatic light level controlling.

E. Provide Late Night Shut down controls as shown on the Drawings.

F. Lighting Contactors:

1. Contactors shall be panelboard or control panel mounted as called for on the Drawings.
2. Contactors shall be 600 volts AC, and ampere rated as required, electrically operated, and held.
3. Acceptable manufacturers shall be Automatic Switch Co., Zenith, or Square ‘D’.

G. Photo-Electric Control:

1. The Contractor shall provide an automatic photo control as shown on the Drawings with the following features:

a. The capacity shall be 1800 watts tungsten at 120 or 208-277 volts, 60 Hertz.
b. The contacts shall be single pole, single throw; contact position at night shall be normally closed.
c. Three prong locking type photo control shall be with locking type receptacles mounting bracket.
d. High impact plastic weatherproof enclosure shall be with built-in lighting arrester.
e. Temperature range shall be minus 40 degrees F to plus 170 degrees Fahrenheit.

f. Thermal delay of 15 seconds shall be provided to prevent switching by artificial light.
g. Hermetically sealed cadmium sulfide light sensitive element shall be provided.
h. Operating levels shall be from 2 to 10 foot candles.
i. Acceptable photo-electric control manufacturer shall be Fischer Pierce Co. or Sigma Corp. Series FP-120.

H. The lighting control panels shall be constructed in accordance with the requirements of Section 261750 Local Control Panels

2.10 ENVIRONMENTAL CONTROL

A. Gaskets:

1. Gasket shall be applied continuous at specified interfaces.
2. Gasket shall be applied around diffuser and its supporting frame and around diffuser door frame and fixture body.
3. Gasket material shall be closed cell neoprene, soft or medium density, even textured with high resistance to aging, heat, ultra-violet light, water, oils, weathering and setting.
4. Gaskets shall be cemented to the various components with resilient neoprene sealing compound. Compound shall be compatible with the finish to which it is applied.
5. Gasket shall not exhibit any noticeable stiffening at temperatures down to 0 degrees Fahrenheit and shall be satisfactory for long life in summer and winter temperatures in Chicago.
6. Water and aqueous solutions shall not cause swelling nor be absorbed by the gaskets.

B. Any drilling made on the fixture for conduit entry or mounting shall be sealed using manufacturer supplied gaskets and weather proof silicone sealers.

2.11 TESTS FOR FIXTURES

A. Fixtures shall be submitted in accordance with the requirements of Related Documents. The Commissioner will determine if the submittal is in compliance with the requirements of this specification prior to the final acceptance of the fixture. Contractor shall submit one sample of each type of light fixture for approval of the Commissioner.

B. Contractor must require the manufacturer’s production facility available to CTA for inspection before and after manufacture of the fixtures called for under this contract.

C. The main beam shall be at 90 degrees to the lens surface.

D. The following test reports shall be provided for each fixture.

1. Photometric calculations (from 3 separate lighting manufacturers)
2. Vibration test data
3. LM-80
4. LM-79
5. TM-21 projection

E. Lighting fixture must be completely assembled, wired, adjusted and tested at the factory. Provide inspection before and after assembly that must assure correctness of design and workmanship. After assembly, custom lighting fixtures must be tested for operation under simulated operating conditions.

F. Complete set of tests must be performed at the factory. Test must include manufacturers' standard, commercial tests as specified.

G. Overall efficiency (fixture output in lumens/lamp lumens) shall not be less than 50 percent for all fixtures.

2.12 FACTORY INSPECTION

A. Contractor to require the manufacturer's production facility available to the Commissioner for inspection before and after manufacture of the fixtures called for under this contract. Provide advance notice of a minimum of six weeks prior to the schedule of factory testing.

B. The Contractor must pay for living, lodging, and transportation expenses for 4 representatives of the City while engaged in witness of factory tests. Living expenses must include transportation, meals, hotel (similar or equal in quality to Holiday Inn Hotels) and a rental car when inspection facilities are out of the City of Chicago area

2.13 EXIT SIGN

A. General Requirements: Comply with UL 924, be Chicago Code Approved/Wet Location, and the following:

1. Provide as indicated on light fixture schedule included with contract drawings.
2. Sign Colors and Lettering Size to comply with Chicago Fire Department requirements.
3. Internally Lighted Sign: Light source for AC Operation to be White LED, 3.7 watts, 25 year life expectancy.
4. Standard input voltage to be 120 Volts AC
5. Exit Sign to be suitable for both interior and exterior locations.
6. Housing to 20 gage stainless steel in all areas except Platform. Platform to have white powder coat finish. With vandal resistant lens. Provide wider housing depth at locations as shown on the drawings to accommodate for custom mounting brackets. Coordinate with Architect.
7. Panel: with red letters on white background, City of Chicago approved.
8. Mounting to be ceiling or back.

B. Exit Signs to be fed fused Emergency Lighting panels that are supplied power from the Uninterruptible Power Supply.

C. Available Manufacturer of Exit Sign fixtures: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Big Beam Emergency Systems.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor to install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

B. There aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, non-absorptive tape or bituminous coating to prevent corrosion. Use stainless steel fasteners. Aluminum fixtures to not be installed in contact with wood, or in any other situation where permanent moisture can exist.

C. Fixtures to be mounted plumb, level and in straight lines. Group-mounted fluorescent/LED fixtures to appear as one unit.

D. In areas where industrial type fixtures are to be installed such as Equipment Rooms, fixtures which are near obstructions near the ceiling such as ducts, large pipes, groups of pipes, etc., to be suspended so that the bottom of the fixture is not higher than the bottom of the duct, etc. Outlets not to be located until the location of these obstructions are determined. Outlets to not be covered; conduits to be installed exposed. Fixture to have standard wireguard.

E. Lighting poles, when required, to be installed as shown on the Drawings. The installation to result in vertically plumb poles, and to provide for a minimum of fixture vibration.

F. The Contractor to supply all required lamps/LED lighting components, clean lamps, diffusers, globes, reflectors and exposed-to-view surfaces of fixtures after aiming and adjusting have been approved.

G. The Contractor to provide gasketing and other means to make the fixture mounting and conduit entry watertight.

H. A 12” maximum length of liquid tight flexible conduit must be installed for connection between fixture and outlet box unless otherwise shown. Use fixture wire from outlet boxes in branch circuits to lighting fixtures.

3.02 FIXTURE SUPPORTS

A. It is the Contractor's responsibility to provide and install all hardware to support all lighting fixtures adequately. Mounting hardware must be stainless steel except when Unistrut is used.

B. Each lighting fixture to be rigidly supported from the building construction and to include suspension hangers devices and extra steel work for fixture support where required.

C. The Contractor to coordinate with the work of other trades to determine modifications required to make fixtures suitable for the location as installed, and verify the construction prior to fixture fabrication.

D. Recessed fixtures to be provided with the proper plaster frame or suitable adapter to receive the finished ceiling construction.

E. Where suspended ceilings with steel channels occur, outlets and fixtures to be supported on members resting on the channel framework. In no case to fixtures be supported from plasterboard, plaster or acoustic material. No chains to be used for hanging fixtures.

F. The Contractor not to use the lighting fixtures as raceways. Any connections to adjacent fixtures or continuous rows of fixtures to be through the conduit system. Unistrut or other metal raceways are not acceptable for wiring connections.

G. Suspended fixtures to be hung on ball and cushion swivel flexible fixture hangers, as manufactured by Appleton Electric Company or approved equal, and furnished by the Contractor and to be adjusted as necessary during installation to insure that all fixtures in the same room or area are a uniform height detailed or noted on the Drawings.

3.03 MOTION SENSOR SWITCH INSTALLATION

A. Provide conduit, wiring and boxes for installation of motion sensor switches to control lighting in the space. Install according to manufacturer's directions. Provide for manual over-ride. Install on the line or side of switches.

B. Program and adjust motion sensor switches for optimum operation at each space and Installation.

3.04 TESTING INSTALLATIONS

A. The Contractor to furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Commissioner. Schedule adjustment of exterior installations to occur during hours of darkness.

B. The Contractor to test lighting circuits for continuity and operation.

C. The Contractor to test fixtures and mounting poles for continuity of grounding system.

D. The Contractor to aim and adjust fixtures to provide distribution patterns approximately as shown and as approved.

E. Once tested and accepted by the Commissioner, Contractor to provide a minimum of 20 percent spare lamps or LED light sources (rounded to nearest whole number) for each type of light source provided.

3.05 CIRCUITING

A. The Contractor to provide complete branch circuiting between panels and lighting fixtures. Circuits to be as shown on the panel schedules.

B. Final connection to light fixture to be with heat resistant wire of the following type:

1. LED lighting 120 volt, minimum Number 12 AWG Type THWN insulation.

3.06 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

A. Furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Commissioner's Representative. Schedule adjustment of exterior installations to occur during hours of darkness.

B. Test lighting circuits for continuity and operation.

C. Test fixtures for continuity of grounding system.

D. Aim and adjust fixtures to provide distribution patterns approximately as shown and as approved.

3.08 ADJUSTING

A. Upon completion of the Work repair surfaces that have been permanently stained, marred, or otherwise damaged. Replace Work which is damaged or cannot be adequately cleaned as directed.

3.09 CLEANING

A. Upon completion of the Work, remove unused materials, debris, containers and equipment from the project site. In addition to the initial cleaning procedure required, and not more than 2 days before occupancy by the Commissioner, clean the Work as recommended by the manufacturer.

3.10 PROTECTION

A. Protect the Work during the construction period so that it must be without any indication of use or damage at the time of acceptance.

3.11 SPARE PARTS

A. Provide 10% spare LED fixtures for type LED but not less than (3) three of each type.

B. Provide a minimum of 20% spare bulbs and lamps and 5% of spare drivers unless noted otherwise (rounded to nearest whole number) for each type of lamp provided, but in no case

less than two (2) lamps and drivers per fixture type. Deliver to the Commissioner in manufacturer's original packaging and store where directed.

C. Provide 10% spare door assembly including door, lens and fastening material for every fixture type supplied on the job. Deliver to the Commissioner in manufacturer's original packaging and store where directed.

3.12 FACTORY INSPECTION

A. Contractor shall require the manufacturer's production facility available to the Authority for inspection before and after manufacture of the fixtures called for under this Contract.

3.13 FACTORY TESTING

A. The equipment must be completely assembled, wired, adjusted and tested at the factory. Rigid inspection before and after assembly must assure correctness of design and workmanship. After assembly, each switchgear assembly must be tested for operation under simulated conditions.

B. A complete set of tests must be performed at the factory. The tests must include the manufacturer's standard and commercial tests, and specified tests, as specified, and a complete simulated operational test of the equipment to guarantee successful operation.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of LIGHTING FIXTURES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of LIGHTING FIXTURES must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 51 15

LIGHTING CONTROLS INTEGRATOR

Part 1 – General

1.01 Section Includes

A. Control Integration for LED Low Resolution DMX Controlled Lighting

1.02 Related Requirements

A. See drawings, schedules, catalog cuts and Section 26 09 43 for controls and lighting components for “Specialty Lighting”.

1.03 Quality Assurance

A. Lighting & Control Systems Integrator Qualifications

1. Must meet requirements for Dealer membership in PLASA.
2. The Lighting & Control Systems Integrator (hereafter referred to as LCSI) shall employ technicians, programmers and project managers experienced in completing work of similar size or scope.
3. The LCSI shall be a lighting systems contractor who regularly engages in the furnishing, installation, commissioning, programming and servicing of systems of a similar nature, size, scope and complexity.
4. The LCSI shall for 5 years prior to the bid date have maintained a suitably staffed and equipped service organization which has continually supplied service for the systems to be used in this project.
5. The LCSI shall have on staff at least 2 technicians certified by the manufacturer to provide service on the equipment to be used in this project. LCSI shall provide phone based technical support within 30 minutes during normal business hours, and within 12 hours during evenings, weekends and holidays.
6. The LCSI shall maintain throughout the course of this project and its warranty period, all required business and professional licenses, certifications and insurance.

1.04 Substitutions

A. LCSIs who are not preapproved shall submit the following at least 14 days prior to bid date.

1. Listing of 10 equivalent installations including:

a. Name, address & contact information for project owner, lighting consultant and electrical contractor.

b. Description of project scope of work including particular manufacturers and products in use.

2. Brief description of LCSI's operations including facilities, departments and key personnel.

3. Biographical information of project manager and integration team who would be involved in this project.

4. A list of any subcontractors the LCSI intends to use including their scope and qualifications to perform that scope.

1.05 Submittals

A. At Bid Date:

1. LCSI qualifications including the Project Manager's qualifications.

2. Bill of materials for all equipment called for in section 2.02 B.

3. Expectations of time and personnel requirements for the scope of services enumerated in this specification, by service type (i.e. project management meetings, submittal documentation, developing scope of work & content schedule, field quality control, low voltage data terminations, commissioning, programming, owner training, etc.).

B. Product Data: Submit product data for each LED system that requires system integration. Review the contract documents and identify each LED system and its components including:

1. Luminaires – including data sheets and photometric data in IES file format in accordance to IES LM-79-08. Photometric data shall be based on test results from an independent, NIST traceable testing lab.

2. Power Supplies and/or Drivers

3. Controller(s)

4. Control Interfaces and Signal Amplifiers – Include network switches & routers, opto-isolators, DALI & 0-10V interfaces, DMX Network Gateways

5. Wire, Cable and Wireless Transmission/Reception Equipment

6. Mounting Brackets and/or Hardware

7. Light Control Accessories such as lenses, louvers, etc.

C. Shop Drawings: Provide coordinated wiring diagrams for each LED system and floor plans and/or elevations indicating location of each device. Device locations shall be indicated in accessible locations coordinated with construction manager.

1. Lighting fixture, power supply, control source & interface.

2. Identify wire type, size and approximate length on wiring diagrams.

3. Identify the required power & control terminations.

4. Coordinate the control addressing scheme with the lighting control system manufacturer and owner's representative.

D. Fixture Schedules – Generate Schedules for each system including the following information on a per fixture and per circuit basis:

1. DMX (or other control source) addressing

2. Control Zone Information

3. Fixture Type & Description

4. Fixture Location

5. Load

6. Fixture Serial Number where required for addressing

7. Performance requirements (dimming curves, color rendering, granularity of fade, etc.)

8. Aiming Notes

9. Other Notes (special mounting conditions, special fixture configurations or modes, desired homing positions, etc.)

E. Control Wiring Schedule – Generate a schedule showing each control wire run including:

1. Wire Number

2. Wire Type

3. Control Protocol Carried

4. End Devices – Where does each end of the wire terminate

5. Notes – Special Pin-outs, termination types, etc.

F. Sequence of Operations and Content Schedule

1. Work with owner's representative and design team to develop a document explaining how the system is to operate. This might include seasonal or holiday operations, daily operations based on time of day and/or astronomical events, manual overrides, occupancy, photocell or other sensor conditions, events scheduled through another system, and interactions with other systems such as building automation, security, fire alarm, emergency lighting, and audio-visual control systems. This document should be submitted for final approval at least 60 days prior to commissioning and approved no less than 30 days prior to commissioning.

2. Work with owner's representative and design team to develop a schedule of content to be used in the system. This might include basic lighting effects, custom video content, interactive effects, audio content, etc. This document should be submitted for final approval at least 45 days prior to commissioning and approved no less than 15 days prior to commissioning. Where custom content must be created LCSI shall coordinate timing requirements with custom content provider and ensure that sufficient time exists for content to be built and approved. Where LCSI is responsible for content acquisition and/or creation, this schedule shall be linked to a content library that is accessible by owner's representative and design team.

G. Operation & Maintenance Manuals:

1. As built drawings including schematics, details, wiring diagrams & floor plans. All wiring diagrams must include wire identification matching labels in the field.

2. Bill of materials including indication of spare equipment delivered to the owner.

3. Any revisions or modifications during the warranty period shall require that the owners' record drawings be updated.

1.06 Warranty

A. The LCSI shall provide a one year system warranty for the complete system (not including expendable supplies), effective from date of system acceptance. Within this period, the LCSI shall be the owner's sole contact for remedy, repair or replacement of system deficiencies (through manufacturers' warranties where applicable).

Part 2 Products

2.01 Acceptable Lighting Control Systems Integrator

A. Pursuant to the above requirements, the LCSI shall be:

1. Chris Prezas – 804-561-7999, chris@protolight.com

Protolight - 200 Howard Ave., Des Plaines, IL 60018

Tel: 847-859-5000

2. Other applicants to provide qualifications per above requirements, and have experience with controls equipment listed in section 260943 Digital Network Lighting Controls.

2.02 System Integration Requirements

A. Provide integration of LED luminaires and controls to comply with the Contract Documents in the following area(s):

1. Low Resolution DMX Controlled System

B. Provide all non-specified equipment required to ensure a complete, working system. This may include:

1. Signal Processing Equipment Racks & Control Enclosures – Provide racks and/or enclosures required for proper mounting & protection of all lighting control equipment

2. Networking Equipment – Switches, patch panels, cable managers

3. UPS devices – Sufficient to keep all control and communications equipment (not including light fixtures or their power supplies) operational through a 10 minute power outage

4. Signal Interfaces – Opto-Isolators, Demultiplexers, protocol converters

5. Patch & Jumper Cables – DMX, Network & Power jumpers required for a complete, working system.

C. Provide data terminations for all lighting system control wire runs (network, DMX, fiberoptic, etc.). Wire to be piped & pulled by electrical contractor to LCSI's specifications.

2.03 Mockups

A. Where required by contract documents, assist in set up and documentation of system mockups. Coordinate location and scheduling of mockup, finishes, mounting conditions and mock-up materials with contractors, design team and manufacturers. Recommend alternate components to have on hand during mockup. Provide sample programming content to approximate final content.

B. Demonstrate LED system matching the design criteria in the contract documents.

C. Document approved mockups including final mounting conditions, dimensions, finishes, accessories, content and other relevant details. Coordinate installation with Electrical Contractor to match approved mockups.

D. When not specifically required by contract documents, provide cost estimates for mockup of each system included in part 2.02.

Part 3 Execution

3.01 Field Quality Control

A. Review the contract documents for performance criteria of the LED lighting systems.

B. Coordinate the installation of the LED systems with electrical contractor and construction manager.

C. Review electrical contractors' submittal documents and bills of materials prior to release for manufacturing to ensure delivery of a complete, working system in compliance with approved mockups and contract documents.

D. Review the LED system installation for compliance with approved mockups, submittal documents and contract documents.

E. Provide guidance and offer recommendations to the electrical contractor.

F. Notify the construction manager of any installation conditions or gaps in the design scope that may be detrimental to the performance of the systems in part 2.02.

3.02 Project Management

A. The LCSI shall designate a project manager.

B. The LCSI's project manager shall be the main contact between the LCSI, manufacturers, design team and contractors from contract award through final sign off. The LCSI's project manager shall be the same person throughout the entire course of the project, unless otherwise approved by the design team.

C. The LCSI's project manager shall arrange and run a kick-off meeting at the project site or, if that is not possible, at another designated place near the project site. The objectives of this kick-off meeting are:

1. Introduce the project team members.

2. Review the project schedule. Include in this schedule all manufacture lead time information and trade coordination information such that the schedule, when approved will not delay the installation of the system.

3. Review the scope of work and any additional materials and documents not in the scope of work.

4. Layout the intent of the project.

5. Further define required mockups and work them into the project schedule.

D. LCSI shall work with the owner's representative and design team to develop an approved sequence of operations for initial system programming, as well as a list of system configuration requirements to allow future programming modifications as the project requires. Where applicable, LCSI will work with owner's representative and design team to acquire or develop content as required for initial system programming.

3.03 Lighting System Mockups:

A. The Electrical Contractor shall provide fixture and control samples with drivers & dimming modules for mockups demonstrating the performance of the LED luminaires and controls where required.

B. Mockup session shall take place during the course of 1 business day. The meeting shall take place within 30 miles of the jobsite.

C. The mockup facility shall have no daylight penetrating the space and its lighting systems shall be shut off when required during the demonstration.

D. The demonstration shall be coordinated by LCSI, with involvement of other trades as required. The LCSI shall notify the owner's representative and design team 2 weeks prior to the demonstration day. LCSI's project manager shall attend the mockup.

E. The goal of the mockup is to verify that the submitted fixtures match the specified performance criteria. Therefore, it is necessary that all parts of the mockup are actual models provided on the project.

3.04 Low Voltage Data Terminations:

A. Perform all lighting control system data terminations including, but not limited to network, dmx and fiberoptic terminations to manufacturer recommended specifications.

3.05 System Startup and Instruction

A. LCSI shall field verify that the installation is ready for factory commissioning.

B. LCSI shall coordinate system startup with the electrical contractor, lighting designer and lighting control system manufacturer.

C. LCSI shall set control addresses and fixture configurations to approved settings based on mockups and submitted schedules.

D. LCSI shall run tests and tune LED systems to match the performance requirements stated in the contract documents.

E. When lighting system is fully operational, LCSI shall demonstrate operation for owner's representative.

F. Once owner's representative has approved system operation, LCSI shall notify electrical contractor and lighting designer that aiming may be completed.

G. When the system and aiming has been approved, final on-site programming sessions with design team and owner's representative may begin. These

sessions are for the purpose of display and final approval of all content and transitions between content, as well as all user interfaces and their operation. Back end programming of triggers, scripting, scheduling, etc. shall take place at separate sessions without owner's representative and design team present. Where custom content is provided, it is preferred that content provider shall be present for these programming sessions. If this is not possible, LCSI shall provide a detailed report to content provider with thorough explanations of any and all required changes.

H. Once final programming is installed and approved, LCSI shall coordinate two four-hour training sessions for the owner's representative. These sessions shall include training on the maintenance of the system and its components and operation of all control interfaces. LCSI is responsible for coordinating manufacturer personnel for this training and ensuring the completeness of this training.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of LIGHTING CONTROLS INTEGRATOR shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of LIGHTING CONTROLS INTEGRATOR shall be included in the contract lump sum price as shown in the Schedule of Prices for ELECTRICAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000.

END OF SECTION

SECTION 26 55 60

LIGHT EMITTING DIODE (LED) SIGN BOX FOR INFORMATIONAL SIGNAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes

1. LED Sign Box drawing for discernment of applicable CTA sign box fabrication details as shown on the Contract Drawings.
2. The Contractor to furnish, install and connect all illuminated signs and sign boxes as shown on the Drawings and indicated on the Schedules.
3. This section includes providing all materials, equipment and labor to fabricate, provide, install and connect the following types of signs:

    a. Light Emitting Diode (LED) Illuminated informational signs and sign box cabinets for installation at the interior and exterior of CTA Rapid Transit Stations and other locations for customer information.
    b. Include all required accessories, attachment and attachment devices necessary for attachment of the sign boxes and make all required electrical and other connections. Provide all required conduit, wiring, switches, disconnects, other electrical devices and electrical work required for functional and proper operation of the signs.
    c. Provide and install illuminated informational signs, sign boxes, mounting accessories, attachment devices, and associated hardware for installation in accordance with requirements of the contract documents. These signs are used at various locations at the transit stations and other locations. The number of signs, size of each sign, type of sign, graphics, location for each sign and type of installation for the signs are indicated on the drawings and/or schedules. The Commissioner will supply original artwork for the sign faces in Adobe Illustrator electronic format. Remove any existing signs as applicable, specified or directed. Provide new and/or additional framing and supports as indicated on the drawings or as required for proper installation of the signs. Provide mounting accessories, attachment devices and associated hardware as specified, as shown on the drawings, or as otherwise required.
    d. Verify actual sign locations and installation conditions in the field. Verify access to electrical sources and requirements to provide power to the illuminated signs and requirements for making electrical connections.
    e. See drawings, schedules, and/or verify in the field for standard and special installation details for each sign; type of installation, anchorage, mounting heights, mounting conditions, additional framing and support required, installation accessories required, spacing of anchors and other details.

f. Refer to Specification Section 26 50 10 for methods of construction and installation that apply to interior and exterior lighting systems at rapid transit stations and other locations as they apply to illuminated sign assemblies.

4. Sign box assemblies to bear the Underwriter's Laboratories labels and to be purchased, wired and installed in accordance with regulations applicable to the Chicago Electrical Code.
5. Sign box manufacturers and catalog numbers provided herein specify the standard of quality and appearance required and to represent the basic sign box of that type. Substitutions to the listed acceptable manufacturers will not be accepted until the Contractor has complied with the requirements of the Division 01 Sections, “Submittal Procedures” and “Product Substitution Requirements”.
6. Signs, graphics, sign boxes, bulbs, mounting brackets, mounting hardware, electrical wiring, conduit, switches, disconnects and all other accessories for all sign boxes to be supplied by the Contractor. The Contractor to install the light box assemblies and make all required electrical connections for a functional and proper working system.
7. LED light sources, drivers and electrical accessories and supplies to be supplied by the approved manufacturer.
8. Reference Standards: The work is subject to applicable portions of the following standards:

   a. "Electric Signs", Standards for Safety, UL Publication 48, Underwriters Laboratories Inc.

1.03 RELATED WORK

A. LIGHT EMITTING DIODE (LED) SIGN BOX FOR INFORMATION SIGNAGE specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Division 10, Graphics Sections apply to this section.
2. Division 26, Electrical Sections apply to this section.

1.04 SUBMITTALS

A. General: Contractor to submit the following in, for the Commissioner review and approval:

B. Product data to include manufacturer's product data, technical data, complete technical specifications, construction details and installation instructions relative to materials, dimensions of individual components, profiles, finishes, and installation details for each type of sign and sign box required. Indicate proposed materials and fabrication of sign assemblies.

C. Submit shop Drawings to the Commissioner for review and approval prior to fabrication of illuminated signs. Provide shop drawings for fabrication of each type of sign and sign box. Provide shop drawings for each installation condition for each type of sign. Include typical details of materials, fabrication, and graphics. Include plans, elevations, and large-scale sections of sign face, sign frame or housing, typical members and other components. Show anchors, reinforcement, accessories, layout, and installation details. Show electrical components and required connections.

1. Provide complete sign schedule for illuminated sign assemblies, including the following information for each sign:

a. CTA sign identifier.
b. Quantity.
c. Mounting type.
d. Dimensions
e. Visual opening
f. Blank size
g. Colors
h. Message
i. Location(s)
j. Cross references to the following detail drawings:

1) Graphic Detail
2) Elevation Detail
3) Section Detail
4) Mounting Detail

k. CTA Design Number
l. Remarks
m. Mounting Height
n. Signage Plan Drawing Reference

2. Provide drawings for graphics for each sign, including dimensions of sign face, sign blank, visual opening, sign message and sign colors.
3. Provide separate elevation details, section details, and mounting details for each sign.
4. For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed.

D. Provide wiring diagrams from the manufacturer for each type of illuminated sign unit. Provide specifications for each type of LED, driver and other electrical components used.

E. Submit samples of each sign material or component used showing finishes, colors, surface textures and qualities of manufacturer.

1. Submit full-size sample units, if requested by the Commissioner. Acceptable units may be installed as part of work.
2. Color samples, 3 each of all paint colors, on specified materials for illuminated signs and station identifier sign. Color samples will be retained by the Commissioner.
3. Provide a sample panel of each sign type, not less than 8-1/2 inches by 11 inches. Include a panel for each color, texture, and pattern required. On each panel include a representative sample of the graphic image process required, showing graphic style, and colors and finishes of letters, numbers, and other graphic devices.
4. As required by the Commissioner, provide full size samples for approval of any accessories proposed for the installation and attachment of the signs, including hangers, straps, frames and other attachment accessories.
5. The Commissioner is not responsible for any samples that are not received.

F. Submit a material list of all mounting accessories including reinforcing, angles, channels, hangers, straps, frames, etc. Indicate all materials, sizes, thicknesses, shapes, etc.

G. Submit a material list of all attachment devices including anchors, screws, washers, grommets, and rivets indicating material, size, and spacings. Indicate weld types, sizes and locations.

H. Submit a material list of all electrical components.

I. Approval of the shop drawings by the Commissioner is required prior to issuance of digital artwork file.

1.05 STANDARDS

A. The work is subject to applicable portions of the following standards:

1 "Electric Signs", Standards for Safety, UL Publication 48, Underwriters Laboratories Inc.

1.06 QUALITY ASSURANCE

A. Submit adequate evidence, prior to awarding of the contract, that the items to be furnished will conform completely to the contract documents.

B. Fabricator and Installer to be experienced specialty firms having a minimum of 5 years successful experience and regularly engaged in fabricating and installing work of same types required for this project. Employ only skilled tradesmen who are thoroughly experienced with the materials and equipment to be used in the work.

C. Sign/Support Performance to provide outdoor sign assemblies designed, tested, and installed to withstand positive and negative wind loading of 40 psf (1.9 kPa) wind pressure loading, in accordance with Chicago Building Code. Signs to be moisture proof.

D. Provide lighting sign boxes and electrical components for illuminated signs that are labeled and listed by UL and comply with applicable NEMA standards.

1.07 DELIVERY, STORAGE AND HANDLING

A. Signs to be adequately protected during delivery of the work to prevent damage by scratches, stains, discoloration, or other causes. The signs to be crated. Damage to any surface during fabrication, handling, shipment, storage, and installation to be remedied by the Contractor at Contractor's own expense.

1.08 PROJECT CONDITIONS

A. Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Show recorded measurements on final shop drawings.

B. For each location, verify in the field prior to installation the number, location, heights, and installation conditions for each type of sign. Discrepancies to be reported to the designated representative from the Commissioner for review and determination. Similarly, report any conflicts to the proper installation of the sign at the location designated. Adjustments in the field will have to be made according to actual field conditions. The Commissioner’s field representative may also dictate adjustments based on actual field conditions at the time of installation.

C. Contractor to coordinate fabrication and delivery schedule of signs with installation schedule of signs, to avoid delays. Contractor to also coordinate supply of mounting and installation

accessories and attachment devices required for installing the signs at each location, according to the installation schedule.

D. Contractor to coordinate and provide all electrical work required including conduit, wiring, adequate electrical supply and connections prior to delivery and installation of the sign assemblies, to avoid delays and according to the installation schedule.

E. The Commissioner will provide art work for signs in Adobe Illustrator electronic format.

1.09 WARRANTY

A. Submit a written warranty for the materials and work of this section. All materials and work, including installation, to be in exact accordance with these specifications and is to be guaranteed for the minimum period of two (2) years from date of acceptance by the Commissioner, unless noted otherwise. Upon notification of defects or malfunction of the sign within the warranty period, the Contractor to make necessary repairs or replacement at the convenience of the Commissioner and at no cost to the Contract.

B. Submit a five (5) year written warranty, signed by the Fabricator, Contractor and Installer, warranting that the signage finishes will not develop excessive fading or excessive non-uniformity of color or shade; and will not chip, crack, peel, pit, or be subject to pin holes, scratching, or otherwise fail as a result of defective materials or workmanship. Upon notification of such details, within the warranty period, make necessary repairs or replacement at the convenience of the Commissioner and at no cost to the Commissioner. Warranty to cover the finishes of all components of the sign assembly: sign face, sign box, sign frame, and all accessories.

1. "Excessive Fading": A change in appearance which is perceptible and objectionable as determined by the Commissioner when visually compared with the original color range standards.
2. "Excessive Non-Uniformity": Non-uniform fading during the period of the guarantee to the extent that adjacent panels have a color difference greater than the original acceptable range of color.
3. "Will Not Pit or Otherwise Corrode": No pitting or other type of corrosion, discernible from a distance of 10', resulting from the natural elements in the atmosphere at the project sites.

C. Additional Warranty Requirements for LED Sign boxes:

1. The LED light source, driver and other LED components (RoHS compliant) of LED sign boxes to be additionally warranted by the manufacturer for a period of five (5) years against defects in materials and workmanship that result in a signbox lumen depreciation of 30 percent or greater. Upon notification of such defects or malfunction within the warranty period, the Contractor to make necessary repairs or replacement of the fixture at the convenience of the Commissioner and at no cost to the Contract.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The Contractor to furnish and install all sign boxes in strict accordance with the Lighting Sign box Schedule and Lighting Sign box Details as described hereunder or on the Drawings. Sign boxes to be complete with all necessary accessories and related work including LEDs, drivers, cable raceways, prismatic style lens, frames, support, wiring, conduit and all connections. The Contractor to provide supports from framework where no finished ceiling occurs.

B. The Contractor to provide auxiliary supports for mounting sign boxes in areas without ceilings (i.e. exposed beams and joists) as may be required for proper installation of sign boxes. Such supports to span a minimum of two joists for each individual sign box, and to be securely and suitable anchored to same. Sign boxes to not be supported from underside of roof deck or built tees except as specifically noted otherwise on the Drawings, the detail to be followed.

C. Sign box to bear the Underwriter's Laboratories labels and to be purchased, wired and installed in accordance with regulations applicable to the City of Chicago Electrical Code.

D. Before, during and after installation of the sign box assemblies, The Contractor to provide adequate protection for the sign boxes and at completion of the work they to be clean and free of foreign material. Replace all burned out or defective LEDs, drivers, etc., until such time as the Commissioner takes complete occupancy of the facility.

E. All material furnished under this contract to be new and of the best quality practicable for the application.

F. All sign boxes to be constructed to be sturdy and rigid. Sign boxes located in public areas at a mounting height of ten feet or less to be designed to be vandal resistant.

G. Sign boxes and all components to be constructed, assembled, fastened and connected for maximum endurance to the vibration present on the CTA platforms.

H. Sign boxes to have simple lines and a clean uncluttered appearance. There to be a minimum of exposed hardware.

I. The sign box to be so constructed, hinged and latched that driver replacement and LED light source component replacement can be performed safely by one individual from a centrally located ladder, without requiring relocation of the ladder or removal of the fixture.

J. Sign boxes to be designed and tested to maintain the temperature of all interior components (LEDs, drivers, gaskets, diffusers, etc.) below their respective manufacturers recommended normal operating temperature, for any predictable electrical or environmental operating condition.

K. Each sign box to be assembled from material components in a careful manner by persons experienced in their line of work. Forming, assembly and subassembly to be accomplished such that all parts come together in the sign box to form a complete, well fitted integrated assembly.

L. Conduit and wire entries to the sign box to be field drilled by the Contractor in the top or end plate of the chassis. Entry to be flush with the top of the sign box.

M. The entire lens area of the sign box (exclusive of door frame members) to be illuminated. There to be no black or unlit areas including those areas where the driver or LED holders are located.

N. Sign boxes and luminaires must be manufactured in the United States and adhere to the ARRA Buy American Compliance Act.

O. Illumination levels on the sign surface to be in the 200 lux range (20 FOOTCANDLES) or greater to comply with the Commissioner's Illumination requirements as well as the current Americans With Disabilities Act Guidelines for Illumination (US DOJ ADAAG – Section A4.30.8).

2.02 POWER DISCONNECT FOR SIGN BOXES

A. Provide a power disconnect in the conductors supplying the sign box or LED engine.

B. Disconnect to be self-aligning (polarized) snap in type and to contain three wires, one each for the hot, neutral and equipment ground conductor.

C. Disconnect to facilitate easy removal of the LED engine for maintenance and to be prewired by the sign box manufacturer.

D. Male side of disconnect to be connected to the LED engine power lead-in wires so that exposed contacts are dead in the disconnected position.

E. Disconnect to be UL listed. The dielectric strength of the connector to be 1500 volt minimum.

2.03 WIRING FOR SIGN BOXES

A. Wire inside sign boxes to be copper conductor of amp capacity required plus twenty- five percent (25%) for continuous load.

B. Insulation to be rated for 1000 volt AC and to be rated for operation at 200 degrees in dry locations.

C. Provide type FF glass braid insulation.

D. All connections inside the sign box to be made with wire nuts rated for a minimum of 90 degrees C.

2.04 ON/OFF TOGGLE SWITCH FOR SIGN BOXES

A. Provide a power toggle switch in the conductors supplying the sign box power supply.

B. Toggle switch to contain three wires, one each for the hot, neutral and equipment ground conductor.

C. Toggle Switch to facilitate easy removal of the power supply for maintenance and to be prewired by the sign box manufacturer.

D. Toggle switch to be UL recognized and CSA approved. The dielectric strength of the connector to be 1000 volt minimum.

E. Toggle Switch to be installed next to power supply.

2.05 WEATHERPROOF GASKETS

A. Gaskets to be continuous on both sides and ends of the sign box between the hinged door and the upper housing (chassis) and between the diffuser and its supporting frame.

B. Gasket material to be close cell sponge neoprene, soft or medium density, evenly textured with high resistance to aging, heat, ultra-violet light, water, oils, weathering and setting.

C. Gaskets to be cemented to the various components with resilient neoprene sealing compound. Compound to be compatible with the finish to which it is applied.

D. Gaskets to not exhibit any noticeable stiffening at temperatures down to 0 degrees F and to be satisfactory for long life in summer and winter temperatures in Chicago.

E. Water and aqueous solutions to not cause swelling nor be absorbed by the gaskets.

F. Gaskets to be self-extinguishing and flame resistant.

2.06 MECHANICAL COMPONENTS

A. Hinges for external sign box components:

1. Hinges to be continuous and designed to prevent accidental disconnection of connected sign box components while being hinged down and in the open position.
2. Hinge to be fabricated from the same material as the pieces connected thereby and to be sufficiently rigid to prevent distortion in service.
3. Hinges where not an integral part of connected components to be affixed to the pieces connected thereby with a continuous weld or other approved means to prevent distortion in service.

B. Hinges for internal sign box components:

1. Hinges for reflector and other internal sign box components to be suitable for the weight suspended and the service requirements.
2. Hinges to be firmly affixed to the pieces they connect and to not bend or distort in service.
3. Hinges to be fabricated from the same or galvanically compatible materials as the pieces connected thereby.
4. Hinges to be designed to prevent accidental disconnection of sign box components connected thereby while being hinged down and in the open position but to be capable of ready disconnection for removal or replacement of parts.

C. Locking Devices:

1. All locking devices that must be activated for maintenance or re-lamping to be stainless steel with positive lock-up that will not disengage due to vibration caused by the trains.
2. All locking devices to be of the captive design. Only stainless retainers to be used to retain the screws in place.
3. External locking devices to be tamper resistant screws.
4. Internal locking devices to be quarter turn fasteners thumb operated type.

D. Fasteners:

1. All threaded fasteners to be made of the same material as the piece into which they are threaded. No aluminum fasteners will be permitted.
2. All fasteners to have a thread sealant applied to prevent vibration from loosening same.

2.07 ILLUMINATION COMPONENTS

A. Lamps:

1. LED

a. LED lighting components to be nominal length as required to completely fill the length of the sign box.
b. LED color 4000K
c. All LED light source manufacturers which may be incorporated in the Work include but not limited to Samsung, Seoul Semiconductor, Cree, Philips, or Nichia.

B. Reflectors:

1. Reflectors to be formed from stainless steel and to extend the full width and length of sign box.
2. Reflector to fasten into position with 1/4 turn fasteners and to lock-up tight to prevent noise during vibration of sign box.
3. Reflectors to be finished with high reflectivity glass white enamel, baked on after the reflector has been degreased and phosphatized. Minimum reflectivity to be eighty-seven percent (87%).
4. Reflector mounting to be such that the reflector can be easily removed for driver changing by one man unaided.
5. Reflector to be prevented from falling out of the sign box when it is unlatched. Provide safety chains, hinges or other approved means of sufficient number and so located as to prevent reflector from swinging down and causing injury.
6. Reflector to be "V" shaped in the middle to give better lighting distribution and increase the efficiency of the sign box.

C. Diffuser:

1. Diffuser to be fabricated from 0.187 inch thick prismatic clear polycarbonate for “H” type sign box. Additional diffuser types for remaining sign boxes.
2. Diffuser to effectively obscure the outline of the source during sign box operation and to as far as practical maintain an even surface brightness across the diffuser.
3. Lens/diffuser to be fully enclosed and mechanically held in a completely gasketed, rigid door frame.
4. The combination of lens/diffuser to have all edges sealed to keep out dust, dirt and moisture.
5. Provide prismatic and clear polycarbonate lens manufactured from General Electric "Lexan" or Rohm and Haas "Tuffac".
6. The light transmittance rating of the lens to be 0.86 inch minimum.

2.08 ENVIRONMENTAL CONTROL

A. Gaskets:

1. Gasketing to be applied continuous at specified interfaces.

2. Gasket to be applied around diffuser and its supporting frame and around diffuser door frame and sign box body.
3. Gasketing material to be closed cell neoprene, soft or medium density, even textured with high resistance to aging, heat, ultra-violet light, water, oils, weathering and setting.
4. Gaskets to be cemented to the various components with resilient neoprene sealing compound. Compound to be compatible with the finish to which it is applied.
5. Gasket to not exhibit any noticeable stiffening at temperatures down to 0 degrees F and to be satisfactory for long life in summer and winter temperatures in Chicago.
6. Water and aqueous solutions to not cause swelling nor be absorbed by the gaskets.

B. Conduit entries to be field drilled by the Contractor in the top or end plate of each sign box as required.

2.09 SIGNFACE MANUFACTURERS

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

1. Illuminated Informational Sign manufacturers which may be incorporated in the Work include but not limited to the following:

a. Western Remac, 1740 International Pkwy., Woodridge, Il. 60517 (630) 972-7770.
b. Doyle Signs, Inc., 232 Interstate Rd., Addison, Il. 60101 (630) 543-9490.
c. Pannier Graphics, 345 Oak Rd., Gibsonia, Pa. 15044 (800) 544-8428.

2.10 MATERIALS

A. Informational Sign boxes: Enclosure to be stainless steel, 20 gage. Number 4 finish.

B. Sign faces: Plastic for the sign faces of Illuminated Informational Signs to be graphic-embedded Fiberglass Reinforced Plastic (FRP), translucent, 0.180 inches thick minimum and 0.250 inches maximum. Follow CTA Specification 616 for Embedded Fiberglass Signs. Contact the CTA Signage and Wayfinding Department for more information.

C. Silk Screens: Photographic screen. Hand cut screens or digital output will not be allowed.

2.11 MATERIALS – PLASTIC

A. All plastic to be UV stabilized. Plastic to be manufactured of a flame retardant resin that has been tested to comply with U.L. flammability classification 94V-0. Manufacturer to supply certification of conformance plus certification of random flame test sampling during production runs as directed by the Commissioner.

B. All plastic to be manufactured of non-yellowing, clear resins.

C. Manufacturer of plastic to certify that all plastic meets or exceeds the following test standards. If requested, the manufacturer to provide the results of these tests to the Commissioner:

1. MIL Spec P7788A surface endurance and scratch resistance, thermal shock, humidity and impact.
2. OSET Lab, Inc. Emmaqua accelerated weathering for a minimum exposure of one million Langleys without color fade.

3. Federal Test Method Standard 141, Method 6152; “Accelerated Weathering”.
4. United States Postal Service: Acidity, cleaning compounds and fluids.

    a. Two plastic sheets to be immersed in a 0.1 M HCL solution for 30 minutes.
    b. Two plastic sheets to be immersed in a 0.1 M MH3 solution for 30 minutes.
    c. Plastic to not be appreciably changed as a result of these tests.

D. Plastic for the sign faces of Illuminated Informational Signs to be graphic-embedded Fiberglass Reinforced Plastic (FRP), translucent, 0.180 inches thick minimum and 0.250 inches maximum. Substitutions will not be permitted.

E. Fiberglass Reinforced Plastic (FRP) to be non-yellowing, UV stabilized, acrylic-modified polyester resin reinforced with high solubility, chopped strand fiberglass mat so that the index of refraction ensures total clarity of all color, copy and graphics. Glass fibers should not be readily discernable on the sign face and signs to have a glass content no less than 28% of the total sign weight.

F. Fiberglass Reinforced Plastic (FRP) to consist of only flame retardant resin that has been tested to comply with UL flammability classification 94V-0. Manufacturer to supply certification of conformance plus certification of random flame test sampling during production runs as directed by the Commissioner.

G. Down light acrylic lens to be clear prismatic material with ¼ inches clear lexan non-glare protective cover, and to be UV stabilized on both sides.

2.12 GRAPHICS

A. All copy and graphics to be permanently embedded in the plastic. The resulting signs to have all graphic elements inseparable from the plastic in which they are embedded. Artwork to become permanent part of plastic sign so it will not delaminate. Laminated products will not be accepted. Lettering for all signs to be Helvetica Bold, upper and lower case, to be electronically reproduced.

B. Legends to include letters, numbers, arrows, symbols, borders and other applications shown for sign panels.

C. After approval of Shop Drawings, the Commissioner will supply final artwork in Adobe Illustrator format.

2.13 PLASTIC FOR ILLUMINATED STATION IDENTIFIER SIGNS (IF APPLICABLE)

A. Plastic for letters and logo for Station Identifier Signs to be formed of all natural Cellulose Acetate Butyrate (CAB).

B. Colors for Identifier Sign letters, logo, and background to be the Commissioner’s standard colors.

C. Plastic Identifier Sign to have studs or metal threaded posts secured on rear of the letters and logo for attachment of the plastic sign. Length, spacing, and locations of studs as required by manufacturer for installation and attachment. Show studs on shop drawings submitted to the Commissioner for review and approval.

D. Plastic manufacturers as specified for Illuminated Station Identifier Sign which may be incorporated in the Work include but not limited to the following:

1. Gemini, Inc., Cannon Falls, MN.

2.14 MOUNTING ACCESSORIES

A. For reinforcing, brackets, angles, channels, support posts, steel tube:

1. Steel plate, bent plates, clip angles, shapes, channels, angles, and bars: ASTM A36/A36M, hot dip galvanized G90 (ASTM B 633 Type GS).
2. Cold-rolled steel sheet: ASTM A 653/A 653M, hot dip galvanized G90, commercial quality.
3. Steel Tubing: Cold-Formed Steel Tubing, ASTM A 500 or Hot-Formed Steel Tubing, ASTM A 501, with hot-dip galvanized coating per ASTM A 53.
4. Steel Pipe: ASTM A 53, galvanized, standard weight and extra heavy.
5. Aluminum plate, pipe: ASTM B 221, Alloy 6063-T6.

2.15 ATTACHMENT DEVICES

A. Use concealed fasteners where possible. Fasteners exposed to view to be of tamper-resistant and anti-vibration design. Fasteners to be of stainless steel unless approved otherwise. See drawings for type, size, spacings, locations for each application. Typically, fasteners to be flat head machine screws. Use fasteners fabricated from metals that are not corrosive to the sign material and mounting surface.

B. Use non-ferrous metal, stainless steel, or hot-dipped galvanized anchors and inserts for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, expansion shields, as required, to be set into concrete or masonry work after drilling.

C. Continuous hinge manufacturers which may be incorporated in the Work include but not limited to National Lock Co. 56-472, Type 2, stainless steel.

D. Flexible Sign Hangers: Similar to flexible sign box hangers, cushion type, enclosed and gasketed, eight degree swing in all directions, cushions 40 lbs., supports 250 pounds, ¾ inch size, as manufactured by Appleton Electric Company. Provide 2 ½ inch diameter galvanized pipe to cover pipe hanger where shown on the drawings.

E. Threaded Pipe Hangers: 1 inch in diameter, galvanized with nut and washer (to be tack welded to frame).

F. Provide brackets, collars, clips, and all other accessories required for installation of signs as approved compatible with the sign and various substrates and as submitted and approved. Fabricate brackets and fittings for bracket-mounted signs from steel to suit sign panel construction and mounting conditions indicated. All metal accessories to be stainless steel or hot-dipped galvanized and factory painted to match the sign frames.

G. Welding Rods and Bare Electrodes to be according to AWS specifications for the metal alloy to be welded.

2.16 ACCESSORIES

A. Provide continuous 0.05 inch rubber gasket at flanges at all locations where sign face assembly meets sign body or/and as shown on Drawings or required for weather- tight installation.

2.17 FINISHES

A. For exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance, provide color matches indicated, or if not indicated, as selected by the Commissioner from the manufacturer's standards.

2.18 PAINT

A. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers.

B. Galvanizing Repair Paint: High zinc dust content paint for touching up galvanized surfaces, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint-20.

C. Paint over galvanized metal:

1. First Coat: Primer over galvanized metal:

a. Devoe: 8502/8520 Mirrolac.
b. Fuller: 621-05 Blox-Rust Latex Metal Primer.
c. Glidden: 5205 Glid-Guard.
d. Moore: Iron Clad Galvanized Metal Latex Primer 155.
e. PPG: 90-709 Industrial Enamel.
f. P & L: Z/F 1003 Supreme Latex Metal Primer.
g. S-W: Galvite Paint B50W3.

2. Second and Third Coats: Gloss alkyd enamel:

a. Devoe: 70XX Mirrolac Alkyd-Urethane Gloss Enamel.
b. Fuller: 312-XX EPA Compliant Heavy Duty Enamel.
c. Glidden: 4550 Series Glid-Guard Alkyd Industrial Enamel.
d. Moore: Impervo Enamel 133.
e. PPG: 6-282 Speed Hide Gloss-Oil Enamel.
f. P & L: S 4500 Series Tech-Gard Maintenance Gloss Enamel.
g. S-W: Industrial Enamel B-54 Series.

3. Color to be CTA White on platform, stainless steel at mezzanine level and street level, or other station color as selected and approved by Commissioner.

2.19 SIGNBOX FABRICATION

A. General:

1. Enlargement or reduction of sign face art to be done electronically. Original artwork will be provided by the Commissioner in EPS or Adobe Illustrator format.

2. Fabricate exposed surfaces uniformly flat and smooth, without distortion, pitting, or other blemishes. Form exposed metal edges to a smooth radius. Grind exposed welds and rough areas to make flush with adjacent smooth surfaces. Provide all sign bodies with tamperproof construction.
3. Sign components to be designed for easy maintenance and replacement.
4. Sign production to not begin until shop drawings have been approved by the Commissioner.
5. Punch, drill, and tap finished members as required for connection to adjoining work.
6. Provide outdoor sign assemblies designed, tested, and installed to withstand positive and negative wind loading of 40 psf (1.9 kPa) wind pressure loading, in accordance with Chicago Building Code.
7. Provide a protective covering to the front of the signs to avoid damage during shipment and installation.
8. Before delivery to the site, each sign to be tagged or labeled with the identifying number and installation location as shown in the appendix. Labeling to be on the back of the sign. Any sign scratched, chipped, stained, or otherwise damaged during fabrication, handling, shipment, storage, and installation to be replaced at Contractor's expense.

B. LED SIGNBOX INTERNAL CONFIGURATION

1. Closure to provide sufficient interior space to enclose the means of illumination, its control, and test equipment.
2. Enclosure to be gasketed, weatherproof, and bug-tight. Illuminated signs to be UL listed for exterior wet locations.
3. Message compartments in the sign to be light-tight from all directions, so as to prevent seepage of light between compartments, except the message face. The interior compartments to be white.
4. Illuminate units in the manner indicated using LEDs. Make provisions for servicing and for concealed connection to the building system.
5. Access to signs for maintenance to be through a continuously hinged message face door frame held in place by external fasteners. Each hinged door to have a means of supporting the door in the open position to facilitate maintenance.
6. Electrical Service: Provide to accommodate 120/208 volt, 3 phase, 4 wire, and 120 volt, single phase, as scheduled on drawings. Where 3 phase signs occur, arrange LEDs and drivers to evenly distribute the load over all phases.
7. Power Distribution: Provide all internal wiring for drivers and LEDs. Connect to load side of disconnect switch.
8. Voltage Regulation: Provide adequate space within sign enclosure to accommodate transformers for voltage regulation should excessive voltage drop occur.
9. LEDs connected to the drivers to remain operating when supply voltage varies plus or minus 10 percent from normal.
10. Make provisions for concealed connection to the building system. Coordinate the electrical characteristics of signs with those of the power supply provided.
11. Furnish electrical components incorporated in sign construction approved and listed by the Underwriters Laboratories, Inc., and which conform to the Chicago Building Code and the National Electrical Code. The maximum temperature limit of the driver to not exceed manufacturer instructions. Install driver below LED in separate thermally isolated compartment. Provide heat sinking or fan cooling if required. Manufacturers to be Advance, General Electric, Jefferson, or Universal. Size drivers properly and having capacity to operate the number and type of LEDs under continuous outside duty and each drivers clearly marked or labeled to shown the following:

a. Manufacturer's name and trademark.
b. Catalog number.
c. Input voltage and frequency.
d. Current rating.
e. Open-circuit voltage.
f. Number of LEDs to be controlled.
g. Nominal current per LED.
h. Type of LEDs and power factor.
i. Wiring diagram to show correct connections for the various loads.

12. Provide all internal wiring of insulated, stranded copper, appliance wire, not lighter than Number 12 AWG and thermoplastic insulation, of such thickness and composition to provide satisfactory performance under a continuous maximum temperature of 90 degrees C. Color-code wire with white for the ground wire and secondary circuit corresponding to the color of the driver leads. Provide terminal blocks for interior power wiring connections.
13. Provide heavy-duty, single pole, toggle switches for local compartment and LED control as indicated on drawings; also, provide a disconnect toggle switch inside the sign case of each sign, as required by the Chicago Building Code.
14. Locate drivers, raceways and other interior components so as to prevent shadows, hot spots or dark spots on the sign faces. Distribute weight of the drivers symmetrically to provide a naturally plumb hanging of the signs. Support drivers and wiring on the bottoms of the sign cases to maintain a minimum clearance of 1/2 inch. Confine drivers lead splices to the driver junction boxes or contain in the raceways. Strip insulation on wires at connections only as required to properly make connections. Bare conductor overhang at the edge of the base to which it is connected is not allowed. Secure splices and wiring connections to LED terminals mechanically and electrically.
15. LED lighting components to be nominal length as required to completely fill the length of the sign box. LED color 5000K.
16. Each compartment of a multi-compartment illuminated sign to be separately controlled and wired.
17. Illumination across the face of the sign to be uniform in brightness when the sign is turned on.

2.20 LED LIGHT SOURCE SIGNBOXES

A. General:

1. “LED Sign box” to be of the type called for on the light sign box schedule.
2. LED Light Source Sign boxes size to be determined by placement and message on the contract drawings.

B. LED Light Source Sign box:

1. Each LED Light Source Sign box to consist of one complete sub-assembly designed for field installation. Sub-assembly to consist of the following:

a. LED board.
b. Aluminum heat sink/chassis.
c. Mounting plate.
d. Power supply.
e. Internal ON/OFF toggle switch.

f. Fuse.

2. LED light source sub-assemblies will be built to UL8750 for LED Lighting Equipment and to UL1598C for Luminaire standards.
3. The LED light sign box to consume zero (0) watts in the off-state, excluding any control devices.
4. Installation instructions for all LED light source sub-assemblies to be provided by the manufacturer.

C. LED Light Source Sign box Sub-Assembly:

1. Each sign box to consist of three (3) LED boards.
2. Total electric power consumption for each sign box to be rated at 54 watts.
3. Each LED board to consist of 54 LED chips with lumen outputs 38 per chip and color temperature 4000K.
4. The LED board to be securely affixed to mounting plate so that it is not affected by vibrations.
5. The chip manufacturer to be Samsung, Seoul Semiconductor, Cree, Philips, Nichia or other approved equal high quality industrial grade manufacturer.

D. LED Light Source and Light Engine Manufacturers:

1. LED color temperature 4000K.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

   a. Cooper Lighting, 1121 Highway 74 South, Peachtree, Ga. 30269 (770) 486-4800.
   b. Kenall Lighting, 1020 Lakeside Dr., Gurnee, Il. 60031 (847) 360-8200.
   c. Seemart Corporate, 4139 Guardian St., Simi Valley, Ca. 93063 (805) 578-2536.
   d. Sloan LED, 5727 Olivas Park Dr., Ventura, Ca. 93003 (888) 747-4LED.
   e. Technilite Systems, 300 Milroy Dr., Peterborough, Ontario, Canada K9H, 7M9 (705) 741-5101.

E. LED Power Supply:

1. Power supply to be Class 2 rated for a nominal input voltage of 120 to 277VAC with a voltage range of 108 to 305 VAC and a constant output voltage of 24VDC with an input frequency of 50/60 Hz, Nominal current of 2 Ampere, Current range of 1 to 2 Ampere, Current overshoot less than 20%, Ripple current less than 5 percent, and output voltage range of 18 to 24 VDC.
2. Power Supply to be securely fixed to mounting plate so that it is not affected by vibrations.
3. Power supply to carry UL and CE labels.
4. Power supply to be rated for temperatures ranging from minus 40 to plus 90 degrees C. The power supply to be suitable for use in dry and damp locations. The Total Harmonic Distortion (THD) to be less than 20 percent. The power supply to have a power factor greater than 95 percent. The power supply to have an audible noise rating of Class A or better.
5. Power supply line transient harmonics to comply with EN 61003-2 and EMC immunity to comply with IED 640004-4. Surge protection to comply with combination wave test procedures per IED 610004-5 and ANSI C62.41.

6. The electronic power supply to be Philips Advance, Mean Well, Thomas Research Product. The power supply to be long-life (100,000 hours) and carry a five (5) year warranty. Manufacturer to be a full line power supply manufacturer with a ten (10) year history of producing power supplies for the North American Market.
7. The power supply to conform to FCC rules and regulations, as per Title 47 CFR Part 15 Non-Consumer (Class A).

F. Lumen Depreciation:

1. Lumen depreciation per IESNA LM-80 is compared to the published lumen output of the product per IESNA LM-79 testing and reporting standards.
2. Normal accumulation of particules on the optical surfaces to not be factored into the lumen depreciation.
3. A Coloring Rendering Index (CRI) of 85 to apply to all LEDs.

G. Light Engine Wattage:

1. Light engine wattage will vary by light sign box type.
2. Light engine modules to provide nominal 4000 initial bare lumens.
3. Life/lumen maintenance to provide greater than or equal to 70 percent of the initial lumens at 50,000 hours.

H. Mounting Accessories:

1. Provide mounting accessories including reinforcing, brackets, angles, channels, bent plates, faming, etc. as indicated on the drawings, specified, or as otherwise required for the installation of the signs.
2. Plates, steel tubes, steel channels, steel bars, sheet metal, and all other mounting accessories to be galvanized after fabrication. Touch up galvanizing as required, apply one coat of primer and two coats of finish paint in the shop.

PART 3 - EXECUTION

3.01 INSPECTION

A. Prior to installation, all signs to be inspected by the Commissioner. The purpose of this inspection is to verify quality of manufacture and conformance to requirements for the fabrication, color, artwork, etc. of each type of sign. Inspection will be conducted at the Contractor's premises, or at any other mutually agreeable location, within the City of Chicago. The Contractor to provide the Commissioner with a minimum of seven working days' notice prior to inspection.

B. Installer of signs to verify all locations, sizes, installation and mounting conditions, type of anchorage required and working conditions in the field.

C. A representative from the Commissioner may review the existing conditions with the installer prior to installation. The purpose of this inspection is to verify actual locations, method and quality of installation, mounting heights, interference with the installation, and other installation conditions for each sign. The scheduling of this inspection to be mutually agreed upon by all parties.

D. After installation, a final inspection in the field will be conducted by the Commissioner. The purpose of this inspection is to verify quality of installation, correct location of signs, etc. The Contractor to provide the Commissioner with a minimum of seven working days' notice prior to inspection.

3.02 TESTS FOR SIGN BOXES

A. Sign boxes to be submitted in accordance with the requirements of the Division 01 Section, “Submittals”. The Commissioner will determine if the submittal is in compliance with the requirements of this specification prior to the final acceptance of the sign box. Contractor to submit one sample of each type of light sign box for approval of the Commissioner.

B. Overall efficiency (sign box output in lumens/lamp lumens) to not be less than 50%.

C. A minimum of 85% of the sign box lumens output to fall within 60 degrees from nadir and 90% of the sign boxes lumens output to fall within 120 degrees from nadir.

D. The main beam to be at 90 degrees to the lens surface.

3.03 FACTORY INSPECTION

A. Contractor to require the manufacturer’s production facility available to the Commissioner for inspection before and after manufacture of the sign boxes called for under this contract.

3.04 INSTALLATION

A. General: Install signs at locations, heights, and mounting details as indicated on the drawings or directed otherwise. Variations may be directed by or approved by the Commissioner’s field representative during a pre-installation walk-thru or during the actual installation based on actual field conditions. Use approved mounting methods, mounting accessories, and attachment devices. No glue installations are permitted.

B. Installation and anchorage to be solid and secure. Provide and install all indicated backer plates, frames, support, posts, hangers, and other mounting accessories. Provide and install any additional steel or wood framing or other support required. Where indicated or required, modify existing frame to accept new sign assembly.

C. Install signs and all mounting accessories level, plumb, and flush with substrates. Sign surfaces to be free from distortion or other defects in appearance.

D. Provide and install all required attachment devices, brackets, pendants and hardware. Fasteners and other accessories to be as specified for the application. Use expansion anchors, self-tapping screws, pop-rivets, bolts and nuts, etc. as required. Drill as required. Use countersunk screws where exposed or necessary. Exposed fasteners to be tamper resistant. Weld where indicated with full, tack, or stitch welds.

E. Installation of Metal Frames, Supports or Hangers:

1. Weld or bolt metal frames, supports, support posts, or hangers directly to the structure, track structure, beam, columns, light poles, railing, canopy fascia, or windbreak as directed. Use expansion anchors for securing frames, supports, or hangers to masonry or concrete.

F. Installation of Pipe Hangers:

1. Install flexible hangers where indicated, securing the pivot assembly to the canopy structure and to the sign frame or backer plate as directed.

G. The Contractor to install the equipment in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.

H. Where aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, non-absorptive tape or bituminous coating to prevent corrosion. Use stainless steel fasteners. Aluminum sign boxes to not be installed in contact with wood, or in any other situation where permanent moisture can exist.

I. In areas where industrial type sign boxes are to be installed such as Equipment Rooms, sign boxes which are near obstructions near the ceiling such as ducts, large pipes, groups of pipes, etc., to be suspended so that the bottom of the sign box is not higher than the bottom of the duct, etc. Outlets to not be located until the location of these obstructions are determined. Outlets to not be covered; conduits to be installed exposed. Sign box to have standard wire guard.

J. Sign boxes to be mounted plumb, level and in straight lines. Group-mounted LED sign boxes to appear as one unit.

K. Lighting poles, when required, to be installed as shown on the Drawings. The installation to result in vertically plumb poles, and will provide for a minimum of sign box vibration.

L. The Contractor to supply all required LED lighting components, clean sign faces, diffusers, globes, reflectors and exposed-to-view surfaces of sign boxes after aiming and adjusting have been approved.

M. The Contractor to provide gaskets and other means to make the sign box mounting and conduit entry watertight.

3.05 TESTING INSTALLATIONS

A. The Contractor to furnish necessary personnel and equipment and perform tests and adjustments in the presence of the Commissioner. Schedule adjustment of exterior installations to occur during hours of darkness.

B. The Contractor to test lighting circuits for continuity and operation.

C. The Contractor to test sign boxes and mounting poles for continuity of grounding system.

D. The Contractor to aim and adjust sign boxes to provide distribution patterns approximately as shown and as approved.

E. Once tested and accepted by the Commissioner, Contractor to provide a minimum of 20 percent spare LED light sources (rounded to nearest whole number) for each type of light source provided.

3.06 FIELD PAINTING

A. Galvanized metals cut or drilled in the field to have its galvanized finish touched up in the field with approved galvanizing repair paint.

B. Dissimilar metals: To avoid galvanic action, separate dissimilar metals with approved paint.

C. Any mounting accessories such as angles, channels, plates, bent plates, clip angles, tubes, posts, etc. that will be exposed to view after installation of the sign, must be field painted to match the pre-finished backer plates. New wood posts and other members to also be primed and finished to match the backer plates.

D. Care to be taken to not get paint on the new signs or any other existing surface.

3.07 CLEANING AND PROTECTION

A. Signs to be adequately protected during their delivery and installation to prevent damage by scratches, marring, stains, discoloration, or other causes. The sign faces to be protected with a protective covering. The signs to be crated. Damage to any surface during fabrication, handling, shipment, storage, and installation to be remedied by the Contractor at Contractor's own expense. Replace any damaged signs that cannot be cleaned or repaired.

B. Before delivery to the site, each sign to be tagged or labeled with the identifying number and installation location as shown in the specifications. Labeling to be on both the sign and the protective covering.

C. At completion of the installation, remove the protective coating and clean soiled sign surfaces, and surfaces against which the new sign has been mounted, in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Commissioner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of LIGHT EMITTING DIODE (LED) SIGN BOX FOR INFORMATION SIGNAGE will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of LIGHT EMITTING DIODE (LED) SIGN BOX FOR INFORMATION SIGNAGE must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 75 00

CABINET AND TERMINAL STRIPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Furnishing and installing of cabinet and terminal strips. The work under this section includes furnishing all labor, tools, equipment and incidentals necessary to install the terminal cabinet.
2. Interface terminal cabinets and terminal strips to provide adequate and proper space for all wires, connections, terminations, and taps.
3. Cabinets to be provided with suitable means for securing, supporting and adjusting the cabinets and trims.

1.03 RELATED WORK

A. Cabinet and terminal strips specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 261950 “Identification”
3. Section 261230 “Wires, Cables, Splices, Terminations”

1.04 SUBMITTALS

A. The Contractor shall submit product data, brochures, cuts, specifications, maintenance data shop drawings, diagrams schedules and samples in accordance with Division 1 Section, Submittals, and supplementary requirements as stated under the sections of these Specifications for all the materials and construction referred to in this Section.

B. See section 26 01 00, General Provisions Electrical for additional submittal requirements.

PART 2 - PRODUCTS

2.01 INTERFACE TERMINAL CABINETS / RELAY CONTROL PANEL

A. The Contractor to provide wall-mounted single-door enclosure with back panel, similar to Hoffman Engineering Company type A-12 or equal, as shown on the Contract Drawings, with the following additional requirements:

1. Enclosures for indoor locations to be formed of 12 gage galvaneal sheet steel minimum, seams continuously welded and ground smooth, without openings or knockouts, with external wall mounting brackets and collar studs for mounting panel. Back panels to be formed of 12 gage galvaneal steel. A rolled lip to be formed on all sides of the door opening. Size to be as shown on the Drawings.
2. Doors to be formed of 12 gage galvaneal sheet steel with rolled lip along top and sides to mate with the enclosure. The door to be fitted with a removable print pocket and a closed-cell neoprene gasket attached with oil-resistant adhesive and bonding stud.
3. Cabinet door to be equipped with a concealed full length, stainless steel continuous piano type hinge. Yale Company, Division of Eaton Security Products & Systems, Catalog Numbers 1400, or Corbin Cabinet Lock Company Catalog Number 1000 vault handles with disc tumbler locks and three point latch to be provided on doors twenty-four inches or over in height.

    a. Yale Company, Division Eaton Security Product & Systems Catalog Number
    b. T 1403, or Corbin Cabinet Lock Company Catalog Number 1001 handles with disc tumbler locks and one point latch to be provided on doors under twenty-four inches in height.

4. Two keys to be furnished with each cabinet and lock. All cabinet locks to be provided to accept a CAT 60 Master Key (Corbin Lock or H. Hoffman Co.). Lock to be arranged to permit key removal in locked and unlocked positions.
5. Enclosure and door fabricated from galvaneal sheet steel to be primed and finished ANSI-61 light gray enamel, back pan to be painted white.
6. Enclosure to be provided with 21 circuit minimum panelboard style equipment ground bar mounted to the back pan.
7. For outdoor locations enclosure including door and back panel to be stainless steel. The cabinet to be Type 304 mill finish stainless steel. Handle to be provided as heavy duty pad lockable stainless steel and three point latch suitable for outdoor or subway locations.
8. Enclosures to bear U/L-508 industrial control label with respective UL enclosure rating based on the location of the installation and construction of the enclosure.
9. Enclosures to also be supplied with breather drains.
10. Each panel to be provided with drip shield rain hood.

2.02 TERMINAL STRIPS

A. Separate terminal strips to be provided to separate 120 volt AC control and input Interconnections and 48 volt DC interface connections to the CTA SCADA system.

B. Terminal blocks to be UL/CSA recognized 94V, 2 thermoplastic material, snap on rail mounted design, 30 Ampere 600 volt, with marking strip, with Number 6-32 terminal screws for use with crimp on ring style wire connectors. Cooper Bussmann (USD) type NSS3-WH, or Eaton type TBAL-30. 20 percent spare terminals to be provided.

2.03 WIRE DUCT

A. Code approved wireways to be provided as necessary to provide separation of various voltages and routing of connected control wiring.

B. Cross sectional area (wire fill) to be in accordance with the Chicago Electrical Code and to be sufficient for the maximum number of connections possible per terminal block row.

C. Wire duct to be white in color, narrow slot design, UL Recognized, specially formulated lead free PVC material. Wire duct to have UL94V-O flammability rating and confirm with NFPA 79-2002 requirements for flame retardant material.

D. Wire duct manufacturers which may be incorporated in the Work include but not limited to Panduit type F.

PART 3 - EXECUTION

3.01 CABINETS

A. Terminal strip cabinets generally to be installed with tops 6 feet-6 inches above the floor, unless otherwise noted on the Drawings.

B. Cabinets to have fronts straight and plumb and arranged so the equipment will be centered in door opening.

C. Each surface mounted cabinet to be supported and mounted away from the wall with "C" shaped channel. The channel to be fiberglass, when stray current control isolation is required, and stainless steel for normal applications. The minimum separation between the equipment and the wall to be one inch.

D. Wiring entering the enclosure to be neatly bundled, routed and supported in the wire duct within the cabinet and to be connected to the terminal blocks with insulated ring tongue lugs.

3.02 IDENTIFICATION

A. All wire and terminal strips to be labeled and marked as specified in Section 261950 “Identification”.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CABINET AND TERMINAL STRIPS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CABINET AND TERMINAL STRIPS must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 77 00

INFRARED HEATING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section of Specification covers the tests and checks that to be made on all electrical equipment and wiring to ensure compliance with the applicable codes and standards and with the Drawings and Specifications.

1.03 RELATED WORK

A. Electrical testing specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 13 34 00, Bus Shelters and Windscreens
2. Division 23 Mechanical
3. Section 260100 “General Provisions”
4. Section 260500 “Raceways and Boxes”
5. Section 261000 “Basic Electrical Materials and Methods”
6. Section 261230 “Wires, Cables, Splices, Terminations”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261900 “Grounding”
10. Section 261950 “Identification”
11. Section 264700 “Panelboards”

PART 2 - PRODUCTS

2.01 GENERAL

A. This Contractor shall provide power and control circuitry for the heaters shown on the Drawings, and specified herein.

B. This Contractor shall furnish, install and connect all infrared heating units, as indicated on the Drawings.

2.02 ELECTRICAL HEATING LUMINARIES:

A. Refer to Mechanical Specifications for electrical infrared heater requirements.

B. Electrical infrared heater shall be rated 208 Volts single phase 60 Hertz.

C. The fixture shall have a U.L. label and be complete with quartz lamps and wire guards. The reflector shall be designed to provide distribution as indicated on the schedules.

D. Infrared electric heating luminaries shall be as manufactured by Aitkens, or approved equal, and shall be provided by the mechanical contractor.

2.03 CONTROLS

A. The system controls shall provide for turning the infrared heaters on from a local momentary contact pushbutton and automatically turning them off after an adjustable timed interval. The on-off function shall be provided from a control panel located in the rooms as shown on the Plans. The on-off function of the infrared heater located above the ADA gate at passenger stations shall be controlled by the station attendant by a “T” rated (push button) switch at the Customer Assistant Kiosk.

B. Control power transformer shall be provided and shall conform to the requirements of Section 26 17 50, Local Control Panels.

C. The control panel shall conform to the requirements of Section 26 17 50, Local Control Panels, and shall have a UL label.

D. The contactor shall be an electrically operated, electrically held, 60 Ampere, 600 Volt, 3 pole, with a 120 Volt coil. The contactor shall be as manufactured by Square D Series 8903, or Allen Bradley Bulletin 500L.

E. The timing relay shall be, industrial type, with an adjustable off time delay of 1 to 10 minutes, set for 5 minutes. Switching contacts shall be rated a minimum of ten amperes. Timing relays shall be Agastat 7000 series or approved equal.

F. The remote mounted pushbutton station shall consist of a Joslyn Clark, 1 RNG-3 heavy duty palm pushbutton in a cast iron device box or by Rees Model No. 04960-412.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor to test the equipment. The Contractor to contact the Commissioner two (2) weeks prior to the testing to provide sufficient notice for scheduling a representative of the Commissioner to be present for the testing.

B. Whenever possible, all checks and tests to be made just prior to energizing the equipment or circuits and to be coordinated with the field schedule and field conditions.

C. Before testing and energizing a system, all necessary precautions to be taken to ensure the safety of personnel and equipment. All conductors and all electrical equipment to be properly insulated and enclosed. All enclosures for conductors and equipment to be properly grounded. Insulation resistance measurements to have been made and approved on all conductors and energized parts of electrical equipment.

3.02 INSTALLATION

A. The infrared heating units shall be installed, at a nine foot mounting height, in the location shown on the Drawings, and in accordance with the manufactures instructions.

B. For installation of heating units in bus shelters and windscreens, refer to Specification Section 13 34 00, Bus Shelters and Windscreens. Wiring shall be hidden within shelter members with access holes and cover plates.

C. The heating control panel shall be located in the Electrical Rooms or Closets and shall be supplied by the Electrical Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of INFRARED HEATING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of INFRARED HEATING must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 26 95 00

ELECTRICAL TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section of Specification covers the tests and checks that to be made on all electrical equipment and wiring to ensure compliance with the applicable codes and standards and with the Drawings and Specifications.

1.03 RELATED WORK

A. Electrical testing specified to be furnished and installed herein have related work in various other sections, including, but limited to:

1. Section 260100 “General Provisions”
2. Section 260300 “Electrical Demolition”
3. Section 260500 “Raceways and Boxes”
4. Section 261000 “Basic Electrical Materials and Methods”
5. Section 261230 “Wires, Cables, Splices, Terminations”
6. Section 261410 “Wiring Devices”
7. Section 261700 “Local Control”
8. Section 261750 “Local Control Panels”
9. Section 261900 “Grounding”
10. Section 261950 “Identification”
11. Section 264700 “Panelboards”
12. Section 265010 “Lighting Fixtures”

1.04 SUBMITTALS

A. At a minimum, the following shall be submitted for review:

1. Field Test procedure
2. Test equipment specifications.
3. Field Test results.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor to test the equipment. The Contractor to contact the Commissioner two (2) weeks prior to the testing to provide sufficient notice for scheduling a representative of the Commissioner to be present for the testing.

B. Whenever possible, all checks and tests to be made just prior to energizing the equipment or circuits and to be coordinated with the field schedule and field conditions.

C. Before testing and energizing a system, all necessary precautions to be taken to ensure the safety of personnel and equipment. All conductors and all electrical equipment to be properly insulated and enclosed. All enclosures for conductors and equipment to be properly grounded. Insulation resistance measurements to have been made and approved on all conductors and energized parts of electrical equipment.

D. The Contractor shall submit certified copies of test reports for all the tests conducted in field for Authority's approval. Test reports shall be submitted to the Authority within seven days after completion of tests. Test reports shall contain the characteristic curves, etc. where required for interpretation of results.

3.02 CONDITIONS FOR TESTS

A. General Conditions

1. Prior to testing of any equipment specified in this Section, all of the following conditions shall be fulfilled by the Contractor:
2. All shop drawings of the equipment to be tested have been approved by the Authority.
3. The Contractor shall submit a step by step test procedure including pass-fail criteria to the Authority two weeks in advance of the commencement of the test. The Authority reserves the right to add, delete and make necessary changes in the test procedure. The Contractor shall arrange to conduct all tests per the Authority's approved procedure.
4. Testing shall not commence without an approved test procedure.

B. Witnessing Tests

1. The Authority's personnel and/or their authorized agents will witness testing of all equipment unless a waiver is granted, in which case test reports of equipment for which waiver was granted, shall be submitted for review. Waiver of witnessing tests on equipment shall not be construed as a waiver for all remaining equipment either of the same type or different type. Contractor shall provide the Authority a minimum of one (1) week notice prior to commencing the test, so the Authority can schedule personnel for witnessing the tests.

C. Responsibility

1. The Contractor shall assume full responsibility during the field testing of all equipment and installation provided by him. Should there be any loss or damage to such equipment, materials or the building as result of these tests, the Contractor shall be fully responsible for replacing the damaged equipment and repairing the building. Replacement of

damaged equipment shall include all costs, including but not limited to, transportation of, testing and installation of replacement equipment.

D. Rejection and Retesting

1. Failure of equipment to successfully pass the tests or to meet ratings shall be sufficient grounds for rejection of equipment.
2. Any equipment rejected shall be retested in presence of the Authority after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams or any other documents submitted and accepted by the Authority, revised drawings or diagrams shall be submitted, showing proposed changes and Authority's approval obtained before changes or modifications are made on the equipment. Modifications or changes which do not warrant revision of any drawing shall be furnished to the Authority along with notice of retesting.
3. If it is not possible to rectify rejected equipment, new equipment shall be manufactured and the requirements of the drawings and design calculations of the original unit shall be applicable for the new unit.

E. Cost of Rectification or New Unit

1. The entire cost of rectification or new unit shall be borne by the Contractor including retesting and cost of witnessing retesting.

3.03 TESTING

A. The following tests are required but to not be limited to this list. Tests to be observed and witnessed by the Commissioner.

1. Proper phase rotation.
2. Short circuits.
3. Improper grounds.
4. Power and control electrical circuits for circuit continuity and function test.
5. Megger insulation test
6. Hypot

B. Equipments/systems tested shall include, but not limited to:

1. Main switchboard controls and operation including testing and calibrating breakers
2. Facility grounding system, and ground relays
3. Lighting system and controls
4. Local alarms and remote monitoring through SCADA
5. Fire alarm system
6. Automatic transfer switches
7. HVAC system
8. Heat trace system
9. Elevator and Escalator controls and operation
10. Generator, UPS, and inverter systems
11. Fare collection system
12. Lightning protection system
13. Generator tap box
14. Transformers

C. The Contractor to furnish all meters, instruments, cable connections, equipment or apparatus necessary for making all tests.

3.04 TESTS

A. The Contractor to check and test all transformers, power panels, feeders, power and control cables, connections and motors to assure correct phase sequence and rotation. Phase sequence to be A-B-C as follows:

1. Top to bottom, left to right and front to rear when facing protective or disconnecting mechanism.
2. Phasing to be accomplished by using distinctive colors for various phases, as indicated in Section 261230 Wires, Cables, Splices, Terminations.

B. After wires and cables are in place and connected to devices and equipment, the system to be tested for short circuits, improper grounds, and other faults. If fault condition is present, the trouble to be rectified and the wiring system to be retested.

C. Phase conductors, if shorted, grounded or at fault to be removed, to be replaced and the wiring system to be retested.

D. A voltage test to be made at each lighting panel, distribution panel and at the last outlet on each circuit. If drop in potential exceeds one percent, the Contractor to correct the condition by locating the ground or high resistance splice or connection and retest.

E. Any wiring device, electrical apparatus, or lighting fixture grounded or shorted on any integral "live" part, to be removed and the trouble rectified by replacing the defective parts or materials.

F. Upon completion of the electrical work, the Contractor to place the entire installation in operation, test for proper function, and show systems and equipment to be free of defects. Motors and driven equipment to not be run until properly lubricated. Pumps to not be run until water or process fluid supply is connected and turned on. The Contractor to test and record motor maximum load amperage and terminal voltage when uncoupled and coupled for each motor.

G. The Commissioner will observe from time to time such tests as may be required to any part of the equipment to determine if it is installed in accordance with specifications. The Contractor to extend to the Commissioner all facilities to this end and to furnish skilled or unskilled help required.

H. All tests to be witnessed by the Commissioner and three copies of the verified test results to be given to the Commissioner promptly upon completion of a test.

I. The Contractor to provide assistance to the various equipment manufacturers' field engineers as required in the testing and adjusting of the electrical power and control equipment. Cooperation of the Contractor to be such that a minimum of time is required for equipment testing.

J. A log to be maintained for all tests. This log to be certified before completion of the Project, both as to test value and date of test. All major equipment such as switchgear, and motors to be energized initially in the presence of the Commissioner.

K. Any faults in the work performed by this Contractor or in materials or equipment furnished by this Contractor to be corrected or replaced promptly by this Contractor at Contractor's own expense. Any faults in materials or equipment furnished by the Contractor which are the result of careless, incompetent or improper handling or installation by this Contractor to be corrected or replaced promptly by this Contractor at the Contractor's own expense.

L. All tests to be made at the Contractor's expense and certification of the tests to be submitted to the Commissioner. If any failures occur during the tests, the Contractor to replace the cable.

M. All tests to be recorded on the following forms:

Form Number	Description
26 95 00-1	MULTIPLE CONDUCTOR CABLE MEGGER TEST, 300 VOLTS & LESS.
26 95 00-2	SINGLE & MULTIPLE CONDUCTOR POWER CABLE MEGGER TEST, 600 V AND LESS.

FORM 26 95 00 - 1

MULTIPLE CONDUCTOR CABLE MEGGER TEST, 300 VOLTS & LESS

WIRING - SIGNAL & COMMUNICATION CABLE

Testing to be performed before connecting the cables to the terminals at either end. Continuity of each conductor to be checked at this time.

Each conductor to be checked with a 500 volt megger to ground, with all other conductors in the cable and shield, grounded. The minimum acceptable megger resistance to be 50 megohms for each conductor to ground.

DATE _____
PROJECT NAME _____
FEEDER NUMBER _____
LOCATION _____
FROM MANHOLE _____ TO MANHOLE _____
CABLE SIZE _____ CABLE LENGTH _____
NUMBER OF CONDUCTORS _____ INSULATION TYPE _____
MANUFACTURER _____ LINE VOLTAGE _____
TEMPERATURE _____ HUMIDITY _____
MEGGER TYPE _____ SERIAL NUMBER _____
TEST VOLTAGE _____ MULTIPLIER _____
REMARKS
_____
_____
_____

CONDUCTOR NO.	MEGOHMS		CONTINUITY		CONDUCTOR NO.	MEGOHM		CONTINUITY	
	C/C	C/S	PAS	FAIL		C/C	C/S	PAS	FAIL

TEST PERFORMED BY: TEST WITNESSED BY:

_____
Signature Date

_____
Signature Date

FORM 26 95 00-2

SINGLE & MULTIPLE CONDUCTOR POWER CABLE MEGGER TEST, 600V & LESS

WIRING - FEEDER CIRCUITS

Testing to be performed before connecting the cable to the terminals at either end. Continuity of each conductor to be checked at this time.

Each conductor shall be checked with a megger to ground, with all other conductors in the cable and shield, grounded. The minimum acceptable megger resistance for each conductor to ground shall be as per the NETA (National Electrical Testing Association) Table 100.1 for each conductor to ground.

DATE _____
PROJECT NAME _____
FEEDER NUMBER _____
LOCATION _____
FROM MANHOLE _____ TO MANHOLE _____
CABLE SIZE _____ CABLE LENGTH _____
NUMBER OF CONDUCTORS _____ INSULATION TYPE _____
MANUFACTURER _____ LINE VOLTAGE _____
TEMPERATURE _____ HUMIDITY _____
MEGGER TYPE _____ SERIAL NUMBER _____
TEST VOLTAGE _____ MULTIPLIER _____
REMARKS
_____
_____
_____

If Applicable, All Shields To Be Properly Grounded prior to Testing.

Cable No.	MEGOHMS Phase A	MEGOHMS Phase B	MEGOHMS Phase C

TEST PERFORMED BY: TEST WITNESSED BY:

_____
Signature Date

_____
Signature Date

NETA TABLE 100.1
Insulation Resistance Test Values Electrical Apparatus and Systems

Nominal Rating of Equipment in Volts	Minimum Test Voltage, DC	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000

3.01 WIRE AND CABLE TESTING (600 VOLTS)

A. The 600-volt insulated wires and cables to be factory tested prior to shipment in accordance with ICEA Standards for the insulation specified.

B. The following 600-volt wires and cables to be tested after installation but before final connections are made up:

1. All feeders from 208-volt switchboards.
2. All feeders from 208-volt motor control centers.
3. All feeders to 208-volt panelboards.
4. All feeders to 208/120-volt lighting panelboards.

C. For the above-listed wires and cables, a DC high potential test voltage, as specified in ICEA, to be applied for a period, as specified in the Standard, between all conductors specified in the Standard, between all conductors in the same conduit and between each conductor to ground.

D. All wires and cables No.6 AWG and larger shall be tested using megger after installation but before final connections are made. All 12 KV cables shall be either hypot tested at 38 KVDC for one minute, or VLF AC hypot tested at 20 KV for 30 minutes.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of ELECTRICAL TESTING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of ELECTRICAL TESTING must be included in the contract lump sum price as shown in the Schedule of Prices for Electrical Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Electrical Work: 260000

END OF SECTION

SECTION 27 00 10

COMMUNICATIONS GENERAL PROVISIONS

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. These specifications and drawings are intended to cover major communication items requested under this contract, however it is the Contractor's responsibility to include any and all materials, labor, engineering, integration, and testing required to provide a complete turn-key communication system at the location identified and integrated with the CTA's Control Center, compliant with the Specifications and Contract Drawings.

B. This specification involves the installation of communications infrastructure as part of this construction project, including, but not limited to:

1. Fiber Optic and Copper Communications Cables
2. OC-48 SONET Optical Communications Node(CTA latest Technology)
3. Telephone System
4. Public Address System
5. SCADA System
6. CCTV Security Camera System
7. Communications Power and UPS System
8. Communications Equipment Cabinets and Enclosures
9. Communications Room
10. Protection, temporary relocation, and permanent relocation of backbone fiber optic and copper communications and signal cables along the elevated rail structure in and around the construction zone.
11. Protection, temporary relocation, and permanent relocation of RCN CATV fiber optic cable along the elevated rail structure in and around the construction zone.

C. Communications Node: The Contractor shall provide a new fiber optic communications node at the Station including all necessary hardware and software to make the node operational and be compatible with the CTA's existing optical communications network. The Contractor shall be responsible for all circuit assignments, programming, and wiring within the new node and the CTA's existing network to make this node operational.

1. The new node shall integrate into the existing OC-48 SONET ring or CTA latest Technology.
2. The Contractor shall provide the following general components at the node as a minimum, unless noted otherwise.

a. (1) OC-48 multiplexer (Alcatel-Lucent DMXtend R9.0 or approved equal)

b. (1) Fully equipped T-1 channel bank (Zhone Acculink Access Controller or approved equal)

c. (2) Ethernet switches (Cisco 3560X-48-E or approved equal)

d. (2) 48-port Category 6 data patch panels

e. (1) 16-DS1 DSX-1 cross-connect panel

f. (1) 96-port SC-type fiber connector housing

g. (1) 96-strand fiber splice housing

3. The Contractor shall provide six (6) new equipment cabinets and system components in the Communications Room.

a. Cabinet #1 – Fiber Optic Node

b. Cabinet #2 – PA

c. Cabinet #3 – SCADA

d. Cabinet #4 – CCTV

e. Cabinet #5 – CCTV Power Supplies and UPS

f. Cabinet #6 – Fiber Optic Node UPS

4. The Contractor shall provide a communications wallfield in the Communications Room to terminate all field or premises cables.

a. Category-5e 25-pair Type 66 punch-down protected blocks

b. Category-5e 25-pair Type 66 punch-down non-protected blocks

c. Category-5e 25-pair Type 110 punch-down protected blocks

d. Category-3 25-pair Type 66 punch down protected blocks

e. 12-pole, sliding disconnect, binding post terminal blocks

f. 4’ x 8’ x1” marine grade plywood backboard

g. Copper grounding and bonding busbar system

h. Cable tray

5. Communications Hubs: The Contractor shall provide new fiber optic communications hubs in the Station including all necessary hardware and software to make the hubs operational and be compatible with the CTA’s existing optical communications network. The Contractor shall be responsible for all circuit assignments, programming, and wiring within the new hubs and the CTA’s existing network to make these hubs operational.

a. Hub Locations as shown on the Drawings:

b. Hub Components:

1) (1) Cisco IE-3000 24-port switch (or approved equal)

2) (2) 12-port Category-6 patch blocks

3) (2) 12-strand pre-terminated SC-type fiber optic single panel housings with 12-strand environmental MT connector

4) (2) Category-5e 25-pair Type 110 protected blocks

5) (1) Power Distribution Panel, 24VAC

c. Hub-to-Hub InterConnect:

1) 12-strand multimode Corning OptiTip pre-terminated fiber optic solution (or approved equal)

2) 25-pair, Category-5e OSP outdoor rated cable

3) 4/C power cable

D. Public Address System: The Contractor shall provide a complete public address system in the Station including all necessary hardware and software to make the PA system operational and be compatible with the CTA's existing master PA head-end system at the CTA's Control Center. The Contractor shall be responsible for all circuit assignments, programming, and wiring within the new PA system and the CTA's existing PA head-end to make the PA system operational.

1. The existing PA head-end system at the Control Center is IED (Innovative Electronic Designs) GlobalCom enterprise solution.

2. The Station PA system shall be an IP-based audio and digital signage system capable of broadcasting pre-canned, assembled audio library messages, live ad-hoc messages, and text-to-speech messages.

3. Audio messages shall be displayed in text form on the digital signage compliant with ADA regulations and recommendations for hearing impaired patrons.

4. PA microphones shall be IP-based, connected to network switches in communication hubs/room, and powered via POE injectors at communication hubs/room.

   a. North Station CA Kiosk – desktop mic console

   b. South Station CA Kiosk – desktop mic console

   c. East North Platform – lock-box mic

   d. West South Platform – lock-box mic

   e. West North Platform – lock-box mic

   f. East South Platform – lock-box mic

   g.

5. PA speakers shall be 70-volt, analog-based, connected via daisy-chain conductors as shown on the Contract Drawings. All speaker wiring shall terminate on the wallfield in the Communication Room and cross-connect to the PA equipment rack.

6. Dynamic message signs shall be LCD display panels with integrated PC, IP-based communications to communication hubs/room. The DMS shall be integrated with the audio control system to synchronize visual text based messages with the audio broadcast. DMS shall display CTA's TrainTracker real-time train arrival information continuously between PA messages.

   a. Station – paid and unpaid area (2)

   b. North Platform – East and west faces (2)

   c. South Platform – East and west faces (2)

7. PA noise sensors shall be provided in each speaker zone to monitor ambient noise and provide return audio sidetone. The ambient noise sensor system shall increase the volume of the audio message if the ambient noise increases. If the ambient noise reaches an extreme level, the PA system shall hold the message for playback when the ambient noise level subsides.

a. Zone as shown on the Drawings

E. Telephone System: The Contractor shall provide new telephones in the Station including all necessary hardware and software to make the telephones operational and be compatible with the CTA's existing telephone network. The Contractor shall be responsible for all circuit assignments, programming, and wiring with the new telephones and the CTA's existing telephone network to make the telephones operational.

1. The existing CTA telephone network is Avaya based.
2. Verify the location for the host PBX for station.
3. Elevator hands-free emergency telephones shall be provided by the elevator contractor. Elevator telephones shall be integrated into the CTA's existing telephone network by the communications contractor.
4. Help Point Telephones shall be interfaced to the CTA's existing telephone network. The HPT, when activated, shall dial the local CA Kiosk. If the CA kiosk does not answer, the call shall roll-over to the CTA Control Center. The HPT shall also trigger a Public Address audio and visual message for assistance over the speakers and DMS, interfaced to the PA system via the SCADA remote terminal unit in the Communications Room.

F. Security Camera System: The Contractor shall provide new CCTV security cameras in the State and Lake Station including all necessary hardware and software to make the CCTV cameras operational and be compatible with the CTA's existing Video Management System. The Contractor shall be responsible for all circuit assignments, programming, and wiring with the new CCTV cameras and the CTA's existing video network to make the cameras operational.

1. The existing CTA video management system at the Control Center is Teleste VMX R6.
2. The CCTV cameras shall be IP-based, high-definition, megapixel cameras compatible and interoperable with the existing Teleste VMX video management system
    a. Dual Image Fixed Dome Camera – Refer to Specification SECTION 28 23 31
    b. PTZ Dome Camera – Refer to Specification SECTION 28 23 32
    c. 360 Camera – Refer to Specification SECTION 28 23 31
3. The Contractor shall provide:
    a. (2) Video client PC's with Teleste VMX client licenses – North Platform CA Kiosk feed, South Platform CA Kiosk feed
    b. (2) Teleste VMX Network Video Recorders
    c. (2) Video monitors – North Platform CA Kiosk, South Platform CA Kiosk – Litemax #SLD-1954-EGBL-C01 / AD5766GDVA (or approved equal). Monitors shall be mounted to a wall-mount swing arm, Innovative Office Products #9110-8.5-4 (or approved equal)
    d. (6) Passive Infrared/Microwave Intrusion Detector Sensors

G. SCADA System: The Contractor shall provide a new SCADA system in the station including all necessary hardware and software to make the SCADA system operational and be compatible with the CTA's existing SCADA Master System at the Control Center. The Contractor shall be responsible for all circuit assignments, programming, and wiring

with the new SCADA system and the CTA's existing SCADA Master network to make the SCADA remote terminal unit and I/O devices operational.

1. The existing CTA SCADA Master System at the Control Center is CG Automation (QEI).
2. All door contacts and alarm status relays shall be wired to corresponding Interface Terminal Cabinets in the Electrical Rooms. The ITC shall be connected to the Wallfield in the Communications Room for cross-connect to the RTU.

1.03 RELATED WORK

A. COMMUNICATIONS GENERAL PROVISIONS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 05 13 – Dialtone Services
2. Section 27 05 26 – Grounding and Bonding For Communication Systems
3. Section 27 05 33 – Conduit and Backboxes for Communication Systems
4. Section 27 05 46 – Utility Poles for Communication Systems
5. Section 27 08 10 – Commissioning of Communication Systems
6. Section 27 11 11 – Communications Room Finishes
7. Section 27 11 16 – Communications Cabinets, Racks and Enclosures
8. Section 27 11 26 – Communications Equipment Power System
9. Section 27 13 13 – Communications Copper Outside Plant Cable
10. Section 27 13 23 – Communications Fiber Optic Outside Plant Cable
11. Section 25 15 13 – Communications Copper Horizontal Cabling
12. Section 27 21 10 – Communications Backbone Network
13. Section 27 21 29 – Data Communications Switches
14. Section 27 31 13 – PBX System
15. Section 27 32 13 – Telephone Sets
16. Section 27 32 26 – Help Point Telephones
17. Section 27 42 16 – Dynamic Message Signs
18. Section 27 51 16 – Public Address System
19. Section 27 51 17 – Public Address Speakers
20. Section 28 16 19 – Intrusion Detection Remote Devices and Sensors
21. Section 28 23 13 – Video Surveillance Control and Management System
22. Section 28 23 16 – Security Video Terminal
23. Section 28 23 19 – Network Video Recorder
24. Section 28 23 31 – Closed Circuit Television Fixed Cameras
25. Section 28 23 32 – Closed Circuit Television PTZ Cameras
26. Section 28 46 11 – SCADA Remote Terminal Unit

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. BICSI – Building Industry Consulting Service International
2. CCTV – Closed Circuit Television
3. CEC – Chicago Electrical Code
4. IEEE – Institute of Electrical and Electronic Engineers
5. NEC – National Electrical Code
6. NESC – National Electrical Safety Code
7. NFPA – National Fire Protection Association
8. OC-48 – Optical Carrier rate 48 (2.5Gbps)
9. PA – Public Address
10. RTU – Remote Terminal Unit
11. SCADA – Supervisory Control And Data Acquisition
12. SONET – Synchronous Optical NETwork
13. UPS – Uninterruptible Power Supply

B. Publications.

1. Chicago Electrical Code, 2012
2. NFPA 70: National Electrical Code, 2011
3. NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems, 2010
4. National Electrical Safety Code, 2012
5. BICSI Telecommunications Distribution Methods Manual (TDMM), 12th Edition

1.05 QUALITY ASSURANCE

A. Contractor's Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the Work. Comply with the requirements specified elsewhere and as specified herein. The Manufacturer(s) of the system equipment shall be submitted to the Engineer for approval. The Contractor shall provide all of the data required for the Engineer's evaluation and shall make all of the necessary arrangements for any required demonstrations and tests. The Contractor shall certify that the proposed Manufacturer(s) shall comply completely with all the requirements of this Contract.

B. The proposed Manufacturer(s) shall have, as a minimum, five (5) years experience in the successful manufacturing and installation of the specified items, unless noted otherwise, and shall have a minimum of five (5) systems of size and complexity comparable to the system specified herein. Each system and components shall have been on-line and operating satisfactorily for a minimum of twelve (12) months.

C. The Manufacturer(s) shall provide the names, addresses, and telephone numbers of operating personnel who can be contacted regarding the systems upon request. A demonstration of the system shall be arranged upon request.

D. The Manufacturer(s) shall demonstrate a Quality Assurance Program that meets the intent of ASQC Q90; General Requirements for a Quality Assurance Program (US

equivalent of ISO 9000). Compliance with the Quality Assurance Program shall produce a thoroughly tested unit that will render long service life to the user and insure that malfunctions cannot be attributed to actions or lack of actions by the Manufacturer.

1.06 SUBMITTALS

A. The Contractor shall provide submittals in accordance with the section on Special Conditions, and section on General Provisions, of this Specification.

B. The Contractor shall submit complete sets of the following to the Engineer for approval prior to ordering any of the equipment specified in this Section. The Contractor shall provide six (6) copies of product literature/catalog cuts, six (6) copies of shop drawings, and three (3) samples upon request.

1. Proposed Manufacturer's detailed product data "cut-sheets", specifications, and operations/installation/maintenance manuals for each piece of equipment to be furnished.
2. Installation and demolition details of all communications material and equipment.
3. Single line block and system diagrams detailing the communications system under this contract including all elements of system integration.
4. A block diagram shall be submitted showing interconnection between major independent elements, such as fiber optic cable, optical patch cord, fiber optic multiplexer, channel bank and distribution frames.
5. Physical equipment layout in plan and rack elevation views.
6. Wiring diagrams of distribution frames, equipment racks, and communications cables.
7. Detailed testing procedures and certified copies of all test results and reports.
8. All shop drawings as detailed herein.

C. The as-built drawings shall be prepared in AutoCad 2018 minimum, compliant with current CTA CAD standards, and delivered to CDOT and CTA in hardcopy and softcopy with all electronic base and reference files.

1. The installation drawings prepared shall be updated during construction to document all as-built information to reflect accurate installation information.
2. All information shall be provided by the Contractor to CTA for input to CTA’s existing Infrastructure Management System database as elements are installed and inspected, compliant with CTA standards and procedures for electronic documentation of communications infrastructure.
3. The completed drawing hardcopies shall be submitted to CDOT and the CTA for approval. System acceptance will not be granted until the as-built submittals have been approved.

1.07 DELIVERY, STORAGE, AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

B. Handling: The equipment shall be shipped on a pallet suitable for forklift handling. The equipment shall be covered with clear plastic or other impenetrable sheeting to prevent dust, dirt and moisture from entering the equipment during shipment and storage.

1.08 WARRANTY

A. Following successful completion of a 30-day Performance Test and Construction Acceptance, a Warranty Period shall commence. The purpose of this period is to ensure that all components of the Communications System under this contract function in accordance with the Specifications over an extended length of time, and to provide continuing assistance to the Chicago Transit Authority in all phases of system operation as required. This consists of a 12 month Warranty Period. For a 12 month period, beginning at construction acceptance of the system, the Contractor shall be responsible for the proper performance of all equipment.

B. The Contractor shall also be responsible for obtaining technical assistance from the equipment manufacturers and/or suppliers in cases where programming, operational or adjustment difficulties are encountered; the Contractor shall be responsible for providing training to the CTA on any communications equipment if new or unusual problems/repairs are discovered during the Warranty Period. The Contractor shall be responsible for correcting any problems attributable to poor workmanship and/or equipment.

1.09 TRAINING

A. The Contractor shall supply training for up to twelve (12) CTA designated personnel in all aspects of operation and maintenance of the communications system.

B. The Contractor shall provide all maintenance and operations training prior to any equipment being made operational in the field.

C. Personnel thoroughly familiar with the operation of the equipment shall provide training. This may be the Contractor's personnel, equipment manufacturer's representatives, or a combination of the two. A complete course outline and summary of the experience and qualifications of the instructional personnel shall be submitted to the Engineer for approval prior to the start of training. Training sessions may be combined and/or shortened with the agreement of the Chicago Transit Authority and the Contractor.

D. Recommended test equipment, literature and drawings for the classes shall be furnished by the Contractor. At the conclusion of classes, all items furnished, which are not currently owned by the Chicago Transit Authority, shall become the property of the Chicago Transit Authority.

E. All training class time (indoor and outdoor) shall be video recorded by the Contractor on high quality DVD format for playback in a standard standalone and computer based DVD players. The video DVD(s) shall become the property of the Chicago Transit Authority.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION – NOT APPLICABLE

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATIONS GENERAL PROVISIONS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATIONS GENERAL PROVISIONS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 05 13

DIALTONE SERVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This specification consists of furnishing and installing DIALTONE SERVICES by the local telephone utility for the new rail station, and the necessary work and materials to interface the telephone circuits at the locations as shown on the Contract Drawings.

B. Local Telephone Utility Service: The Contractor shall obtain the necessary services from the local telephone utility to furnish and install a new telephone service cable from the closest telephone manhole to the Main Station NETPOP in the Communications Room, as defined herein and as shown on the Contract Drawings. The Contractor shall coordinate, order, test, and reimburse the local telephone utility for all utility charges for this work and shall pay the utility all service costs until the system is accepted by the CTA.

C. Dialtone Services shall support the following:

1. Measured Business (MB) / POTS
2. Payphone
3. Leased Line (4-wire) Data

D. The Dialtone Services cable provided by the utility from the utility manhole to the NETPOP shall be a minimum of 25 pairs. The cable shall comply with the local telephone utility's established standards.

E. The NETPOP shall be located in the Main Station Communication Room. Any devices elsewhere in the station that require PSTN communications shall use Owner cables, called "house cables", as shown on the Contract Drawings. Devices shall connect over the "house cable" to termination blocks on the wallfield in the Communication Room and cross-connect to the local telephone utility's NETPOP.

F. Cross-connections from the wallfield to the NETPOP shall be performed by the local telephone utility.

G. The Contractor shall coordinate with the local telephone utility for all grounding and make them aware of the unique grounding system in the Station as a result of the elevated train structure floating ground. If the telephone utility requires Earth ground, the utility must isolate the ground from the Station ground and make provisions to avoid ground voltage potentials.

1.03 RELATED WORK

A. Dialtone Services specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions. The abbreviations, acronyms and their definitions listed in Specification Item 27 00 10 – Communications General Provisions, Section 1.04, and those listed below may be used throughout this Section:

1. ATM – Automated Teller Machine
2. CPE – Customer Premises Equipment: Communication devices in the Owner system that connect to private and/or public telecommunications networks.
3. CSU – Channel Service Unit
4. DSU – Data Service Unit
5. MB – Measured Business line
6. NETPOP – NETwork Point Of Presence: Local telephone utility demarcation point where utility service cables terminate and cross connect to customer premises equipment.
7. PSTN – Public Switched Telephone Network
8. POTS – Plain Old Telephone Service: Traditional (dial-up) 2-wire analog telephone service from the Public Switched Telephone Network.

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 TELEPHONE SERVICE CABLE

A. Telephone service cable for Dialtone Services shall be furnished by the local telephone utility as part of the services obtained by the Contractor from the local telephone utility.

B. Telephone service cable shall be minimum 25 pairs.

C. Telephone service cable shall comply with local telephone utility's established cable standards.

2.02 NETPOP TERMINATION PANEL

A. The NETPOP termination panel shall be furnished by the local telephone utility as part of the services obtained by the Contractor from the local telephone utility.

B. The NETPOP termination panel shall be sized to terminate a minimum of 25 pairs, equal to or greater than the cable provided.

C. The NETPOP termination panel shall comply with local telephone utility's established standards.

PART 3 - EXECUTION

3.01 TELEPHONE SERVICE CABLE

A. Telephone service cable for Dialtone Services shall be installed by the local telephone utility as part of the services obtained by the Contractor from the local telephone utility.

3.02 LOCAL TELEPHONE UTILITY NETPOP

A. The NETPOP termination panel shall be installed by the local telephone utility as part of the services obtained by the Contractor from the local telephone utility.

3.03 GROUNDING

A. The Contractor shall coordinate with the local telephone utility for all grounding and make them aware of the unique grounding system in the Station as a result of the elevated train structure floating ground. If the telephone utility requires Earth ground, the utility must isolate the ground from the Station ground and make provisions to avoid ground voltage potentials.

3.04 IDENTIFICATION

A. All cable pairs, connecting blocks, and terminals shall be labeled with circuit numbers and other relevant identifying information.

3.05 FIELD ACCEPTANCE TEST

A. Following completion of the installation of the telephone service cable and the NETOP, the Contractor shall inspect all equipment and wiring to verify that all mechanical connections are made and properly secured, and all cable terminations are properly terminated. This inspection shall include conductor and shield continuity and ground isolation verification of all installation wiring. This testing shall be accomplished from the NETPOP in the Communication Room with a Telephone Butt Set on applicable pairs. Data sheets containing evidence of such inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be delivered to CDOT and the CTA for approval. The Contractor shall request from and shall receive approval of such inspection certification before proceeding with further testing.

B. In accordance with the local telephone utility's established installation procedures, provide Shop Drawings and As-Built record documents.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of DIALTONE SERVICES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of DIALTONE SERVICES must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

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 specification consists of furnishing and installing GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS at the locations as shown on the Contract Drawings.

B. The Contractor shall furnish and install a complete Communication Infrastructure Grounding System as required by the Contract Drawings and as specified herein.

C. The elevated steel structure that supports the Rapid Transit ROW shall serve as the Code required reference grounding electrode.

D. The Communications Room shall have a continuous ground bus / bonding conductor around the perimeter of the room as shown on the Contract Drawings.

E. The Telecommunications Main Grounding Busbar in the Communication Room shall be the common point of connection for telecommunications grounding, with a Unit Bonding Conductor to the Main Station Electrical Room main ground bus.

F. The TMGB shall be installed below the Communications Room wallfield.

G. A Telecommunications Grounding Busbar shall be installed on the wall over the floor conduit entry area in the Communications Room with busbar insulator standoffs.

H. A Telecommunications Grounding Busbar shall be installed on the wall over the floor conduit entry area in the Station Electrical Room with busbar insulator standoffs. The TGB shall be bonded to the Station Electrical Room ground busbar.

I. A Horizontal Rack Grounding Busbar shall be installed on the cable tray over the equipment cabinets in the Communications Room with busbar insulator standoffs.

J. A Grounding Bonding Conductor shall be installed on the walls around the perimeter of the Communications Room.

K. The Communications Room equipment cabinets shall be isolated from the concrete floor with a rubber insulation pad.

L. Each equipment cabinet shall be bonded to the TGB along the cable tray.

M. Each transient protected telephone termination block on the wallfield shall be bonded to the TMGB.

N. The GBC from the TMGB to the Electrical Room main ground bus shall be a green

insulated #4/0 AWG conductor.

O. The GBC around the perimeter of the Communications Room shall be a bare #4/0 AWG conductor.

P. UBC for equipment cabinets and protected telephone blocks shall be green insulated #6 AWG conductors.

1.03 RELATED WORK

A. GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions
2. Section 27 13 13 – Communications Copper Outside Plant Cable
3. Section 27 08 10 – Commissioning Of Communications
4. Section 27 11 11 – Communication Room Finishes
5. Section 27 11 16 – Communications Cabinets, Racks, and Enclosures
6. Section 27 11 26 – Communications Equipment Power System

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. A.F.F. – Above Finished Floor
2. AWG – American Wire Gauge
3. BCT – Bonding Conductor for Telecommunications
4. BICSI – Building Industry Consulting Service International
5. CEC – Chicago Electrical Code
6. GBC – Grounding Bonding Conductor
7. GE – Grounding Equalizer
8. HRGB – Horizontal Rack Grounding Busbar
9. NEC – National Electric Code
10. NESC – National Electric Safety Code
11. NETPOP – NETwork Point Of Presence
12. ROW – Right Of Way
13. TBB – Telecommunications Bonding Backbone
14. TEBC – Telecommunications Equipment Bonding Conductor
15. TGB – Telecommunications Grounding Busbar
16. TMGB – Telecommunications Main Grounding Busbar
17. UBC – Unit Bonding Conductor
18. UL – Underwriters Laboratories

B. Publications.

1. Chicago Electrical Code
2. National Electric Code
3. National Electric Safety Code

C. Reference Standards.

1. ANSI/TIA-607-B, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
2. ANSI/NECA/BICSI-607, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
3. ANSI/IEEE 1100, 2005, Recommended Practice for Powering and Grounding Electronic Equipment
4. ANSI/IEEE C2, 2007, National Electrical Safety Code (NESC)
5. ANSI/ATIS 0600333, Grounding and Bonding of Telecommunications Equipment
6. ANSI/TIA/EIA-606-A, 2007, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 GROUNDING BONDING CONDUCTOR

A. GBC shall be:

1. Stranded copper wire
2. Type XHHW
3. Green insulated or bare, as required.
4. 600 volt rated insulation
5. Sized and installed in accordance with Code requirements, and as noted on the Contract Drawings.

2.02 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR

A. The TMGB shall be constructed of ¼" thick solid copper.

B. The TMGB shall be 4 inches high and be provided in lengths of 12 inches and 20 inches as required.

C. The TMGB shall have 2 rows of 9 pairs of attachment points for two-hole grounding lugs.

D. The TMGB hole pattern for grounding lugs shall comply with ANSI/TIA-607B and accept 15 lugs at 5/8 inch hole centers and 3 lugs at 1 inch hole centers.

E. The TMGB shall include wall mount stand-off brackets with insulators to provide a 4 inch wall standoff.

F. The TMGB shall be UL listed for grounding and bonding.

2.03 TELECOMMUNICATIONS GROUNDING BUSBAR

A. The TGB shall be constructed of ¼" thick solid copper.

B. The TGB shall be 2 inches high and be provided in lengths of 10 inches and 12 inches as required.

C. The TGB shall have 1 row of 7 pairs of attachment points for two-hole grounding lugs.

D. The TGB hole pattern for grounding lugs shall comply with ANSI/TIA-607B and accept 4 lugs at 5/8 inch hole centers and 3 lugs at 1 inch hole centers.

E. The TGB shall include wall mount stand-off brackets with insulators to provide a 4 inch wall standoff.

F. The TGB shall be UL listed for grounding and bonding.

2.04 HORIZONTAL RACK GROUNDING BUSBAR

A. The HRGB shall be constructed of 3/16" thick, minimum, solid copper or copper alloy.

B. The HRGB shall be ¾ inches high and be provided in lengths of 19 inches, 23 inches, and 35 inches.

C. The HRGB shall have 1 row of 8 #6-32 tapped lug mounting holes at 1 inch centers and 2 pairs of 5/16 inch lug mounting holes spaced ¾ inches apart.

D. The HRGB shall include standoff brackets with insulators to provide a 1 inch stand-off from the cable tray.

E. The HRGB shall be UL listed for grounding and bounding.

2.05 BONDING ACCESSORIES

A. Compression lugs shall be manufactured from electroplated tinned copper.

B. Compression lugs shall have 2 holes spaced at 5/8 inch or 1 inch centers for connection to busbars.

C. Compression lugs shall be sized to accept specific conductors, #6 AWG to #4/0 AWG as required.

D. Compression lugs shall be UL listed for wire connectors.

PART 3 - EXECUTION

3.01 GROUNDING BONDING CONDUCTOR

A. GBC shall be installed on the walls around the perimeter of the Communications Room:

1. 12 inches A.F.F
2. Insulator stand-offs 2 inches from the wall.
3. Electrically and mechanically bond the GBC to the TMGB and TGB as required.

B. GBC shall be installed along the overhead cable tray in the Communications Room:

1. Insulator stand-offs 2 inches from the cable tray outer wall.
2. Electrically and mechanically bond the GBC to the HRGB as required.

C. GBC insulated shall be installed from the TMGB to the Main Station Electrical Room and bonded to the main grounding bus.

D. The elevated steel structure that supports the Rapid Transit ROW shall serve as the Code required reference grounding electrode. The Communications Infrastructure Grounding System must be isolated from Earth Ground and only be connected to Station Ground. Coordinate with Electrical construction for common grounding implementation.

3.02 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR

A. TMGB shall be installed on the wall below the wallfield in the Communications Room:

1. 12 inches below the wallfield
2. Busbar insulator stand-offs 4 inches from the wall
3. Bond TMGB to perimeter GBC

B. Conductor connections to the TMGB shall be made with two-hole compression lugs, sized to fit the corresponding busbar holes and the conductor size.

C. Each bond connection on the TMGB shall be treated with antioxidant to prevent corrosion at the bond.

D. Each lug shall be attached with stainless steel hardware.

E. Each protected telephone terminal block on the wallfield shall have a dedicated bond connection to the TMGB.

3.03 TELECOMMUNICATIONS GROUNDING BUSBAR

A. TGB shall be installed on the wall over the floor conduit entry area in the Communications Room:

1. 12 inches A.F.F.
2. Busbar insulator stand-offs 4 inches from the wall
3. Bond TGB to perimeter GBC

B. TGB shall be installed on the wall over the floor conduit entry area and below the Communications Hub in the Station Electrical Room:

1. 12 inches below the Communications Hub
2. Busbar insulator stand-offs 4 inches from the wall.
3. The TGB shall be bonded to the Station Electrical Room ground busbar with #6AWG GBC.
4. Each Communications Hub enclosure shall be bonded to the TGB.

C. Conductor connections to the TGB shall be made with two-hole compression lugs, sized to fit the corresponding busbar holes and the conductor size.

D. Each bond connection on the TGB shall be treated with antioxidant to prevent corrosion at the bond.

E. Each lug shall be attached with stainless steel hardware.

F. Copper outside plant cable shall be bonded to the TGB.

3.04 HORIZONTAL RACK GROUNDING BUSBAR

A. HRGB shall be installed in the Communications Room:

1. On the outer wall of the cable tray over the equipment cabinets
2. Busbar insulator standoffs 1 inch from the cable tray wall
3. Bond each HRGB directly to the adjacent HRGB over each cabinet
4. Bond the mated HRGB assembly to the cable tray GBC.

B. Conductor connections to the HRGB shall be made with one-hole compression lugs, sized to fit the corresponding busbar holes and the conductor size.

C. Each bond connection on the HRGB shall be treated with antioxidant to prevent corrosion at the bond.

D. Each lug shall be attached with stainless steel hardware.

E. Each equipment cabinet shall be bonded to the HRBG.

3.05 TESTING

A. The Communications Infrastructure Grounding System shall be tested with a resistance meter to confirm isolation from Earth Ground and continuity with Station Ground.

B. Tests to be conducted:

1. TMGB to Station Ground
2. TGB to TMGB
3. HRGB to TMGB
4. HRGB to Equipment Cabinets

C. Tests shall be recorded and submitted to CDOT and the CTA.

D. Refer to Electrical Specifications for grounding testing information.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 05 33

CONDUIT AND BACK BOXES FOR COMMUNICATION SYSTEMS

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 specification consists of furnishing and installing CONDUIT AND BACK BOXES FOR COMMUNICATION SYSTEMS at the locations as shown on the Contract Drawings.

B. This section is in addition to raceways, boxes, and appurtenances specified under Division 26.

C. The Contractor shall provide Reinforced Thermosetting Resin Conduit (RTRC) under the new station platform and under the track structure as shown on the Contract Drawings for routing communication and signal cables through the station area.

1.03 RELATED WORK

A. CONDUIT AND BACKBOXES FOR COMMUNICATION SYSTEMS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions
2. Section 26 50 30 - Cable and Light Tray Enclosure
3. Section 26 05 00 – Raceways and Boxes

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. RTRC – Reinforced Thermosetting Resin Conduit

B. Publications.

1. Chicago Electrical Code
2. National Electric Code
3. National Electric Safety Code

C. Reference Standards.

1. UL 1684, Standard For Reinforced Thermosetting Resin Conduit

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 GENERAL

A. All wire and cable shall be installed in electrical raceways of the type specified herein and shown on the Drawings.

B. Minimum size conduit shall be 3/4 inch for RGS, 1-1/2 inch for fiberglass.

C. Intermediate metal conduit (IMC) is not acceptable.

2.02 GALVANIZED RIGID STEEL CONDUIT

A. Galvanized rigid steel (GRS) conduit and fittings shall be installed in all above ground areas of this Project except as noted herein.

B. GRS conduit shall be heavy wall type, hot-dipped galvanized with zinc-coated threads, and Underwriters' Laboratory labeled.

C. GRS conduit and couplings shall be threaded, rigid steel, hot-dipped galvanized after fabrication and shall be in accordance with UL 6.

2.03 RIGID NON-METALLIC CONDUIT

A. Non-metallic rigid conduit shall be used for underground feeders, service feeders, and under concrete slabs on grade.

B. Non-metallic rigid conduit shall be of the fiber glass reinforced epoxy type, minimum size of 1-1/2 inches in diameter.

C. Fibre glass conduit shall be composed of glass filament encapsulated in an epoxy matrix. Each conduit length shall have an integral wound in expanded coupling. No threads or adhesives shall be required to assure watertight joints for underground installations.

D. Conduit shall be suitable for continuous operation from minus 40 degrees C to plus 100 degrees C without significant change of mechanical properties. Conduit shall be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for UV protection.

E. Conduit shall be UL listed.

F. Non-metallic rigid conduit shall be:

1. Minimum of 1-1/2 inches in diameter
2. Pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for UV protection
3. Each conduit length shall have an integral wound in expanded coupling. No threads or adhesives shall be required to assure watertight joints for underground installations.

G. Fiberglass Reinforced Epoxy (FRE) non-metallic rigid conduit shall be:

1. Used for underground communication and signal cables, and under concrete slabs on grade
2. Composed of glass filament encapsulated in an epoxy matrix
3. Suitable for continuous operation from minus 40 degrees C to plus 100 degrees C without significant change of mechanical properties

H. Reinforced Thermosetting Resin (RTRC) non-metallic rigid conduit shall be:

1. Used for above ground under platform/track structure to route and protect communication and signal cables through the station area
2. Composed of epoxy based fiberglass resin with anhydride curing agent, 65-70% glass content, nominal 55 degree winding angle, halogen free.
3. Dielectric strength: greater than 400 volts/mil (ASTM D-149).
4. Tensile strength: 9,000 psi nominal
5. Coefficient of thermal expansion: 1.5x10^-5 in/in/oF nominal
6. Impact resistance: 60 ft lbs nominal for 3” diameter conduit
7. Deflection: 140 lb/in/in nominal for 3” diameter conduit
8. Suitable for continuous operation from minus 60 degrees C to plus 250 degrees C without significant change of mechanical properties.
9. Champion Fiberglass, or Authority approved equal.

2.04 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

A. Liquid tight flexible metallic conduit shall be used for termination at recessed light fixtures, in non-plenum ceilings, motors, transformers, and installations subject to vibration.

B. Liquid-tight galvanized steel flexible conduit shall conform to UL 360. Fittings shall be of a type designed to provide a liquid-tight continuation of the conduit system.

2.05 LIQUID TIGHT FLEXIBLE METAL TUBING

A. Liquid tight flexible metal tubing shall be used for termination at recessed light fixtures, in plenum ceilings.

B. Liquid tight metal flexible metal tubing shall conform to UL 360, Fittings shall be of a type designed to provide liquid-tight continuation of the conduit system.

2.06 CONDUIT FITTINGS

A. Galvanized Rigid Steel Conduit:

1. All fittings shall be; malleable iron; threaded type; hot dip galvanized or cadmium plated. Feraloy, aluminum, or threadless fittings are not acceptable and shall not be provided.
2. All LB, LR, and LL fittings shall have detachable cover, captive brass machine screws, and full neoprene gasket. All LB, LR and fittings shall be NEC Series Mogul Type.
3. Locknuts shall be malleable iron or steel, with non-slip notches.
4. All bushings shall be of the insulated and grounding type.
5. Expansion couplings shall have capability of four inch movement and be complete with flexible bonding jumper.

B. Rigid Non-Metallic Fiberglass Reinforced Epoxy Conduit:

1. All fittings shall be composed of glass filaments encapsulated in an epoxy matrix.
2. All fittings shall be pigmented with carbon black dispersed homogeneously throughout the epoxy glass matrix for ultra-violet protection.
3. All fittings shall be suitable for continuous usage in ambient temperatures ranging from minus 40 degrees C to plus 100 degrees C without significant change of mechanical properties.
4. Fittings in all sizes shall have inside diameters equal to the trade sizes.

C. Liquid-tight Flexible Metallic Conduit:

1. All fittings for use with liquid-tight flexible metallic conduit shall require the use of a wrench during installation.
2. All fittings shall; have a deep grip ferrule for thorough engagement of the flexible conduit and grounding continuity; provide high resistance to pull out of the flexible conduit from the fitting; withstand extreme external flexing, vibration and moist environments.

2.07 CONDUIT HANGERS AND SUPPORTS

A. The Contractor shall provide all necessary conduit hangers, and equipment supports or hangers, including all structural steel members and shapes, standard rods, nuts, bolts,

concrete inserts, expansion shells, pipe brackets, tubing and conduit clamps, as indicated, hereinafter specified, or as required to support and/or suspend all equipment and conduit.

B. Exposed conduit on walls or ceilings shall be supported, a minimum of every five feet, with galvanized malleable iron one hole clamps and matching backs, utilizing anchors as specified herein.

C. For concrete or brick construction, when stray current isolation is not required, insert anchors shall be zinc alloy steel or steel anchors as manufactured by Ackerman-Johnson, Paine or Philips with noncorroding round head machine screws.

D. For wood construction provide galvanized round head wood screws.

E. For exposed work, where two or more conduits, one inch or larger are run parallel, trapeze hangers, spaced on five foot centers may be used.

F. The Contractor shall secure fasten conduits to each support with U-bolts, or conduit straps. Conduit supports shall be as manufactured by B-Line, OZ/Gedney, Unistrut Corp., or approved equal. Supports shall be held to concrete walls and ceilings by electro-galvanized steel inserts as manufactured by B-Line, Ramset, Unistrut Corp., or approved equal. Supports suspended from steel structure shall be supported from drilled holes in the steel flange. The use of beam clamps for this work is not acceptable.

G. The Contractor shall provide hanger rods for trapeze-type hangers made from high tensile strength carbon steel not less than 1/2-inch diameter. The rods shall have free-running, burr-free Unified National Coarse threads, with an electro-galvanized finish. Conduit supports shall be located at intervals not exceeding 5 feet as required by City of Chicago Electrical Code.

H. For exposed work attached to the support structure of the Rapid Transit right of way, conduits shall be supported as shown on the Drawings. The use of beam clamps, and or trapeze type hangers for this work is not acceptable.

I. The use of explosive force, hammer actuated, booster assist, piston drive, or like devices is strictly prohibited.

J. The use of perforated strap hangers, plastic, or composition inserts is not acceptable.

K. The Contractor shall support vertical conduits by heavy wrought iron clamps or collars anchored in construction at each floor.

L. Where threaded fasteners are provided, either a jam nut or aerobic thread sealant manufactured by Loctite or approved equal shall be used.

2.08 OUTLET, JUNCTION AND PULL BOXES

A. Outlet boxes, shall be hot dipped galvanized sheet steel or cast ferrous metal conforming to UL 514, suitable for use in damp areas.

B. Outlet boxes installed outdoors, on, or under the platform, shall be cast iron type with a cast or malleable iron gasketed cover.

C. Junction and pull boxes shall be constructed of galvanized sheet steel, with continuously welded seams, and shall be hot dipped galvanized after construction. or cast Ferrous metal

conforming to UL 50.

D. The size shall be as shown on the Drawings or required by the NEC and Chicago Electrical Code.

2.09 CABLE TRAYS

A. Cable trays shall be of the ventilated, steel ladder type with 9 inch rung spacings. Trays shall have the depth and width as specified, required or shown on the Contract Drawings. All components of the tray system shall be of the same design and manufacture.

B. Cable trays and accessories shall conform to NEMA Standard VE 1 and shall be hot dipped galvanized after fabrication.

C. Cable trays shall have minimum load rating of 50 pounds per linear foot with safety factor of 1.5 at 12-foot support span.

D. Fittings in cable trays system shall have a minimum radius of 24 inches for both vertical and horizontal turns.

E. Trays and fittings shall be of Ventray Design as manufactured by B-Line Systems, Chalfant Mfg Co., MP Husky Corp. or approved equal.

PART 3 - EXECUTION

3.01 CONDUIT INSTALLATIONS

A. General:

1. All conduits shall be installed as required. The conduit system shall be installed complete with all accessories, fittings, and boxes, in an approved and workmanlike manner to provide proper raceways for electrical conductors.

2. All conduit runs shown on the Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits. Conduit shall be run underground or in concrete slabs only when shown on the Drawings. It shall be the Contractor's responsibility to avoid interferences.

3. Exposed conduit runs shall be installed true, plumb, parallel with or at right angles to adjacent structural members, and must present an orderly, neat and workmanlike appearance.

4. Factory-made conduit bends or elbows shall be used wherever possible in making necessary changes in direction. Field bends shall be made with proper tools for the size and type of conduit being used. Field bends shall be carefully made to prevent conduit damage or reduction in internal areas. The bending radius shall not be less than six times the nominal diameters of the conduit, with carefully matched bends on parallel runs to present a neat appearance. The number of crossovers shall be kept to a minimum.

5. All conduit cut on the job shall be carefully reamed after threading, to remove burrs. All field cut threads shall be tapered. No running threads will be permitted. Field cut threads on steel conduit shall be given a coat of zinc dust in oil, or other approved compound.

6. All threaded joints shall be watertight and ensure a low resistance ground path in

the conduit system.

7. All conduits shall be carefully cleaned before and after installation and all inside surfaces shall be free of imperfections likely to injure the cable. After installation of complete runs, all conduits shall be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Any conduits through which the mandrel will not pass shall be removed and replaced. After snaking, the ends of the dead-ended conduits shall be protected with standard malleable metal caps to prevent the entrance of water or other foreign matter.

8. Lines of nylon or polypropylene, propelled by carbon dioxide or compressed air, shall be used to snake or pull wire and cable into conduits. Flat steel tapes or steel cables may be used for branch circuit runs less then 50 feet long.

9. Where conduits are connected to boxes or equipment enclosures, drilled holes or full size knockout openings shall provide electrical continuity for grounding and shall be assured by the use of bonding type locknuts. Where connections are at eccentric or concentric knockouts, jumper type grounding bushings and wire jumpers shall be installed.

10. At pull and junction boxes that have any dimension in excess of 18 inches and having a total of more than four conduit terminations, jumper type grounding bushings shall be installed on conduit ends and jumper wires shall be installed to bond all conduits and to bond conduits to boxes.

11. Communication conduit radius shall not be less than 10 conduit diameters.

12. Conduit bends which are crushed or deformed in any way shall not be installed.

13. Conduit systems shall be installed, with fittings, double locknuts and bushings, and made up tight to insure ground continuity throughout the system.

14. Conduit connections to NEMA Type 3R enclosures shall terminate in a threaded hub with an insulated throat to provide a positive seal, an electrical ground and a water tight connection. Each hub shall be manufactured by Meyers, 0Z/Gedney Type CH-T, or approved equal.

B. As far as practicable, conduit shall be pitched slightly to drain to the outlet boxes, or otherwise installed to avoid trapping of condensate. Where necessary to secure drainage, a breather-drain fitting, shall be installed in the boxes or trapped conduit at low points. Each breather drain fitting shall be manufactured by Crouse-Hinds Co., Appleton Electric Co., or approved equal.

C. Conduit shall not run through columns or beams unless so specifically detailed on the drawings.

D. Conduit Installed in Concrete Slab

1. Metal conduits shall not be installed in concrete slabs on grade. Where installed in slabs, conduit shall be placed in the center of the slab and no closer than 3 diameters from adjacent conduits. The maximum outside diameter of conduits in the slab shall be no greater than 1/3 of the slab thickness.

2. Joints in conduit installed in concrete slabs shall be made watertight.

3. Conduit openings shall be temporarily plugged with metal caps to exclude water, concrete, plaster and other foreign material.

4. Conduits run in earth below any floor slab shall be rigid non-metallic conduit and shall be entirely encased in reinforced steel concrete. In no case shall conduit be

laid in fill below the slab.

5. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during the placing of concrete.

6. The Contractor shall be held responsible for proper position of conduits and shall rearrange any conduit that may be displaced while concrete is placed.

7. Conduits run in floor slabs shall be a minimum one inch in size, and as shown on the Drawings.

E. The number of 90 degree bends shall be limited to 3 or a total of 270 degrees including all offsets, sweeps, kicks, etc. This shall include conduit runs between panelboards, switchboards, pullboxes, outlets boxes, fittings, or between outlets and fittings including bends located immediately adjacent to outlets or fittings. The maximum run without pull boxes shall be 150 feet.

F. The Contractor shall furnish and install expansion fittings and bonding jumpers for the metallic conduit system where conduit crosses each building expansion joint, at each straight uninterrupted run of surface mounted conduit, or each vertical riser in excess of 100 feet and where conduits transfer between structurally independent buildings or supports. The distance between fittings as installed shall not exceed 200 linear feet.

1. Expansion fittings shall provide for 8 inch movement and shall include bonding jumpers.

2. Expansion fittings shall be Appleton XJ with XJB jumpers, Crouse-Hinds, OZ/Gedney, or approved equal.

G. All wiring systems shall be "pullable" and use of "BX" is prohibited.

H. Conduits entering motor control center conduit compartments, free standing panels, and free standing control cubicles shall be fitted with jumper type insulated grounding bushings, bonded together and to the structure of the enclosure by a continuous bonding wire.

I. Conduits and concrete type boxes, masonry boxes, and other flush mounted boxes shall be installed concealed in masonry walls, plaster walls, dry wall and concrete walls.

J. All concealed conduits shall be placed in walls, floors, ceilings, or ducts at the proper time, in accordance with the progress of the structural work.

K. Concrete encased conduit runs extending through structural expansion joints shall have fittings permitting longitudinal and lateral movement of the conduit ends without damaging the contained wires. The fittings shall be watertight and include a grounding bond.

L. Conduit runs that enter the building from outdoors are subject to moisture accumulation due to condensation. A pull box shall be provided in the conduit run near the point of temperature change, to prevent trapping of moisture within the conduit system. A 1/4 inch weep hole shall be drilled in the bottom of the pull box. After the wires and cables are installed, the end of the conduit continuing into the warmer area shall be packed with a non-setting sealing compound.

M. All communication, telephone, data and computer conduits shall have a minimum separation of 12 inches from any AC power and control conduits.

N. When work is not in progress, open ends of conduit and fittings shall be securely closed so that no water, earth or other substance will enter.

3.02 CONDUIT CONNECTIONS TO EQUIPMENT

A. The conduit system shall be terminated at the conduit connection point of electric motors, devices, and equipment. Terminations of conduits at such locations shall permit direct wire connections to the motors, devices, or equipment.

B. Conduit connections shall be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement, or vibration. Rigid conduit connections shall have union fittings, to permit removal of equipment without cutting or breaking the conduit.

C. Conduit connections shall be made with approved flexible metallic conduit if the equipment is subject to adjustment, mechanical movement, or vibration. Flexible conduit connections shall be watertight.

3.03 OUTLET BOX INSTALLATION

A. Boxes shall generally be 4 inches square or octagonal except as follows:

1. In masonry walls, where conduit is installed concealed, each box shall be installed square cut masonry boxes.
2. In concrete walls and floor slabs, where conduit is installed concealed, boxes shall be suitable and constructed for installation in concrete.
3. In exposed work, surface outlet boxes shall be used for switches and receptacles.
4. Outlet boxes for use with rigid conduit shall be of the threaded hub, malleable iron cast metal type, with malleable iron cast covers and gaskets.
5. In finished plaster walls, drywall, etc., raised device covers on outlet boxes shall be provided.
6. Where 1-1/4 inch conduits are required, the box size shall be a minimum of 4-11/16 inches square.

B. Proper covers on boxes mounted flush shall be provided.

C. All ceiling outlets shall have adequate supports and shall be equipped with adequate devices to carry and mount lighting fixtures provided fixtures do not weigh more than fifty pounds.

D. An outlet box shall be provided at each device location requiring one.

1. Outlet box locations as shown on the Drawings shall be considered as approximate only.
2. Exact locations shall be determined from the Drawings or from field instructions. The Contractor shall coordinate box locations with the work of other trades.
3. Boxes shall be installed true and plumb, so that the covers or plates shall be level and at uniform elevations for the type of outlets contained.
4. Boxes for toggle switches and pilot lights at doorways shall be located at the strike side of the door.

E. There shall be no more openings made in any box than are required for the conduits entering same. Depths of boxes shall be such as to allow for easy wire pulling and proper installation of wiring devices.

F. Switches and receptacles shall be ganged in a common box only where the Drawings so indicate.

G. Device Boxes:

1. Recessed ceiling fixtures shall have 4 inch square sheet steel box with cover and suitable hanger bar. The box shall be secured to the ceiling suspension members not more than 1 foot from the fixture opening.

2. Surface mounted ceiling fixtures, for plaster or dry wall ceilings, shall have 4 inch sheet steel octagon box with round opening plaster ring and suitable hanger bar with 3/8 inch fixture stud.

3. Fixtures which weigh more than fifty pounds shall be supported independently of the outlet box.

4. Surface mounted wall bracket fixtures (concealed conduit) shall have 4 inch square sheet steel box with plaster ring as required for the fixture.

5. Ceiling outlets and wall bracket outlets (exposed conduit) in dry locations shall have 4 inch sheet steel octagon box with 3/8 inch fixture stud.

6. Outlet boxes on exposed conduit run in wet or damp locations shall have 4 inch cast box with threaded hubs and gasketed covers.

7. Wall switch and receptacle boxes installed in tiled or plastered walls shall have 4 inch square sheet steel boxes or multigang boxes with proper tile or plaster ring as required. Two gang may be provided by means of 4 inch square box with two gang tile or plaster ring.

8. Wall switch and receptacle boxes in dry locations in brick walls, unfinished walls, woodwork, etc. shall have single or multigang 4 inch square sheet steel boxes.

H. Plaster rings shall have threaded ears and shall be of suitable depth for the application.

I. The Contractor shall provide boxes with metal barriers, baffles or separators for grouping of dis-similar conductors or system separation.

3.04 PULL BOX INSTALLATION

A. Pull boxes shall be installed where shown and where necessary to insure that finished cable will not be damaged.

B. Pull boxes shall be supported independently from the conduit system.

C. The Contractor shall add pull boxes where needed even though not shown on the Drawings.

3.05 CABLE TRAYS:

A. The entire cable tray system shall be installed and supported by devices as shown on the Drawings. A system of preformed galvanized channel members may be used to support cable trays subject to the approval of the Engineer.

B. To prevent fire from spreading between cable trays, the fire resistant blanket, "Flame-Safe" blanket manufactured by Thomas & Betts or approved equal and shall be installed as required whether or not it is shown. For control cable trays, fire resistant blanket shall be installed on top of the cable tray as shown.

3.06 FILLING OF OPENINGS

A. Where conduit and raceway pass through interior fire-rated walls, ceilings or floors, the Contractor shall provide seals to prevent passage of fire and fumes and to maintain integrity of fire-rated structure.

B. The Contractor shall close unused openings or spaces in floors, walls and ceilings, and plug or cap all unused conduit and sleeves.

C. Where conduit passes through walls or floors which are below grade, the Contractor shall provide watertight sealing fittings, OZ/Gedney Type W5K, or Approved Equal.

3.07 IDENTIFICATION

A. Conduit runs shall be identified as specified under Section 26 19 50 Identification.

3.08 FIELD QUALITY CONTROL

A. The Contractor shall arrange with the Authority for inspection and approval of embedded conduit and boxes prior to concrete placement.

B. The Contractor shall test metallic conduit and boxes for electrical continuity. The tests shall be conducted in presence of the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CONDUIT AND BACK BOXES FOR COMMUNICATION SYSTEMS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CONDUIT AND BACK BOXES FOR COMMUNICATION SYSTEMS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 08 10

COMMISSIONING OF COMMUNICATION SYSTEMS

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 specification consists of furnishing and installing COMMISSIONING OF COMMUNICATION SYSTEMS at the locations as shown on the Contract Drawings.

B. This Section describes the interfaces between the Contractor furnished items, existing items, and items provided by third parties for the rapid transit station/node. This Section also defines the division of responsibility for the Contractor.

C. The Contractor shall be responsible for design, development, installation and testing of each interface defined in this Section. The Contractor shall verify that the interfaces to the operator work stations do not affect the operation of the actual subsystems.

D. The Contractor shall communicate with the contractors of other related contracts at the station to ensure compatibility and avoid unnecessary conflict. All interfaces shall be handled through the CTA. The CTA shall receive all requests for information and transmit the request to the appropriate party. The Contractor shall receive the response to the request via the CTA within five (5) working days.

E. All requests and responses shall be confirmed in writing.

F. The rapid transit station included under this Contract shall be considered existing, unless otherwise noted. The station shall receive complete subsystems as defined in related sections.

G. As part of the rail operations at the new control center, new equipment for this station shall be integrated with existing equipment. Complete subsystems to be provided at this rapid transit station include:

1. Public Address
2. Telephone
3. CCTV
4. SCADA
5. Fiber Optic and Copper Backbone Network

H. Each of the subsystems listed above shall operate as a stand alone system, independent of any other system. However, operator control of the subsystems shall be integrated to the extent possible by using the existing control center hardware.

I. The Contractor shall be responsible for providing all wiring and cabling, conduit, backboxes

and junction boxes necessary for complete and fully operational systems.

J. The Contractor shall provide all wiring and termination blocks, mounting hardware, labeling, cross-connect wiring, plywood backboard used for wallfield and any other appurtenances required for a complete communications wallfield at each node.

K. Cable trays and other required cable supporting devices shall be provided at each node. Cable tray materials and installation shall conform to specifications defined elsewhere.

L. All cable entrances to the communications room(s), in conduit provided by others, shall be sealed after acceptance of cable installation to prevent the ingress of dirt or moisture.

M. Communications room(s) shall be visually inspected for obvious problems or deficiencies, such as leaking ceilings, power or lighting malfunctions, etc. by the Contractor prior to commencement of any work within the room. Such problems shall be brought to the attention of the CTA.

N. Space for any equipment deemed necessary for the integration process shall be coordinated with CTA. The furniture shall be supplied under a separate contract. For the purposes of this Contract, assume that each work station is a stand alone station. Refer to Contract Drawings for the control center layout.

O. The Contractor shall supply all of the necessary hardware and software for each of the two (2) control stations to make them operable.

P. The Contractor shall not modify in any way the Radio and existing SCADA subsystems. Any modifications required shall be requested in writing and performed by the respective Contractor for that subsystem.

Q. The final control center shall consist of several local area networks connected via bridges. The initial networks have been identified as: existing SCADA, RSMS, and BSMS. The Contractor shall be concerned only with the SCADA network.

R. The existing SCADA network has been supplied under a separate contract to the CTA. It will be the responsibility of this Contractor to interface with this existing SCADA network. The network is an Ethernet 10Base-T topology. The network operating system is Netware. The network protocol consists of both TCP/IP and DecNet.

S. CTA shall be responsible for connecting the Radio Server, the existing SCADA Server and the Public Address Server to the network through an intelligent concentrator (CTA supplied).

T. CTA shall supply the network environment. The Contractor shall only supply the necessary cables to connect the operator stations to the network.

U. This section specifies the requirements for testing of the new communication system. The Work of this section shall consist of integrated testing of the complete communication system and all subsystems thereof supplied under this Contract, and their external interfaces. The Contractor shall perform these tests after successful completion of the Factory Acceptance Tests and the Local Field Acceptance Tests required by related Specification Sections.

V. The Contractor shall provide new fiber optic test sets with fiber and electrical interfaces for monitoring and troubleshooting of the CTA's fiber optic and copper transmission systems.

1.03 RELATED WORK

A. COMMISSIONING OF COMMUNICATION SYSTEMS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. RT – Rapid Transit

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. The Contractor shall submit all interface plans and schedules for approval to the CTA for interfacing with other contractors with related contracts. The schedules shall also indicate any milestones. If any coordination with other contractors is required, it shall be indicated in the schedules.

C. For the equipment provided, submit the following:

1. Manufacturer's Specifications (catalog cut sheets) for each product to be provided.
2. Factory Acceptance Test Procedures for each product.
3. Factory Acceptance Test Reports - a certified copy for each item, demonstrating successful completion of the factory acceptance tests and compliance with the specifications.
4. Local Field Acceptance Test Procedures for approval by the Commissioner.
5. Local Field Acceptance Test Reports for each installation showing satisfactory operation and performance to meet specifications.
6. Integrated Test Plan for all installed equipment for approval by the Commissioner.
7. Test Procedures for approval by the Commissioner for all tests required by the Integrated Test Plan.
8. Test Reports for each test conducted.

D. The Contractor shall submit all interface plans and schedules for approval to the Commissioner. The schedules shall also indicate any milestones. The interface plans shall include drawings indicating all electrical, communication and cable connections. All components shall be properly labeled. If any coordination with other Contractors is required, it shall be indicated in the schedules.

E. In addition to the general submittal requirements specified in Section 27 00 10, the Contractor shall include the following system test information in required submittals:

1. Factory Acceptance Test Procedures for each item.

2. Factory Acceptance Test Reports - a certified copy for each item demonstrating successful completion of the tests and compliance with the Specification.

3. For the Integrated Acceptance Tests of the complete Communication System, submit the following:

    a. Test Plan - 60 days prior to the beginning of testing, to the Engineer for approval, a complete plan listing the test procedures that will be developed and used to test the Communication System and its subsystems as an integrated system, demonstrating its satisfactory end to end operation and conformance with every requirement of these Specifications. The tests shall also demonstrate satisfactory operation with all external interfaces. Provide any revisions required upon review by the Authority.

    b. Test Procedures - 30 days prior to the beginning of testing, to the Authority for approval, a procedure for each test in the approved Test Plan. Include for each test, data sheets showing the pass/fail value or range of values for each parameter to be measured. Provide any revisions required upon review by the Authority.

    c. Test Schedule - 30 days prior to the beginning of testing, to the Authority for approval, a schedule for all tests in the approved Test Plan. Provide any revisions required upon review by the Engineer.

    d. Test Notification – 48 hours prior to each test notify the Authority of the date, time and place, so that arrangements may be made for witnesses if desired.

    e. Test Reports - Provide to the Authority within 2 weeks after each test a certified Test Report.

    f. Variance Reports - Provide to the Authority with each Test Report, a report of any failures to attain acceptable results. Include either of the following:

        1) Corrective action taken and retest results.

        2) Request, with complete justification for relaxation of the test requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 OPERATOR STATIONS

A. The Contractor shall design, furnish, install, and test all necessary hardware and software in order to integrate the above stated components into a working system. The Contractor shall not be responsible for the Radio subsystem, but shall be responsible for the Public Address subsystem as well as the Telephone subsystem, CCTV subsystem and the new SCADA subsystem.

B. This Section shall describe the interfaces between Contractor furnished products, existing products, and products provided by others.

C. There are existing operator stations. Each station shall operate independent of the others. A failure on one station shall not cause any degradation in functionality in the other stations.

D. Each of the operator stations shall be connected to the local area network which shall also connect the Public Address subsystem computer, the Radio subsystem computer and the existing SCADA subsystem computer. Each of these computers shall be known as servers for the purpose of this Document.

E. The Contractor for each of the subsystems shall be responsible for supplying the necessary interface cards and software for their system to allow it to communicate over the network.

F. Each of the stations shall be identical in hardware and performance and be purchased from the same vendor.

G. The Contractor shall not have to add any software or hardware to the Traction Power SCADA or Radio subsystem servers.

H. To access one of the subsystems, the operator shall double click on an icon. Each subsystem shall have its own unique icon. Only one function shall be active at any one time on a given station.

I. The Contractor shall ensure that all of the functions that are available from the respective systems are available at the operator station.

2.02 PUBLIC ADDRESS INTERFACE

A. As part of the control station, the Contractor shall test a desktop microphone station for voice input and transmitting the voice input over the network to the Public Address controller and server.

B. When an operator logs into the Public Address system, all of the functions that are available from the server console shall be available from the operator station.

C. The operator shall be able to transmit a voice message as well as to hear the voice message. As such, the Contractor shall supply the necessary speakers.

2.03 ELEVATOR COMMUNICATION SYSTEM

A. Communications between the elevator at the rapid transit station and the Control Center will be by means of telephone communications. The elevator will have a handsfree, one button auto-dial telephone (provided by others) connected to the CTA PBX at the Control

Center. The Contractor is responsible for the wiring and connection of the elevator telephone from the demarcation point at the station to the station communications room.

B. The control center shall be provided with a feature telephone set with display also connected to the CTA PBX, as specified elsewhere.

C. When an elevator telephone button is pressed, the telephone shall dial the respective attendant kiosk telephone or the control station telephone(s) if the kiosk phone goes unanswered. The operator shall also have the option of dialing into any elevator on the RT system.

2.04 ETHERNET/TDR/DS-1 TEST SET

A. The lightweight, handheld, modular, ruggedized test set shall offer cable maintenance and service verification testing including: TDR, background noise, insertion loss, signal-to-noise, impulse noise, DMM, load coil detector, NEXT and FEXT, longitudinal balance, level meter, frequency generator, cable pair detect, and loop resistance.

B. The test set shall be provided with T1 testing capabilities including: BERT, loopback, fractional T1, VF DSO talk and listen.

C. The test set shall be provided with Ethernet 10/100 BaseT, 100 BaseFX, and Gigabit Ethernet testing capabilities at 850nm and 1310 nm wavelengths.

D. The test set shall have optical loss testing capabilities at 1310nm and 1550nm wavelengths.

E. The test set shall have the capability to act as a visual fault locator.

F. The test set shall have a high resolution color display that is easily readable under all lighting conditions, indoor and outdoor.

G. The test set shall be battery powered and field upgradeable.

H. The test set shall be provided with a carrying case.

I. The test set shall be compatible with existing CTA connector types.

J. The test set shall perform complete BERT and Performance Monitoring in compliance with ANSI, Telcordia and ITU-T standards.

K. The Contractor shall provide any incidentals and accessories necessary to ensure the test set is functional and compatible with the CTA's network.

L. The handheld test set shall be Sunrise Telecom model Sunset MTT, or Engineer approved equivalent.

2.05 OPTICAL MULTITESTER

A. The multitester mainframe shall have the following features:

1. Display: Touch screen, 10.4in Active Matrix Color (TFT)
2. Processor: Ultra-low power 300MHz Intel Celeron

3. Memory: 256MB
4. Operating System: Windows 2000
5. Control Interface: Touch screen, cursor control, dedicated hardkeys, and status LEDs
6. Standard I/O Ports: USB (2), PC Card Slots (2), Ethernet 10/100 (1), IrDA (1), Video (1), PS/2 Mouse (1), Parallel (1), RS-232 Serial (1)
7. Data I/O (modular): CD-ROM (standard), CD-RW
8. Hard Drive: 13GB minimum
9. Operating Temperature: 0°C to 45°C (32° to 122°F)
10. Storage Temperature: -25° to 60°C (-13° to 140°F)
11. Humidity: 95% max, non-condensing
12. Power Supply: Battery: 6-8hrs typical (2 batteries); recharge time: < 3hrs; AC: 92-132V, 47-63 Hz; Autoranging: 12VDC operation
13. Capacity: 4 module

B. The multitester shall offer an OTDR application for testing singlemode and multimode fiber with a power meter, visual fault locator and light source with the following features:

1. Fiber Type: Singlemode and Multimode
2. Center Wavelength: 850nm ± 30nm and 1300nm ± 30nm; 1310nm ± 20nm and 1550 ± 20nm
3. Spectral Width: < 15nm
4. Dynamic Range: 850/1300nm – 25dB; 1310/1550 – 45dB
5. The OTDR shall be provided with a light source that has the following features:
   a. Wavelength: 850/1300nm and 1310/1550nm
   b. Output Power: -8dbM minimum
   c. Output Fiber: Singlemode
   d. Modes of Operation: CW, 1KHz and 2KHz
   e. Stability: ± 0.2db (8 hours)
   f. Spectral Width: 850nm: <15nm; 1310nm: <15nm

C. The multitester shall be provided with a video inspection probe application which allows fiber optic connector to be viewed, stored and analyzed. The video probe shall have the following features:

1. Magnification: 400x digital probe
2. Connector Tips: Standard 1.2mm and 2.3mm Universal
3. Operating Temperature: 0° to 50°C
4. Storage Temperature: -20° to 50°C
5. Software: Windows 2000
6. Image Storage Format: JPEG, BMP, PNG
7. The video probe shall be provided with a hard case for the inspection microscope.

D. The multitester shall be provided with a talk set module that allows duplex communication over a single dark fiber to another multitester or a stand-alone fiber talk set. The talk set shall have the following features:

1. Center Wavelength: 1550nm
2. Dynamic Range: 45dB
3. Transmission: Half Duplex
4. Fiber Type: Singlemode
5. Range: up to 230km
6. Power Supply: AC/Battery
7. In addition to the module, the multitester shall be provided with a spare headset and the stand-alone talk set

E. The multitester shall be provided with a hard-shell carrying case, AC adapter and charger.

F. All mulitester modules shall be compatible with existing CTA optical connectors. The Contractor shall provide a bare fiber adapter for testing.

G. The OTDR shall be Corning Optical Multitester Model 500 or Engineer approved equivalent.

2.06 FIBER IDENTIFIER

A. The fiber identifier shall be a self-contained, handheld tool that identifies fiber path and transmission direction without disrupting service or opening points for identification.

B. The fiber identifier shall have the ability to detect a 2kHz test signal from a laser source to distinguish a single fiber from other active or dark fibers.

C. The fiber identifier shall be designed so as not to damage any fibers during, before or after proper use of the product.

D. The minimum operating temperature range shall be –20°C to 50°C.

E. The fiber identifier shall be provided with a leather carrying pouch, interchangeable adapters for testing 250um/900um coated fibers and 3mm jacketed fibers, and batteries.

F. The fiber identifier shall be Corning Checkpoint model or Engineer approved equivalent.

2.07 VISUAL FAULT LOCATOR

A. The visual fault locator shall be a hand-held, lightweight, visible laser light source used to isolate fiber breaks, improper terminations, bad splices, tight bends or crimps, damaged components, and other similar faults in both singlemode and multimode fiber optic cables.

B. The visual fault locator shall be compatible with existing CTA optical connector types.

C. The visual fault locator shall be provided with batteries.

D. The visual fault locator shall be qualified as a maximum Class II laser product in accordance with IEC 825-2.

E. The visual fault locator shall be Corning Model VFL-350, or Authority approved equivalent.

2.08 POWER METER

A. The portable power meter shall have the capability to simultaneously test and store dual-wavelength attenuation measurements.

B. The power meter shall have the capability to test singlemode and multimode fiber at 1310nm and 1550nm wavelengths and shall be compatible with existing CTA compatible connectors.

C. The backlit display shall be easily readable in all lighting conditions, indoor and outdoor.

D. The power meter shall be operational from 0° to 50°C.

E. The power meter shall be provided with a carrying case, AC adapter, and any other incidentals including jumper cables in order to perform the necessary tests on the CTA's network.

F. The power meter shall be Corning Model OTS-300 Express series.

2.09 FIBER TALK SETS

A. The fiber talk sets shall be a compact, lightweight, hands-free communications tool that provides full-duplex communication; with a typical 50dB dynamic range and typical 150km operating range over singlemode fiber.

B. The fiber talk sets shall be operational at 1310nm and 1550nm and shall be compatible with existing CTA optical connectors.

C. The fiber talk sets shall be operational from 0° to 50°C.

D. The fiber talk sets shall be provided with a carrying case and AC adapter.

E. The fiber talk sets shall be Corning FTS-300 series, or Engineer approved equivalent.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall be responsible for inspecting all equipment ordered when it arrives on site. Any damaged equipment shall be returned and replaced at the Contractor's expense.

B. At the completion of the Contract, the Contractor shall perform a site inspection to verify that all equipment supplied is in operable condition and contains no physical damages. Any piece of equipment deemed inoperable shall be made operable by the Contractor prior to Contract completion. Any damaged pieces of equipment shall be returned and replaced at the Contractor's expense. The site inspection shall be performed with CTA personnel.

C. The Contractor shall ensure that all returned equipment is replaced within thirty (30) days. No schedule modifications shall be allowed due to returned equipment unless authorized in writing by CTA.

3.02 OPERATOR STATIONS

A. The Contractor shall install and test all necessary hardware and software in order to integrate the above stated components into a working system. The Contractor shall not be responsible for the Radio and SCADA subsystems, but shall be responsible for the Public Address subsystem, the Telephone subsystem, and the new SCADA subsystem.

3.03 ELEVATOR COMMUNICATIONS SYSTEM

A. The Contractor shall not integrate this feature with the network. This shall be considered as a stand-alone system via the PBX. The Contractor shall verify that communication can be established with the operating elevator at the station.

B. The Contractor shall verify that the display indicates the correct elevator number for the operating elevator at the station.

3.04 COMMUNICATIONS ROOM

A. The Contractor shall integrate the equipment furnished with the equipment in place to form a working Control Center and install in accordance with all Sections of this Specification.

B. All equipment racks shall be provided 120VAC feed from the main room power panel.

3.05 CABLING

A. The Contractor shall be responsible for connecting the required system equipment to the network via the concentrator. This shall include all necessary cables.

B. All cables installed shall be properly tagged and recorded. The Contractor shall supply the necessary drawings that shall indicate the locations of each cable. The drawings shall include the cable tags. The documentation associated with the drawings shall include the cable tag, cable type, cable length and which components are connected to each end of the cable.

3.06 SYSTEM ACCEPTANCE TESTS

A. The Contractor shall perform all tests in accordance with the approved Test Plan and Test Procedures.

B. Perform all tests in accordance with the approved Test Plan, Test Procedures and Test Schedule provided per Section 1.06.

C. Provide complete reports of all testing in accordance with Section 1.06.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMISSIONING OF COMMUNICATION SYSTEMS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMISSIONING OF COMMUNICATION SYSTEMS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 11 11

COMMUNICATION ROOM FINISHES

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 specification consists of furnishing and installing COMMUNICATION ROOM FINISHES for the preparation of the Communication Room at the new station as shown on the Contract Drawings.

B. The Work under this section includes furnishing all labor, materials, tools, equipment, and incidentals necessary for the preparation of the Communication Room for fiber optic and other communications equipment.

C. The Communication Room walls and floor shall be thoroughly cleaned, painted, and sealed, lighting installed, and HVAC climate control systems installed to create an appropriate environment for operation of sensitive electronics. NO equipment racks or electronics shall be installed in the room until the room construction, preparation, painting, lighting, and HVAC as been installed and accepted in order to prevent construction dust, dirt, and debris from contaminating the sensitive electronics.

D. The floor and walls of the communication room shall be thoroughly cleaned by removing all debris, dirt and grime, and shall be primed for the application of paint and sealer, where applicable.

E. The floors and walls shall be sealed with at least two coats of a vapor-proof sealant, per manufacturer instructions, where applicable. After sealing, the floor shall be primed and then painted with an epoxy paint floor cover. The floor paint shall act as a contaminant barrier and provide a hard, yet elastic, durable, damage-resistant surface. The floor paint shall be Dura-Seal 400 Tile Red Color or Authority approved equivalent.

F. The Contractor shall apply a block filler (where applicable), primer, undercoat and then a white heavy duty glossy paint to the walls and any exposed conduit, per manufacturer instructions and as specified on the Contract Documents.

G. All cable and conduit entry points shall be sealed with fire rated caulk after acceptance of cable installation to prevent the ingress of dirt or moisture.

H. The Communication Room door shall include a bottom sweep threshold to prevent dust, dirt, and water from entering the room under the door.

I. The Contractor shall install cable trays in the room as specified in the Contract Documents. The Contractor shall install wiring and cabling in the cable trays so that it is neat and orderly throughout the cable trays. All new wiring shall also be carefully arranged on the cable trays so that the minimum bend radius of the cables are not to be exceeded.

J. For any overhead HVAC units in Communication Room, the Contractor shall install a drip pan below the unit to prevent water leakage on the communication equipment.

1.03 RELATED WORK

A. COMMUNICATION ROOM FINISHES specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. HVAC – Heating, Ventilation and Air Conditioning

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. In addition to the general submittal requirements specified in Section 27 00 10, the Contractor shall include the following information in required submittals:

1. Shop Drawings of the room showing the proposed size, rack layout, location layout, and installation method.
2. Details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
3. Single line diagram of equipment cabinet power connections.
4. Wiring diagrams showing AC electrical breaker panel servicing the room HVAC, lighting, communication cabinets, and other electrical equipment. Lighting switches and AC duplex receptacles along each wall shall also be shown.
5. Samples for initial paint color selection in the form of the manufacturer’s color charts.
6. Coating manufacturer’s technical information, label analysis, and application instructions for each material proposed for use. List each material and cross reference the specific coating and finish system and application.
7. The coating manufacturer shall submit certification that the products in a multi-layer coating system are appropriate for the intended use and are compatible with each other and with project substrates.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

B. For coating products, deliver materials to the job site in the manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material
2. Product description (generic classification or binder type)
3. Federal Specification number, if applicable
4. Manufacturer's stock number, if applicable
5. Contents by volume, for pigment and vehicle constituents
6. Thinning instructions
7. Application instructions
8. Color name and number

C. The Contractors shall maintain containers used in storage in a clean condition, free of foreign materials, and residue; keep storage area neat and orderly; remove oily rags and waste daily; and take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 FLOORS / WALLS

A. SEALANT

1. The sealant shall be a non-toxic, penetrating, and permanent concrete sealer.
2. The sealant shall act as a vapor barrier, alkali and corrosion inhibitor, curing agent and dust-proof compound.
3. The sealant for the floor shall be Moxie Flooring Sealant II (MFSII) or Engineer approved equivalent.

B. MANUFACTURERS

1. General Coatings: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are not limited to the following:
   a. Devoe and Reynolds Co. (Devoe)
   b. The Glidden Company (Glidden)
   c. Benjamin Moore and Co. (Moore)

d. PPG Industries, Pittsburgh Paints (Pittsburgh)

e. Pratt and Lambert (P&L)

f. The Sherwin-Williams Company (S-W)

g. ICI Dulux Paints (ICI)

C. PRIMERS

1. Interior Flat Latex-Based Paint: Flat latex paint used as a primer over concrete and masonry under alkyd flat and semigloss enamel:

a.	Devoe:	36XX Wondertones Latex Flat Wall Paint
b.	Glidden:	5300 Ultra Hide Flat Wall Paint
c.	Moore:	Moore's Latex Quick-Dry Prime Seal #201
d.	Pittsburgh:	80 Line Wallhide Flat Latex Paint
e.	P&L:	Vapex Latex Flat Wall Finish
f.	S-W:	Pro-Mar 200 Latex Flat B30W200
g.	Authority approved equivalent	

2. Interior Flat Latex-Based Paint: Flat latex paint used as a primer on cement plaster under flat, semi-gloss, and full-gloss alkyd finishes:

a.	Devoe:	36XX Wondertones Latex Flat Wall Paint
b.	Glidden:	5019 PVA Primer Sealer
c.	Moore:	Moore's Latex Quick-Dry Prime Seal #201
d.	Pittsburgh:	80 Line Wallhide Flat Latex Paint
e.	P&L:	Vapex Latex Flat Wall Finish
f.	S-W:	Wall and Wood Primer B49W2
g.	Authority approved equivalent	

3. Galvanized Metal Primer: Primer used to prime interior and exterior zinc-coated (galvanized) metal surfaces:

a.	Devoe:	13201 Mirrolac Galvanized Metal Primer
b.	Glidden:	5229 Glid-Guard All-Purpose Metal Primer
c.	Moore:	Ironclad Galvanized Metal Latex Primer #155
d.	Pittsburgh:	6-215/216 Speedhide Galvanized Steel Primer
e.	S-W:	Galvite HS B50WZ3
f.	Authority approved equivalent	

4. High-Performance Latex Block Filler: Heavy duty latex block fillers used for filling open textured interior concrete masonry block before application of top coats:

a.	ICI:	3010-XXXX Ultra Hide Interior/Exterior Acrylic Block Filler
b.	Carboline:	Flexxide Masonry Block Filler
c.	Moore:	Moorcraft Block Filler #145
d.	Pittsburgh:	6-7 Latex Masonry Block Filler

e. S-W: Heavy-Duty Block Filler B42W46

f. Authority approved equivalent

D. UNDERCOAT MATERIALS

1. Interior Enamel Undercoat: Ready-mixed enamel for use on the interior as an undercoat over a primer on concrete or masonry under an odorless, semi-gloss enamel:

a. Devoe: 8801 Velour Alkyd Enamel Undercoat

b. Glidden: 4200 Spred Ultra Semi-Gloss Enamel

c. Moore: Moore's Alkyd Enamel Underbody #217

d. Pittsburgh: 6-6 Speedhide Quick-Dry Enamel Undercoater

e. P&L: E6 Enamel Undercoater

f. S-W: Prep Rite 200 Latex Wall Primer B28W200

g. Authority approved equivalent

2. Interior Enamel Undercoat: Ready-mixed enamel for use as an undercoat over a primer on cement plaster under full gloss or odorless semi-gloss enamels:

a. Devoe: 8801 Velour Alkyd Enamel Undercoat

b. Glidden: 4500 Glid-Guard Enamel

c. Moore: Moore's Alkyd Enamel Underbody #217

d. Pittsburgh: 6-6 Speedhide Quick-Dry Enamel Undercoater

e. P&L: Interior Trim Primer

f. S-W: Wall and Wood Primer B49W2

g. Authority approved equivalent

3. Interior Enamel Undercoat: Ready-mixed enamel for use as an undercoat over a primer on ferrous or zinc-coated metal under an interior alkyd semi-gloss enamel or full-gloss alkyd enamel:

a. Devoe: 8801 Velour Alkyd Enamel Undercoat

b. Glidden: 4200 Spred Ultra Semi-Gloss Enamel

c. Moore: Moore's Alkyd Enamel Underbody #217

d. Pittsburgh: 6-6 Speedhide Quick-Dry Enamel Undercoater

e. P&L: Interior Trim Primer

f. S-W: Pro-Mar 200 Alkyd Semi-Gloss B34 Series

g. Authority approved equivalent

E. INTERIOR FINISH PAINT MATERIAL

1. The floor paint shall be Dura-Seal 400 Tile Red color or Engineer approved equivalent.

2. Interior Semi-gloss Odorless Alkyd Enamel: Low-odor, semi-gloss, alkyd enamel for use over a primer and undercoat on concrete, masonry (including concrete masonry block), cement plaster, gypsum board, and both ferrous and zinc-coated (galvanized) metal surfaces.

a. Devoe: 26XX Velour Alkyd Semi-gloss Enamel

b. Glidden: 4200 Spred Ultra Semi-gloss Enamel

c. Moore: Moore's Satin Impervo Enamel #235

d. Pittsburgh: 27 Line Wallhide Semi-gloss Enamel

e. P&L: Cellu-Tone Alkyd Satin Enamel

f. S-W: Pro-Mar 200 Alkyd Semi-Gloss B34 Series

g. Authority approved equivalent

3. Latex-based, Interior Flat Paint: Ready-mixed, latex based paint for use over plaster and gypsum board surfaces.

a. Devoe: 36XX Wonder-Tones Latex Flat Wall Paint

b. Glidden: 3400 Spred Satin Latex Wall Paint

c. Moore: Regal Wall Satin #215

d. Pittsburgh: 50-35 Latex Ceiling Paint

e. P&L: Vapex Latex Flat Wall Finish

f. S-W: Pro-Mar 200Alkyd Semi-Gloss B34 Series

g. Authority approved equivalent

F. The primer and undercoat paint provided shall be produced by the same manufacturer as the finish coats, where applicable.

2.02 POWER / LIGHTING

A. POWER

1. A dedicated 15A circuit shall be installed from the power panel to the cabinet containing the UPS and battery packs, terminated in a dual outlet, white in color, labeled as "UPS Battery Charge".

2. Two dedicated 30A circuits shall be installed from the power panel to the cabinet containing the UPS and battery packs, to service the UPS', terminated in separate outlets, white in color, labeled as "UPS Source".

3. Auxiliary outlets shall be installed in each of the equipment cabinets, with a dedicated circuit for each cabinet fed from the UPS cabinet, orange in color, labeled as "Protected".

4. Auxiliary outlets shall be installed in each of the equipment cabinets, fed from the panel, labeled as "Non-Protected".

5. The breaker panel in the communication room shall be 100A minimum.

6. For any wall outlets that interfere with the location of new cabinets, the Contractor shall relocate the outlet above the cabinets to provide necessary access, as specified on the Contract Documents.

B. LIGHTING AND WIRING DEVICES

1. LED lighting shall be installed above the aisles to provide illumination to the front of the equipment racks. The light intensity, at the floor level in aisle and Work areas, shall be a minimum of fifty (50) foot-candles maintained after all equipment has been installed. Fluorescent light fixtures shall be industrial type with porcelain

reflectors and wire guards.

C. ENVIRONMENTAL REQUIREMENTS

1. The HVAC system shall be a combination “climate control” unit designed to operate to maintain interior temperatures of minimum 50° F and maximum 90° F, with a nominal temperature range of 55-78° F. The unit shall include an Ethernet IP interface with the ability to generate alarms for low and high temperatures, remote monitor and control of the unit via the IP network.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The walls and floor shall be cleaned, painted, and sealed in a manner that does not damage, disturb, or degrade any wires, cables, conduits, equipment, and other ancillary devices.

B. The block filler shall be applied to concrete masonry block at a rate to ensure complete coverage with pores filled.

C. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixture and similar items in place that are not to be painted, or provide surface applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATION ROOM FINISHES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATION ROOM FINISHES must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 11 16

COMMUNICATION CABINETS, RACKS, AND ENCLOSURES

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 specification consists of furnishing and installing COMMUNICATION CABINETS, RACKS, AND ENCLOSURES at the locations as shown on the Contract Drawings.

B. The equipment cabinets shall be modular in design.

C. The equipment cabinet shall be designed to protect communication, electrical and electronic equipment from dirt, dust, moisture, oil and other contaminants.

D. The equipment cabinets shall consist of a rugged fixed 4-post frame with equipment mounting rails on the front and back of the frame.

E. The equipment cabinets shall include front swing steel doors with Plexiglas windows and back swing steel doors.

F. Mounting options shall accommodate electronic rack equipment, telecommunications equipment, industrial control equipment and computer systems where necessary, as well as manage wiring and cabling.

G. The outside dimensions of the equipment cabinets shall be 32 inches wide, 32 inches deep, and 79 inches high.

H. The equipment cabinets shall be Rittal TS-8 or approved equal.

1.03 RELATED WORK

A. COMMUNICATION CABINETS, RACKS, AND ENCLOSURES specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions
2. Section 27 11 11 – Communication Room Finishes

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. NEMA – National Electrical Manufacturers Association
2. UL – Underwriters Laboratories

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. In addition to the general submittal requirements specified in Section 27 00 10, the Contractor shall include the following information in required submittals:

1. Shop Drawings of the room showing the proposed size, rack layout, location layout, and installation method.
2. Details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections.
3. Single line diagram of equipment cabinet power connections.
4. Wiring diagrams.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 EQUIPMENT CABINET

A. Materials

1. General: The equipment cabinets shall comply with all of the following industry standards:
    a. UL508 Type 12
    b. NEMA/EEMAC Type 12
    c. CSA Type 12
    d. VDE IP55
    e. TUV-IEC 529

f. IP55

2. Frames: Frames shall be a single-roll-formed, robotically welded design made of 12-gauge steel with solid steel, fully welded corners.

3. Flange: A flange shall be placed on door and side openings to deflect liquids away from the equipment cabinet interior.

4. Sides and Doors: External sides and doors, unless otherwise indicated, shall be 14-gauge steel.

5. Window Doors: Window doors shall be fully welded aluminum extrusions. All non-windowed doors shall have standard door bars to increase strength and rigidity and allow for an extra mounting surface.

6. Accessories: Where external accessories are used, seamless foam-in-place gaskets shall be used to provide a watertight, dust-tight seal against moisture and contaminants. A latching system shall be used to assure a solid seal with low closure force. Integral frame channels shall support the full weight of the subpanels.

B. Internal Components

1. The frame shall be a swing out frame capable of supporting the intended weight load of each respective subsystem's equipment.

2. The frame shall have welded corners with steel corner blocks to add strength and rigidity. The frame shall be 12 gauge, roll-formed frame sections for strength.

3. The frame shall accommodate the 25mm DIN standard and include rectangular holes for clip nuts and thru holes for use with thread forming screws.

4. The frame shall have symmetry in all directions.

5. There shall be rectangular frame holes designed for metric cage nut fasteners.

6. There shall be round frame holes to allow numerous grounding locations using M5 thread-forming screws.

7. The frame shall have access to both sides of the frame mounting holes to allow standard components to be easily installed.

8. Provisions for slide-in subpanel, rack mounting, and accessory mounting shall be incorporated.

9. The frames shall support simple means for joining frames to create multiple-bay equipment cabinets.

10. The frame design shall use an open roll formed profile to afford complete surface corrosion protection.

11. The equipment cabinet shall be capable of supporting a grid system that shall provide a flexible extension to the internal mounting system of the frame. The grid system shall allow flexible mounting capabilities in height, width, and depth. Accessories or equipment shall be attached directly to the grid system using either cage nuts or front loading cage nuts.

12. Grid straps shall be 14-gauge steel. They shall have rectangular holes to allow for the use of cage nuts or front-loaded cage nuts. Mounting holes shall be provided on 25mm centers. Grid straps shall be available with either one (1) row or three (3) rows of holes and shall be furnished in pairs. Mounting hardware to attach the grid straps to the frame or to other grid straps shall be included. The grid straps shall be mounted from the front or back horizontally across the bottom or sides of the frame. The grid straps shall be capable of being mounted left to right horizontally

between front-to-back pairs or from the sides of the frame. The grid straps shall be capable of being mounted vertically between other horizontally mounted grid straps.

13. 23-inch rack angles shall be used and available in both square hole and tapped hole designs. Tapped rack angles shall be 12 gauge with 10-32 tapped holes. Square hole rack angles shall be 14 gauge designed to accept metric or English cage nuts. 23-inch rack angles shall fit directly into 700 mm wide frames or in 800 mm wide frames using frame reducing brackets.

14. All rack angles shall have two mounting surfaces that shall serve as mounts for both rack equipment and rack accessories. Rack angles shall be furnished in pairs and shall be available with tappered holes for use with cage nuts and M5 or 10-32 screws. They shall be mounted directly to the equipment cabinet frame or on grid system straps at a multitude of depth locations. They shall comply with ANSI/EIA RS-310-D rack mounting standards. All mounting hardware needed to install rack angles shall be included.

15. Frame reducing brackets or rack reducing brackets (adapters) shall mount directly to the frames or to grid straps. This accessory shall convert wider frames to allow 19-inch rack angles to fit. Brackets shall be used to left or right justify the rack mounted equipment. Frame reducing brackets shall be furnished in sets of four and shall be 14-gauge steel plated with zinc. All mounting hardware shall be included.

16. Frame accessory brackets shall mount directly to the frame and shall be used in place of rack angles to mount rack accessories such as shelves and pullout shelves. Frame brackets shall be furnished in sets of four and shall be 14-gauge steel plated with zinc. All mounting hardware shall be included.

17. Fixed shelves shall mount on two pair of rack angles or on frame accessory brackets. Fixed shelves shall be 16-gauge steel and shall include slots for improved ventilation. Rack accessories that are shorter than the equipment cabinet depth shall be mounted to rack angles or frame accessory brackets attached to grid straps. All mounting hardware shall be included.

18. Pullout shelves shall allow for easy access to shelf mounted devices. Pull-out shelves shall be 16 gauge steel. The shelf slides shall hook directly to two pair of rack angles or frame accessory brackets. All mounting hardware shall be included.

19. Pullout shelf locks shall be used in combination with the pullout shelf to hold the shelf in the recessed position. It shall be mounted on either the left or right side. The lock shall have a wing knob for easy hand operation.

C. External Components

1. Solid Doors: Solid doors shall include standard door bars for additional mounting space and rigidity. Solid doors shall be made from 14 and 16 gauge steel. Optional data pockets, door stops, grounding kits and 180 degree hinges shall be made available upon the request of the CTA. Solid doors shall utilize a 3-point latching system and shall have a slotted insert with a flush bezel. Hidden hinges (130 degree swing) shall permit attachment to the front or back of each equipment cabinet frame. Hinges shall use easy slide retained hinge pins. The solid door gasket shall be foamed-in-place urethane to provide a resilient seamless seal. All mounting hardware is included.

2. Window Doors: Window doors shall be used on the front of the frames to provide viewing of electronic equipment. The window doors shall be designed around an extruded aluminum profile rigidly welded in all four corners. They shall have 140 degree hidden hinges and a flush bezel with a slotted insert that operates a 3-point

latching mechanism (doors for 700mm frames shall have 2-point latching). The windows shall be smoke gray tinted polycarbonate. 180 degree hinges shall be made available on the request of the CTA. All mounting hardware shall be included. All window doors:

a. shall install easily on front or rear of equipment cabinet frame; and shall be hinged on left or right

b. shall have a .25-inch thick window for providing maximum protection and viewing area

c. shall utilize foam-in-place urethane gaskets for door and window to provide optimum sealing

3. Vented Plinth Base: Vented plinth bases shall be installed under the equipment cabinet to provide space for cables to enter from below, if desired, and to provide suitable airflow. The base shall consist of four corner supports connected with four access panels. Front and rear access panels shall be vented to permit air circulation. The corner supports shall be cast aluminum. The access panels shall be 16 gauge steel and attach to the corner supports with screws. The bases shall include all necessary mounting hardware. The base shall also include a vented gland plate. The vented gland plate shall only be used in conjunction with the vented plinth base. The plate shall be compatible with all subpanels or rack angles. The gland plate shall consist of a base mounting surface, two adjustable foam gasketed plates for cable entry, filter, and filter retaining rails. The plate shall be capable of rotating 180 degrees for front or rear cable entry (with front cable entry, filter access shall be at rear of equipment cabinet).

4. Vented Tops: The equipment cabinet shall have vented tops with integral fan tray to provide a cooling/ventilation solution for electronic and networking applications housed within. An integral fan tray with three (3) pre-wired and mounted fans shall provide up to 200-300 cfm of intake or exhaust. Accessory fan kits (consisting of three pre-wired fans) shall be installed to provide additional airflow, if the CTA or Contractor deems necessary. Unused fan positions shall be provided with covers to prevent short-circuiting of airflow. The vented top shall be designed to allow for cable entry from above (i.e., cable tray) without any deficiencies to the integrity of the rack equipment cabinets. All mounting hardware shall be included.

5. Solid Sides: Solid sides shall close the open sides of an equipment cabinet frame and shall attach to the equipment cabinet frame with semi-flush screws. Hangers shall be included for easy alignment of screws. Sides, either 14 gauge or 16 gauge steel, shall have two grounding studs and foam-in-place gaskets. All mounting hardware shall be included. Solid sides shall not be suitable as barriers between joined equipment cabinets.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall install the rack cabinet equipment cabinets per the Manufacturers specified guidelines, the CTAs discretion and the Contract Drawings. The equipment cabinets shall be tested according to the Manufacturers recommended procedures for complete and satisfactory system performance. The CTA shall be the responsible party to ensure that total and complete installation and testing have been achieved.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATION CABINETS, RACKS, AND ENCLOSURES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATION CABINETS, RACKS, AND ENCLOSURES must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 11 26

COMMUNICATION EQUIPMENT POWER SYSTEM

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 specification consists of furnishing and installing COMMUNICATION EQUIPMENT POWER SYSTEM at the locations as shown on the Contract Drawings.

B. This section specifies the requirements for furnishing and installing the complete Communication Equipment Power System, otherwise referred as CEPS. The work under this section includes furnishing all labor, materials, tools, equipment, and incidentals necessary to install the complete CEPS.

C. Provide a Communication Equipment Power System as specified herein, hereafter referred to as the "CEPS" to provide continuous, regulated power to the Audio/Visual Paging System, the SCADA System, the CCTV System, and the Fiber Optic and Copper Transmission System under normal and abnormal conditions, including loss of utility AC power.

D. The Communications Equipment Power System includes the following subsystems and components:

1. Station Communications Node UPS and extended runtime batteries
2. Station CCTV System UPS and extended runtime batteries
3. Station CCTV Camera power supply
4. Each Communication Hub power supply
5. Fiber Optic Node -48VDC Rectifier
6. 24VAC to 24VDC voltage regulator for blue light strobe power at HPT
7. 24VAC to 24VDC voltage regulator at communication hub network switch

E. The Station communications node and CCTV system UPS’ shall be line-interactive, true sinewave, solid-state, uninterruptible power supply (UPS) systems. The UPS’ shall provide high-quality, regulated AC power to sensitive electronic equipment connected to the system. Conditioned AC power shall be distributed to each of the Communication Room equipment cabinets via IP network controllable, remote power manager PDU’s. A base unit RPM shall daisy-chain to client unit RPM’s in each cabinet to provide a single network point for control and monitoring. The AC feed to each RPM shall be a dedicated power outlet from the respective UPS.

1. The UPS’ shall be Triplite 6000 with minimum five extended run-time battery packs, or Engineer approved equivalent.
2. The remote power manager shall be Minuteman RPM-1601 main unit and RPM-1600 clients, or Triplite, or Engineer approved equivalent.

F. The Station CCTV Camera power supply shall be a rack mount unit to distribute individual low-voltage power to the Main Station cameras:

1. 16 fuse protected outputs
2. 25 Amps @ 24VAC / 20 Amps @ 28 VAC
3. Individual outputs @ 3.5 Amps
4. 115VAC input, 6A, 660W
5. Altronix R2416600UL or Engineer approved equivalent.

G. The Communication Hub power supplies shall be rack mount units in the Communications Room to distribute high capacity, low-voltage power to each of the Communications Hubs. Each power supply shall provide:

1. 2 fuse protected outputs
2. 25 Amps @ 24VAC / 20 Amps @ 28 VAC
3. 12.5 Amps @ 24 VAC / 10 Amps @ 28 VAC per transformer
4. 115VAC input, 6A, 660W
5. Altronix R242600UL or Engineer approved equivalent

H. The Station Fiber Optic Node rectifier shall be a rack mount unit to distribute redundant -48VDC power to the OC-48 SONET multiplexer:

1. 19” rack mount chassis
2. Dual -48VDC rectifiers
3. Output: 25 Amps @ -54.5VDC, 1362W
4. Input: 85-150VAC, 12 Amps
5. Controller: IP controllable w/ Form C relays for system monitoring
6. GE Energy CPS6000 series, or Authority approved equivalent

1.03 RELATED WORK

A. COMMUNICATION EQUIPMENT POWER SYSTEM specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. AC – Alternating Current
2. ANSI – American National Standards Institute
3. CEPS – Communication Equipment Power System
4. dB – Decibel
5. dBa – Decibel Audible
6. dBrn – Decibel Random Noise
7. DC – Direct Current

8. EIA – Electronics Industry Association
9. Hz – Hertz
10. KVA – Kilo-Volt Amperes
11. LED – Light Emitting Diode
12. NFPA – National Fire Protection Association
13. PDU – Power Distribution Unit
14. PF – Power Factor
15. RMS – Root Mean Square
16. RPM – Remote Power Manager
17. SCADA – Supervisory Control And Data Acquisition
18. THD – Total Harmonic Distortion
19. UPS – Uninterruptible Power Supply
20. UL – Underwriters Laboratories
21. V – Volts
22. VAC – Volts, Alternating Current
23. VDC – Volts, Direct Current
24. VPC – Volts Per Cell
25. ^{o}C - Degrees Centigrade
26. ^{o}F - Degrees Fahrenheit

B. Publications.

1. American National Standards Institute / National Fire Protection Association (ANSI/NFPA): ANSI/NFPA 70, "National Electric Code". All conductors shall be sized according to their current ratings with appropriate derating when required.

C. Reference Standards.

1. The UPS shall be designed and manufactured in accordance with the applicable sections of the current revision of the following regulatory organizations codes. Where a conflict may arise between these standards made herein, the statements in this specification shall govern.
    a. ANSI C62.41 Category A
    b. FCC Class A
    c. ISO 9001 & 14000
    d. UL 1778
    e. CUL CSA22.1
2. The UPS shall be UL listed per UL Standard 1778, and shall be CUL, CE and TUV certified.

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

B. Quality Assurance Program: The equipment supplier shall have a quality assurance program with checks on incoming parts, modular assemblies, and final products. A final test procedure for the product includes a check of all performance specifications and a minimum twenty-four (24) hour "burn-in." An on-site test procedure shall include a check of controls and indicators after installation of the equipment.

C. UL Listing: All electrical equipment and accessories shall be UL listed.

D. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and Municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.

E. Manufacturer's Qualification: A minimum of twenty year's experience in the design, manufacture, and testing of solid-state UPS systems is required. The system shall be designed and manufactured according to world-class quality standards. All production manufacturing facilities shall be ISO9001 certified.

F. Factory Testing: Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. In addition to the general submittal requirements specified in Section 27 00 10, the Contractor shall include the following information in required submittals:

1. Details of bus, connections, terminals, etc. including the complete ground bus arrangement and enclosure ground connections
2. Single line diagram of equipment
3. Wiring diagrams
4. Bill of materials shall include all items with catalog cut-sheets describing the electrical and physical characteristics of each item
5. Battery sizing calculations

C. Shop Drawings: The Contractor shall prepare and submit to the CTA for review before fabrication and assembly of equipment, electronic files and four prints of each of the following:

D. Record Drawings: Furnish record drawings annotated with the changes made during installation of the Work so as to be a complete set of "as-installed" drawings and wiring diagrams.

E. Test Reports: The Contractor shall submit for record and distribution after installation of equipment, 10 copies of the certified test report.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

B. The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

1. Operating Ambient Temperature: UPS Module: 32°F to 104°F (0°C to 40°C); Battery Module: 32°F to 104°F (0°C to 40°C)
2. Storage/Transport Ambient Temperatures: 5 degrees F to 113 degrees F (-15C to +45C)
3. Relative Humidity: 0 to 95% non-condensing
4. Altitude: Operating: 0 to 3,000 meters (0 to 10,000 feet); Storage/Transport: 0 to 15,000 meters (0 to 50,000 feet)
5. Audible Noise: Noise generated by the UPS under any condition of normal operation shall not exceed 45dBA measured at 1 meter from the surface of the UPS.

1.08 WARRANTY

A. The contractor shall provide the warranty for this section in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

B. UPS Module: The UPS manufacturer shall warrant the UPS module against defects in materials and workmanship for 36 months from purchase date.

C. Battery: The UPS manufacturer shall warrant the UPS battery module(s) against defects in materials and workmanship for 36 months from purchase date.

D. The warranties in this section are in addition to and do not limit other warranties or other requirements in the Contract or law.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 UPS Design Requirements – UPS Module

A. Voltage – Input/output voltage specifications of the UPS shall be:

1. System Input: 80-164VAC single-phase, two-wire plus ground
2. System Output: 105-134VAC single-phase, two-wire plus ground
3. Output Load Capacity – The specified output load capacity of the UPS shall be 3000VA with a 0.85 lagging power factor
4. Battery Cells: Sealed, non-spillable, lead acid, valve regulated
5. Reserve Time: 8 minutes at full load, 0.85 power factor, with ambient temperature between 20 and 30 degrees Celsius
6. Recharge Time: To 90% capacity within 4 hours after return of nominal AC power from low battery cut-off

B. Modes of Operation - The UPS shall be designed to operate as a line-interactive, extended

runtime system in the following modes:

1. Normal – The critical AC load is supplied by the utility power source. Any non-hazardous harmonics and/or anomalies are filtered through internal electronics. Internal batteries are simultaneously float-charging through a two-stage process.
2. Boost – During a sag in utility power starting at 105VAC (189/215VAC) down to 75VAC (150/185VAC), the internal two-stage transformer of the UPS will provide a boost of utility AC voltage, depending on the level of the sag, to a nominal AC voltage output level without the use of internal batteries. The UPS must be able to operate indefinitely in this mode until utility AC voltage rises to 109VAC (196/223VAC).
3. Buck - With a surge in utility power starting at 128VAC (236/260VAC) and continuing up to 164VAC (271/290VAC), an internal, two-stage buck transformer will suppress, or buck, the utility AC voltage to nominal AC output voltages without the use of internal batteries. The UPS must be able to operate indefinitely in this mode until utility AC voltage drops to 124VAC (227/252VAC).
4. On Battery – Upon failure or overvoltage of utility AC power, the connected AC load is supplied power by the UPS switching from Normal mode to the inverter while using the internal batteries. There shall be a minimum interruption in power lasting no more than 4 milliseconds. When utility AC power returns, the UPS will return to Normal mode with an interruption of no more than 4 milliseconds.
5. Recharge – Upon restoration of AC utility power, after a utility AC power outage, the internal charger shall automatically start recharging the internal batteries.
6. DC cold start – The UPS shall start and operate without AC utility power applied.

C. Performance Requirements
   - AC Input to UPS
   - Voltage Configuration for Standard Units: Single-phase, 2-wire plus ground.
   - Voltage Range (Non-Battery mode): 80 – 164VAC
   - Frequency: Auto-Select 50/60Hz (+/- 6Hz.).
   - Power Factor: 0.85 lagging minimum at nominal input voltage and full rated UPS output load.
   - Inrush Current:
     - o @ 3000VA – 258 Amps for 8.4mS
   - Current Limit:
     - o @ 3000VA 120VAC – 30 Amp input circuit breaker
   - Surge Energy Rating: The UPS shall have Non-Flammable Metal Oxide Varistors for surge energy protection with a rating of:
     - 500 Joules – 120VAC models
   - Surge Protection: Sustains input surges without damage per criteria listed in ANSI C62.41 Category A.
   - AC Output, UPS Inverter
   - Voltage Configuration: Single-phase, 2-wire plus ground.
   - Output Waveform: True Sinewave.
   - Voltage Regulation @ 120VAC: Not to exceed +/-4% until Low Battery Warning
   - Frequency: Nominal Frequency +/- 0.5Hz
   - Voltage Distortion @ 120VAC: Not to exceed 7% at full linear load
   - Load Power Factor Range: 1.0 to 0.85 lagging without de-rating
   - Output Power Rating: 3000 KVA at 0.85 lagging power factor
   - Current Distortion @ 120VAC: Not to exceed 7% at full linear load

- Overload Capacity: AC Mode –output and input circuit breakers; DC Mode – 110% for 30 Seconds/125% Immediate
- Inverter Output Manual Adjustment: 108, 113, 117VAC
- Voltage Transient Response: 0nS – Normal mode. <5nS – Common Mode
- Transient Recovery Time: 0.4mS
- Efficiency: AC Mode 92% at full load, DC Mode 76% at full load
- Dynamic Response: +/- 15% at 100% load change
- Transfer time: 4-milliseconds.

D. Independent Battery Bypass

1. The UPS design must allow it to operate in Normal, Boost, or Buck mode with utility AC power available when internal batteries, (and external battery packs), have failed or produce insufficient power for the UPS to operate in battery mode. The device must provide spike and surge protection during this stage, as well. It shall not be necessary to remove power or unplug the UPS in order to replace the internal batteries.

2.02 Materials

A. All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

B. The maximum working voltage, current, and di/dt of all solid-state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component sub-assembly shall not be greater than 75% of their ratings.

2.03 Wiring

A. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70).

2.04 Construction and Mounting

A. The UPS enclosure shall be adaptable for standing vertically or mounted horizontally on the floor or mounted on a wall with appropriate mounting hardware supplied by the manufacturer of the UPS. It shall also be capable of mounting within a 19” wide rack or cabinet structure with the appropriate mounting hardware supplied by the manufacturer.

B. The UPS shall be constructed of replaceable subassemblies. Any internal batteries shall be replaceable by removing the front bezel and detaching the retaining bracket.

2.05 Physical Dimensions:

A. Height: 5.25 inches (3U), Width: 17 inches, Depth: 16 inches

2.06 Cooling

A. Cooling of the UPS shall be by forced air. High quality fans shall be used to minimize audible noise output.

2.07 Grounding

A. The UPS chassis shall provide proper grounding to reduce the risk of electrical shock hazard.

2.08 Input Power Plug/Connector

A. NEMA L5-30P locking plug

2.09 Output Power Receptacles

A. 7-Battery Backup and 1-Surge only (NEMA 5-15R)

2.10 Telephone/Network Protection

A. The UPS shall have a RJ11/45 connector on the rear panel for protecting a single line phone/fax/modem or 10-base T network.

2.11 Charger

A. The term charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for battery charging. The charger shall be a pulse-width modulated, switching-type with constant voltage/current limiting control circuitry.

2.12 DC Filter

A. The charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 2% RMS. The filter shall be adequate to insure that the DC output of the charger will meet the input requirements of the inverter.

2.13 Automatic Restart

A. Upon restoration of utility AC power, after a utility AC power outage, the UPS shall automatically restart and resume the battery recharge mode.

2.14 Battery Recharge

A. The charger shall be capable of producing battery-charging current sufficient to replace 90% of the battery-discharged power within four hours. After the battery is recharged, the charger shall maintain the battery at full charge until the next emergency operation.

2.15 Overvoltage Protection

A. There shall be charger over-voltage protection so that if the charger voltage rises to the pre-set limit, the charger will turn off and issue a fault alarm.

2.16 Inverter

A. The term inverter shall denote the solid-state equipment and controls to convert DC power from the battery to regulated AC power for supporting the critical load. The inverter shall use MOSFETS in a phase-controlled, pulse width modulated (PWM) design capable of

providing the specified AC output.

2.17 Overload Capability

A. The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 110% of full load current for 30 seconds. A status indicator and audible alarm shall indicate overload operation.

2.18 Fault Clearing and Current Limit

A. The inverter shall be capable of supplying an overload current of 110% of its full-load rating for 30 seconds. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.

2.19 Output Power Transformer

A. A dry-type power transformer shall be provided for the inverter AC output. It shall have copper wiring exclusively. The transformers hottest spot winding temperature shall not exceed the temperature limit of the transformer insulation class of material when operating at full load at maximum ambient temperature.

2.20 Inverter Output Voltage Adjustment

A. The inverter shall have adjustable output voltages of 108, 113 and 117VAC.

2.21 Fuse Failure Protection

A. Power semiconductors in the inverter unit shall be fused so that loss of any one power semiconductor will not cause cascading failures.

2.22 Inverter DC Protection

A. The inverter shall be protected by the following disconnect levels:

1. DC Overvoltage Shutdown
2. DC under-voltage Warning (Low Battery Reserve)
3. DC under-voltage Shutdown (End of Discharge)

2.23 Over-discharge Protection

A. To prevent battery damage from over-discharging, the UPS control logic shall automatically turn off the inverter at a predetermined level as to not damage the batteries.

2.24 Output Frequency

A. The output frequency of the inverter shall be microprocessor controlled. The microprocessor shall regulate the inverter output frequency to +/- 0.1% for steady state and

transient conditions. Total frequency deviation, including short time fluctuations and drift, shall not exceed 0.1% from the rated frequency unless synchronized to utility power during brownout and overvoltage events.

2.25 Display and Controls

A. The UPS shall be provided with a microprocessor based unit status display and controls section designed for the convenient and reliable user operation. A multi-LED display shall be used to show status of the UPS, and shall be provided as part of the monitoring and controls sections of the UPS. The power controls and monitors shall be located on the front of the UPS cabinet.

2.26 Controls

A. UPS start-up operations shall be accomplished through the front panel pushbutton control. To initiate a complete shutdown of the UPS below 1500VA in size, the input power cord must be removed from AC utility power. The UPS shall have an input circuit breaker that must be turned off to completely shut off the UPS unit.

2.27 Power Monitoring Software

A. The UPS shall be provided with Power Monitoring Software to report important status information concerning the UPS and the utility power.

2.28 Communications Port

A. The UPS shall have a 9-pin subminiature D-shell connector on the rear panel of the UPS for connecting a RS232 communication cable between the UPS and the computer. The UPS shall also provide simulated contact closure, for AC Fail and Low Battery Warning alarms, via the 9-pin subminiature D-shell connector.

2.29 Alarm Messages

A. The following alarm messages shall be displayed via LED indicators located on the front panel:

1. Boost/Buck: When the UPS is operating in the Boost or the Buck mode the Boost/Buck LED will flash
2. On Battery: When the UPS is operating with the use of battery power, the battery LED will flash and the audible alarm will sound every 10 seconds
3. UPS Fault: When the UPS detects an internal hardware fault, the fault LED will illuminate and the UPS will emit a sustained tone
4. Overload: When the connected equipment attached to the UPS exceeds the capability of the UPS inverter to support it, the Overload LED will illuminate and the UPS will emit a sustained tone
5. Low Battery Warning: The audible alarm will sound twice every 5 seconds until unit shuts down
6. Site Wiring Fault (120VAC models only): The unit will illuminate an LED indicator when improper utility service wiring is detected on the electrical circuit to which the UPS unit is connected

2.30 Battery Power Pack(s)

A. The battery power packs shall include sealed, non-spillable, lead-acid valve regulated battery cells housed in a separate cabinet that matches the UPS cabinet styling and dimensions to form an integral system line-up. Battery cells shall be mounted in metal cases designed to exactly match the dimensions and installation of the control UPS. A battery disconnect circuit breaker shall be included for isolation of the battery pack from the UPS module. Brackets shall be provided for installation into a 19' rack or cabinet. Also, a set of brackets shall be included for installation of the UPS in a vertical formation for use on a floor. The feet shall be of a design so as to interconnect with the feet of the control UPS to form a solid configuration. Each battery power pack will have an independent charger with the ability to operate with a utility input voltage of 115VAC or 230VAC. The charger shall be capable of producing battery-charging current sufficient to replace 90% of the battery discharge power within less than six (6) hours. After the battery is recharged, the charger shall maintain the battery at full charge until the next emergency operation. Battery power packs shall be provide to supply a minimum of 4 hours of backup time for the loads indicated.

2.31 Remote Contact Closure Card

A. Isolated Form C contacts shall be provided to indicate a change of status for each of the following:

1. UPS on Battery Alarm
2. Low Battery Warning Alarm

2.32 SNMP Card

A. The UPS shall come equipped with an internal SNMP adapter card slot located on the backplane of the unit, which will connect the UPS directly to any I.P. based network using Ethernet communications. The UPS will become a managed device on the network. From a network management station, the system administrator shall be capable of monitoring important system measurements, alarm status, and alarm history data. The network administrator shall also be capable of executing battery tests, observing the results of such tests, and turning the UPS on and off via his SNMP communication network. In the event of a utility failure, the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low Battery. On resumption of utility power, the SNMP card shall resume full SNMP communication automatically. The optional SNMP card shall also be capable of HTTP communications when SNMP management is not available or practical. Using most industry standard web browsers as an interface, the system administrator shall have access to all information available through the web interface.

2.33 Multi-Port Computer Interface Card

A. A Multi-Computer Interface Card shall be provided where a single UPS is powering multiple computers, (up to three). This system shall perform an automatic unattended shutdown of the customer's operating system in each computer when necessary or programmed by the system manager. The Multi-Interface Unit shall provide the hardware required to interface the UPS to each computer. The software provided allows each computer to monitor the UPS for power failure and low battery alarm while operating as a background task. After a power failure occurs, the software shall perform an automatic shutdown of each connected computer when the pre-programmed timer expires. If the UPS reaches a low battery alarm, the software shall override the timer and perform an automatic shutdown of each

connected computer. This system shall include a shielded primary cable with a 9-pin subminiature D-shell connector, the Multi-Interface card, and shielded secondary cables with RJ45 and 9-pin subminiature D-shell connectors. Cables shall be available in 6-foot lengths.

2.34 UPS/Remote Power Manager Interface Card

A. A UPS/Remote Power Manager Interface Card shall be provided where communication is required between the UPS control unit and a Remote Power Management device. The card shall relay information through a non-shielded cable with an RJ11 connector. This card allows the UPS to become a managed device on the network using the I.P. addressed card in the RPM unit. From a network management station, communicating through the RPM device, the system administrator shall be capable of monitoring important system measurements, alarm status, and alarm history data. The network administrator shall also be capable of executing battery tests, observing the results of such tests, and turning the UPS on and off via his SNMP communication network. In the event of a utility failure, the SNMP shall continue with live communication without the requirement of additional or separate UPS equipment until such time as the UPS shuts down for Low Battery. On resumption of utility power, the SNMP card shall resume full SNMP communication automatically. The optional SNMP card shall also be capable of HTTP communications when SNMP management is not available or practical. Using most industry standard web browsers as an interface, the system administrator shall have access to all information available through the web interface. The interface card will enable the RPM device to automatically initiate a pre-programmed shutdown sequence of connected equipment to the RPM device.

PART 3 - EXECUTION

3.01 MANUFACTURING

A. The Manufacturer shall design, build, test and arrange for shipment of the Communication Equipment Power System.

B. The Manufacturer shall prepare and deliver the required drawings and instruction manuals with the equipment.

3.02 SITE PREPARATION

A. The Contractor shall prepare the site for installation of the equipment.

3.03 INSTALLATION

A. The Contractor shall provide local electricians to make the final installation of the equipment.

B. The equipment shall be installed in accordance with local codes and the Manufacturer's recommendations.

3.04 FIELD QUALITY CONTROL

A. With all loads connected, the equipment shall be checked out and started by a field service representative of the Manufacturer. A signed field service report shall be submitted after

the equipment is operational.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATION EQUIPMENT POWER SYSTEM will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATION EQUIPMENT POWER SYSTEM must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 13 13

COMMUNICATIONS COPPER OUTSIDE PLANT CABLE

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 specification consists of furnishing and installing COMMUNICATIONS COPPER OUTSIDE PLANT CABLE at the locations as shown on the Contract Drawings.

B. The section specifies the requirements for furnishing, installing, and testing of the Copper Outside Plant portion of the Communication System within the RT station. This shall be complete with copper twisted pair cable, with and without integrated messenger, ready access splice enclosures, circuit distribution frames, equipment racks, conduit, all as required for a fully operational system that provides all the features and functions identified herein and shown on the Contract Drawings.

C. Description of Work: The Copper Outside Plant shall accommodate distribution of all copper circuits under this Contract, to the fiber optic node. The copper cable shall be rerouted to the new Communications Room through a new conduit. The copper plant uses the first 25 pairs of the cable to perform local distribution of copper circuits to fiber optic nodes. The second 25 pairs are used for point to point distribution to create an end-to-end distribution link. All cables must remain operational at all times. Cable cutovers shall be coordinated with the Authority.

D. The copper plant at the fiber node shall be terminated on 25 pair protection blocks, as specified elsewhere. The copper plant shall be interconnected from the protection blocks to punchdown blocks on the wallfield. All cross-connects shall be made between the blocks from the cross-connect side of the blocks, as shown on the Contract Drawings.

E. The copper plant also shall include smaller density cables for drops to equipment and rooms as specified in Section 27 15 13 Horizontal Copper Cabling. All pairs shall be terminated at the wallfield within the communication room, as shown on the Contract Drawings.

F. All materials, components, equipment, installation techniques and tools shall comply with current CTA requirements and shall be 100% compatible and interchangeable with the existing CTA backbone communication system.

G. The Contractor shall be responsible for providing complete and operational copper links as required to transport the signals to the copper transmission system. The complete link, including portions of existing cable or cable installed by others, shall be measured and tested for performance and loss by the Contractor. The Contractor shall notify the Authority immediately if any link measures below the necessary level to transport the copper signals.

1.03 RELATED WORK

A. COMMUNICATIONS COPPER OUTSIDE PLANT CABLE specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. OSP – OutSide Plant

B. Publications.

1. Telcordia TR-EOP-000063, "Network Equipment Building System (NEBS) Generic Equipment Requirements"

C. Reference Standards.

1. ANSI/EIA/TIA -T1.102, "North American Electrical Digital Hierarchy"
2. ANSI/EIA/TIA - T1.403, "Telecommunications Carrier to Customer Installation - DS-1 Metallic Interface"
3. RUS/REA PE-22, "Aerial and Duct Air Core Copper Conductor Cables"
4. RUS/REA PE-38, "Figure-8 Self-Supporting Air Core Copper Conductor Cables"
5. RUS/REA PE-89, "Foam Insulation Copper Conductor Cables"
6. RUS/REA PE-39, "Filled Core, Copper Conductor Cables"

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. Shop Drawings: The Contractor shall prepare and submit to the CTA for review before fabrication and assembly of equipment, electronic files and four prints of each of the following. The Contractor shall submit complete original sets (photocopies of printed material are not acceptable) of the following to the CTA for approval prior to ordering any of the equipment specified in this Section.

1. All submittals as required by the Special Conditions of this Specification.
2. The Contractor shall submit the following items as specified herein:
    a. All submittals as required by the Special Conditions of this Specification.
    b. Proposed Manufacturer's detailed product data "cut-sheets" and specifications for each piece of equipment to be furnished.
    c. Installation details of copper cable, and termination/splicing equipment.
    d. Wiring diagrams of distribution frames, equipment racks, and the copper cable.
    e. Detailed testing procedures and certified copies of all test results and

reports, including actual path loss measurement data.

f. All shop drawings as detailed herein.

g. Copies of the Contractors splice log.

C. Record Drawings: Furnish record drawings annotated with the changes made during installation of the Work so as to be a complete set of "as-installed" drawings and wiring diagrams.

D. Test Reports: The Contractor shall submit for record and distribution after installation of equipment, 10 copies of the certified test report.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 COPPER COMMUNICATIONS CABLE

A. The communications cable to be furnished under this Contract shall conform to RUS/REA Specification PE-38 except as noted herein. The size, type, and location of the cables are as shown on the drawings.

B. General Requirements

1. The conductors shall be solid annealed bare copper conforming to the latest requirements of ASTM-B-3.

2. The conductors shall be No. 22 AWG.

3. Conductors shall be individually insulated with a colored, solid insulating grade, high density polyethylene copolymer material meeting the requirements of RUS/REA Specification PE-200, "Polyethylene Raw Materials" for high density insulating grade material, and ICEA S56-434 fifth edition "Polyolefin Insulated Communication Cables for Outdoor Use".

4. The polyethylene compound color shall be coded per U.S. telephone industry standards with color concentrates chosen for permanency and electrical balance of individual circuits. The colors of insulated conductors shall be supplied in accordance with ICEA S56-434 and shall comply with the requirements of EIA Standard RS-359.

5. The insulated conductors shall be twisted into pairs. The length or pair twists shall

be designed to meet ICEA S45-434 fifth edition.

6. The average twist length of any pair in the finished cable shall not exceed six inches (6").

7. The insulated pair shall be twisted into specified color combinations to provide pair identification as well as low susceptibility to noise pick-up and with varying lay lengths to minimize cross-talk.

8. The number of pairs shall be as shown on the Contract Drawings.

9. The insulated pairs shall be assembled into a cable core. Cable cores of less than 25 pairs shall be assembled concentrically. Cable cores of more than 25 pairs shall be formed of 25 pair units. Each 25 pair unit shall be wrapped with a color-coded non-hygroscopic binder.

10. The finished cable core shall be air core for aerial cables with integrated messenger, and filled core for cables without integrated messenger.

11. For filled cables, the filling compound, a petroleum jelly base multi-component, shall be applied to the cable core in such a way as to provide as near to 100 percent fill of the available air space within the core as is commercially practicable. The filling compound shall be applied in a manner to fill all voids and conductor interstices under the core to restrict the migration of moisture. The filling compound shall be compatible with the insulation and other cable compounds. All underground duct and conduit installations shall require filled compound cable (RUS/REA PE-39).

12. The filled core shall be completely covered with a layer of non-hygroscopic, non-wicking polymeric tape applied with overlap over the cable core to ensure high dielectric strength from cable core to shield.

13. An inner jacket of virgin black high molecular weight polyethylene copolymer with a minimum thickness of 30 mils shall be applied over the core wrap. The jacket shall be free from holes, splits, blisters or other imperfections and shall be smooth and concentric.

14. A 0.008 inch thick coated corrugated metal shield shall be applied over the core. The shield shall be applied longitudinally with overlap. Cables with integrated messenger shall include an aluminum shield; cables without the integrated messenger shall include a copper shield.

15. The space between the core tape and the shield, including its overlap, and between shield and jacket shall be filled with a flooding compound designed to prevent moisture and/or water entry and migration.

16. The outer jacket shall be of virgin, black, high molecular weight polyethylene copolymer, with a minimum wall thickness of 60 mils. The overall jacket shall be sequentially marked at two foot intervals with cable type, year of mfg., footage, pair count, conductor size and Manufacturer. The jacket shall be free from holes, splits, blisters or other imperfections and shall be smooth and concentric.

17. The following factory tests shall be performed, and test results submitted for approval by the Authority, prior to shipment of the cable.

    a. Conductor insulation shall be tested per REA Specification PE-38, PE-39, PE-22 and PE-23 for the following:

Test	Minimum Criteria
Tensile Strength	2,400 lb/sq in. minimum

Ultimate Elongation	300% minimum
Shrinkback	3/8 in. maximum.

The jacket material shall be tested per REA Specification PE-39, PE-22 and PE-23 for the following:

Test	Minimum Criteria
Tensile Strength	1,700 lb/sq in. minimum
Ultimate Elongation	400% minimum
Environmental Stress Cracking	20% maximum
Shrinkback	5% maximum
Impact Failure	20% maximum.

The finished cable shall be tested per REA Specification PE-39, PE-22 and PE-23 for the following:

Test	Minimum Criteria
Mutual Capacitance	0.072 +/- 0.004 mF/mi.
Mutual Capacitance Deviation	3% rms maximum
Mutual Conductance	(1000Hz) 3.3 microhms/mi.
Pair-to-Pair Conductance Unbalance	25 pF/1000 ft.
Pair-to-Ground Unbalance, (individual conductor)	800 pF/1000 ft. max.
Pair-to-ground Unbalance	175 pF/1000 ft. max.
Far End Crosstalk (150 kHz, average)	63 dB in 1000ft. RMS
Near End Crosstalk (772 kHz)	56 M-S dB
Compartmental Core Cable (772 kHz)	84 M-S dB
Insulation Resistance	1000 megohm/mi.
High Voltage Test (3 sec.) (Conductor-to-Conductor	7 kV
High Voltage Test (3 sec.) (Conductor-to-Shield)	15 kV
High Voltage Test (3 sec.) (Conductor-to-Screen)	5 kV
Maximum Conductor Resistance (20 C)	45.9 ohms/mi.
Maximum Average Attenuation	

(1000 Hz at 20 C)	1.85 dB/mi.
Maximum Average Attenuation (150 kHz at 20 C)	7.36 dB/mi.
Maximum Average Attenuation (772 kHz at 20 C)	15.87 dB/mi.
Cable Bend Test	No shield cracks
Shield Continuity	Positive continuity

2.02 BUILDING ENTRANCE TERMINALS

A. The Building Entrance Terminals shall consist of twenty-five (25) pair protection punch-down blocks (Category-3 Type-66 or Category-5e Type-66/Type-110 as shown on the Contract Drawings) mounted to the wood backboard (wallfield) in the Communications Room or Communication Hubs.

1. The building entrance terminal base shall be made of high-impact resistant, flame-retardant plastic, fastened to a metal mounting bar. The IDC terminals, test field, and protector sockets shall be mounted to this base.
2. Each building entrance terminal shall be equipped with an off-set mounting bracket for installing the block on a backboard.
3. Each building entrance terminal shall be equipped a No. 6 AWG lug for a ground conductor.
4. Twenty-five (25) pair building entrance terminals shall be provided for all required locations, as shown on the Contract Drawings. Cables larger than Twenty-five pair shall use additional 25-pair building entrance terminals in combination.
5. The Category-5e, 110-type, 25 pair building entrance terminal shall be Circa 1880ENA1/NSC-25e, or Engineer approved equivalent.
6. The Category-5e, 66-type, 25 pair building entrance terminal shall be Circa 2625QC/QCe, or Engineer approved equivalent.
7. The Category-3, 66-type, 25 pair building entrance terminal shall be Circa 2625QC/QC, or Engineer approved equivalent

2.03 PUNCHDOWN BLOCKS

A. The Punchdown Blocks shall consist of twenty-five (25) pair punch-down blocks (Category-5e Type-66/Type-110 as shown on the Contract Drawings) mounted to the wood backboard (wallfield) in the Communications Room or Communication Hubs.

1. The blocks furnished under this Contract for cross-connection of communications equipment shall have four (4) columns of twenty-five (25) pair, terminations, embedded in an impact resistant molded plastic base, with a removable plastic cover.
2. The terminations shall accept No. 20 - No. 26 AWG insulated conductors and No. 18 - No. 19 AWG skinned conductors.
3. The base of the block shall have a 25 PR plastic fanning strip on each side of the split block. Each fanning strip shall be permanently marked so as to identify the pair number (1 through 25) terminated on each clip. The base shall be equipped with an offset mounting bracket for mounting to a wall or backboard.

4. The Category-5e 66-type, 25-pair punchdown block shall be Hubbell HPW66M125, or Engineer approved equivalent.

2.04 INDOOR SPLICE CLOSURES

A. The Contractor shall provide indoor copper splice closures adjacent to the wallfield to splice the outside plant copper cable to cable stubs on protector blocks at the locations indicated on the Contract Drawings and as specified herein.

B. Each splice closure shall be non-metallic, re-enterable type to allow for access to, and inspection of, the splice.

C. The splice enclosures shall be installed in the Communication Room and shall be sized to accommodate one 50-Pair #22AWG shielded OSP cable spliced to two 25-Pair #22AWG indoor rated, shielded cables.

D. Splice enclosures shall provide positive moisture and chemical resistance and shall be fire retardant. All associated hardware and clamps shall be stainless steel.

E. The closure shall be capable of accommodating the required number of copper splice connectors, as specified elsewhere.

2.05 READY ACCESS SPLICE CLOSURE (RASC)

A. The ready access splice closure shall be used for outside plant main cable splicing and for drop cable applications along the rail right of way.

B. The ready access splice closure shall be capable of aerial applications using separate messenger or integrated messenger installations.

C. The RASC shall be a weatherproof, re-enterable, plastic enclosure with separate areas or compartments for drop wire terminations away from the main splicing chamber.

D. The RASC shall be suitable for application in the temperature range of -40 degrees C to +70 degrees C.

E. The RASC shall provide entry of a minimum of three main cables and six drop cables, or as required in the Contract Drawing

F. The RASC shall be capable of through, branch, or mid-span type splices.

G. The RASC shall allow splicing up to 250 pairs.

H. The RASC shall accommodate the required number of termination or splicing clips.

I. The RASC shall be fungus and UV resistant.

2.06 SPLICE CONNECTORS

A. The Contractor shall provide copper splice connectors for splicing copper cables at required locations, and as shown on the Contract Drawings.

B. The splice connector shall be capable of joining insulated conductors in gauges 17 through 26, without stripping the insulation.

C. The splice connector shall be encapsulated to prevent the ingress of moisture.

D. The splice connector shall be capable of providing splice, bridge, and half-tap options, in either foldback or in-line configurations.

E. The splice connector shall be provided in 5 pair and 25 pair modules.

F. The splice connector shall meet the following specifications:

1.	Di-electric Strength	3.0 ac-kV
2.	Contact Resistance	1 in 10,000 failures @ 1milli-ohm
3.	Temperature	-40 to +60 degrees C
4.	Humidity	10 to 90 % relative
5.	Insulation Resistance	> 20 x 10^9 ohms at 1000VDC

G. The Contractor shall provide all necessary tools and appurtenances to properly splice or terminate 5 and 25 pair modules.

H. The splice connector provided shall be used in the indoor splice closure and the ready access splice closure, specified elsewhere.

2.07 PLUG-IN PROTECTION MODULES

A. The Contractor shall provide Plug-in Protection Modules (PPM) for the Building Entrance Terminals.

B. The Plug-in Protection Modules shall be 5-pin construction.

C. The PPM shall be compatible with and be of the same manufacturer as the Building Entrance Terminal.

D. All pairs on each protective block shall be protected, whether active or inactive.

E. Plug-in Protection Modules shall be type Cat-5e, rated for the level of voltage protection required for each type of circuit:

1. 30v
2. 75V
3. 240v
4. 300V

F. The Plug-in Protection Module shall be Circa 4B6S series, or Engineer approved equivalent.

PART 3 - EXECUTION

3.01 COPPER COMMUNICATIONS CABLE

A. The installation of the copper cable shall be conducted in a phased manner. The Contractor shall make every effort to protect the cable during construction and installation, including protection from vandalism.

B. The Contractor shall perform the cable installation in accordance with the CTA approved plan that was submitted to the Authority. Any deviations from the approved plan must be submitted in writing to the Authority.

C. The Contractor shall, at all times, conduct the installation of the copper cable in a workmanlike manner identical to installations found in the telephone industry, and in complete conformance with the recommended practices of the manufacturer. The tensile ratings, minimum bending radius, and any other cable installation restriction shall not be exceeded.

D. The Contractor shall give the Authority five (5) working days notice in writing of all copper cable installations so that authorized representative may be present, if necessary.

E. All cable runs shall be continuous from equipment demarcation to the wallfield. No splices of any kind shall be accepted between locations other than approved splice points or as shown on the Contract Drawings.

F. All cable shall be clearly marked and tagged to identify the cable origin, destination, function, and CTA designated identification number. Such tags shall be of nylon or other CTA approved construction, with permanent mechanically printed markings.

G. All cables shall be grounded ONLY ONCE on the inbound end of the cable at each communication room. The outbound end shall be left ungrounded. All cable splice and/or drop points shall extend the ground through to the inbound end.

H. Testing of the copper cable shall be as follows:

1. Manufacturer's Factory Tests. The Contractor shall insure that each finished and installed copper cable segment shall be traceable to the test date on file for each step in its manufacturing process.

    a. The Authority, or its authorized representative, shall have the right to make inspections and tests as are necessary to determine if the cable meets the requirements of this Specification. The Authority shall have the right to reject cable which is defective in any respect.

    b. The Authority shall be given ten (10) working days advance notice of the date the cable will be ready for final testing so that the Authority may be present at the tests, if it so elects.

    c. Physical tests shall be made on samples selected at random at the place of production. Each test sample shall be taken from the accessible end of different reels. Each reel selected and the corresponding sample shall be identified. The number and lengths of samples shall be as specified for the individual test. All applicable tests for the cable materials and cable construction specified shall be performed.

    d. Attenuation tests shall be made on the entire length of each continuous conductor provided within each copper cable. Each test shall be completed during manufacture as required, and again prior to shipping, after the cable is secured to the reel in final shipping packaged form.

    e. The Contractor shall conduct, at the point of production, the following cable tests, under the supervision of the Authority, to include, but not be limited to:

        1) Tensile Strength

        2) Impact Resistance, Crushing and Flexing

3) Attenuation

4) Mutual Capacitance

5) Insulation Resistance

6) Conductor Resistance

f. Upon completion of each test, the Contractor shall provide certified test results, and submit these results to the Authority for approval prior to shipping the cable.

2. Installed Field Tests. Testing of installed copper cable shall be performed before and after installation, and after complete termination of the cable.

a. The Contractor shall notify the Authority in writing five (5) working days in advance of the testing of the cable so that the Authority, or its representative, may be present for the tests, if the Authority so elects.

b. Testing shall be performed on the copper conductors, as terminated on the wallfield.

c. All necessary test equipment shall be provided by the Contractor to perform tests to include, but not be limited to, the following:

1) Attenuation at 1000 Hz, 150 kHz, and 772 kHz

2) Time Domain Reflectometer (TDR) records (labeled and identified), either photographic or computer printer/plotter output. Test shall be conducted for both directions of transmission. All TDR tests shall be made with a TDR approved by the Authority.

I. Existing Communications Cable

1. Contractor will locate and identify existing communications cable and will inform the Authority of their location.

2. Contractor will coordinate with the Authority for the staged removal of existing cables, as directed by the Authority.

3.02 BUILDING ENTRANCE TERMINALS

A. The Building Entrance Terminals shall be wall-mounted on a new marine-grade, fire-retardant gray painted wood backboard, unless noted otherwise, in the Communications Room, as shown on the Contract Drawings.

B. All cross-connections shall be made within each building entrance terminal from the punchdown blocks, unless noted otherwise. Cross connections shall be made using No. 22 AWG solid copper insulated pairs, dressed in a neat and workman-like manner.

C. The cross-connections shall only be made from the cross-connect side of each block, as shown on the Contract Drawings.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATION COPPER OUTSIDE PLANT CABLE will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATION COPPER OUTSIDE PLANT CABLE must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 13 23

COMMUNICATIONS FIBER OPTIC OUTSIDE PLANT CABLE

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 specification consists of furnishing and installing COMMUNICATIONS FIBER OPTIC OUTSIDE PLANT CABLE at the locations as shown on the Contract Drawings:

B. General: The section specifies the requirements for furnishing, installing, and testing of the Fiber Optic Outside Plant portion of the Communications System within the R/T station. This shall be complete with fiber optic cable, inner duct with and without integrated messenger, splice and slack enclosures, pigtails and patch panels, and equipment racks, all as required for a fully operational system that provides all the features and functions identified herein and shown on the Contract Drawings.

C. Description of Work: Existing backbone fiber optic cable at the site and/or shown on the drawings to be verified in the field. This cable shall be rerouted to the new Communications Room under this project. All cables must remain operational at all times. Cable cutovers shall be coordinated with the CTA.

D. The cables are used for rail station and system communications. The Contractor shall be responsible for continuing the cables to the fiber distribution panels in the communication room and providing splicing and termination equipment to keep the cables operational and functional. The Contractor shall provide fiber distribution panels installed in the fiber cabinet and splice the designated fiber strands to the pre-terminated fiber pigtail connector panels or to respective outgoing fiber strands.

E. The Contractor shall provide the necessary optical connections between the fiber optic transmission system equipment and the fiber optic outside plant, both at the rail station and the CTA's Control Center at 120 N. Racine.

F. The Contractor shall be responsible for providing complete and operational optical links as required to transport the optical signals to the CTA Control Center. The complete link, including portions of existing cable or cable installed by others, shall be measured and tested for optical performance and loss by the Contractor. The Contractor shall notify the CTA immediately if any optical link measures below the necessary optical link budget to transport the optical transmission equipment, specified elsewhere.

G. All materials, components, equipment, installation techniques and tools shall comply with current CTA requirements and shall be 100% compatible and interchangeable with the existing CTA fiber optic backbone communication system.

H. These cables shall be relocated under the platform after the station platform conduits are completed. Splicing and cutover of the relocated cables to portions of the existing cables shall be coordinated with the CTA to avoid downtime.

1.03 RELATED WORK

A. COMMUNICATIONS FIBER OPTIC OUTSIDE PLANT CABLE specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. OSP – Outside Plant (cable)

B. Publications.

1. ANSI/EIA/TIA-472, "Generic Specification of Fiber Optic Cables"
2. ANSI/EIA-472D000-A, "Sectional Specification for Fiber Optic Communication Cable for Underground and Buried Use"
3. ANSI/EIA/TIA-526-07, "Optical Fiber Systems Test Procedures - Optical Power Loss Measurements of Installed SingleMode Fiber Optic Plant"
4. ANSI/EIA/TIA-475-AAAA, "Detail Specification for Fiber Optic Connector Set; Type SC, Singlemode, Simplex and Duplex Versions"
5. ANSI/EIA/TIA-455-8, "Measurement of Splice or Connector Loss in Reflectance Using OTDR"
6. ANSI/EIA/TIA-609AA00, "Blank Detail Specification for Conventional, Permanent, Optical Fiber Splices"
7. ANSI/EIA/TIA-598-A, "Color Coding of Fiber Optic Cables"
8. ANSI/EIA/TIA-455, "Generic Fiber Optic Test Procedures", as applicable
9. ANSI/EIA/TIA-568, "Commercial Building Telecommunications Wiring Standard"

C. Reference Standards.

1. Telcordia TR-TSY-000020, "Generic Requirement for Optical Fiber and Optical Fiber Cables".

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. Shop Drawings: The Contractor shall prepare and submit to the CTA for review before fabrication and assembly of equipment, electronic files and four prints of each of the following. The Contractor shall submit complete original sets (photocopies of printed

material are not acceptable) of the following to the CTA for approval prior to ordering any of the equipment specified in this Section.

1. All submittals as required by the Special Conditions of this Specification.
2. Single line block and system diagrams detailing the entire fiber optic outside plant system.
3. Proposed Manufacturer's detailed product data "cut-sheets" and specifications for each piece of equipment to be furnished.
4. Installation details of fiber optic cable, and termination/splicing equipment.
5. Cable pulling plan.
6. Cable bend radius warning per manufacturer's specifications.
7. Wiring diagrams of distribution frames, equipment racks, and the fiber optic cable.
8. Detailed testing procedures and certified copies of all test results and reports, including actual path loss measurement data.
9. All shop drawings as detailed herein.
10. Copies of the Contractors splice log.

C. Record Drawings: Furnish record drawings annotated with the changes made during installation of the Work so as to be a complete set of "as-installed" drawings and wiring diagrams.

D. Test Reports: The Contractor shall submit for record and distribution after installation of equipment, 10 copies of the certified test report.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 FIBER OPTIC CABLE

A. Mounting hardware for the Fiber Optic Cable shall be as shown on the plans.

B. The cable shall meet, as a minimum, the following specifications and shall conform with the latest issue of Bellcore TR-TSY-000020: Generic Requirement for Optical Fiber and

Optical Fiber Cables, and ANSI/EIA-472: Generic Specification of Fiber Optic Cables, and appropriate Sectional Specifications thereof.

1. Cable Construction. Cable construction, other than as specified, must be approved by CDOT and the CTA. The cable shall be constructed entirely from dielectric material.
2. A cable suitable for the following installations shall be supplied: direct installation into a duct bank; installation into an innerduct for underground installation or self-supported suspension between poles or supported from elevated structures, (e.g., within an aerially self-supported or figure eight innerduct).
3. The cable shall be of gel-filled, loose tube construction with up to twelve (12) buffer tubes wrapped around a dielectric central strength member. All fiber(s) shall be contained within buffer tubes, and each buffer tube shall have an inside diameter much greater than the total diameter(s) of the fiber(s) it supports.
4. Each fiber or group of fibers shall be free-floating within the tubes such that all mechanically or environmentally induced stress placed upon the cable is de-coupled from the fibers. The air within the buffer tubes shall be displaced with a gel to prevent entry by water and to facilitate free movement of the fiber(s) within.
5. The fiber optic cable shall conform to the latest issue of EIA/TIA-598, for color coding. Identification of buffer tubes and fiber strands shall be such that they can be easily identified by field forces without the use of special equipment or tools.
6. Cables constructed of less than six fibers shall have a buffer tube provided for each fiber; cables constructed of more than six fibers may have several fibers occupy a buffer tube, with equal distribution of fibers as far as practicable. When more than one fiber occupies a buffer tube, the fibers shall be color coded for identification.
7. The cable shall have a water block tape between the outer jacket and the buffer tubes applied longitudinally along the entire cable to prevent entry of water.
8. A binder wrapping strength member of Kevlar, or approved equal, fibers shall be provided as a final layer prior to application of the outer jacket.
9. A low smoke, zero halogen, fire retardant fiber optic cable shall be provided for all subway installations and as shown on the Contract Drawings. The cable shall meet all specifications described herein for fiber optic cable.
10. The cable shall be provided in continuous lengths. Each fiber shall be pulled from the same optical waveguide form and shall be free of splices. Optical fibers are to be made from silica; the use of any other material must be approved by the CTA.
11. A permanent marking shall be employed on the outer jacket of the cable which shall show the date of manufacture, the Manufacturer's name, and the words "CTA FIBER OPTIC CABLE". A numerical sequence shall be marked on the outer jacket, at intervals no greater than ten (10) feet, to facilitate determination of length of cable and amount of cable remaining on the reel.
12. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi, see submittals this section.
13. All optical fibers shall be 100% attenuation tested at the factory for compliance with performance specifications described herein. The attenuation of each fiber shall be provided with each cable reel, see submittals this section.
14. The outer jacket shall be constructed of medium density polyethylene, minimum jacket thickness of 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The outer jacket shall be ultra-violet ray and fungus resistant.

15. The cable used in the subway shall be of low smoke, zero halogen, fire retardant manufacture that meets or exceeds National Fire Protection Association Standard 130.

16. Fiber optic cable shall be provided with the required number of strands as shown in the Contract Drawings.

C. Optical and mechanical specifications for the standard fiber optic cable and the low smoke fiber optic cable:

1. Optical Specification:

a. Operational Wavelength: 1,300 nm and 1,550 nm

b. Optical Attenuation @ 1,300 nm: 0.4 dB/km @ 20 degrees C (max)

c. Optical Attenuation @ 1,550 nm: 0.3 dB/km @ 20 degrees C (max)

d. Optical Dispersion @ 1,300 nm: 3.5-4.5 psec/nm-km (max)

e. Optical Dispersion @ 1,550nm: more than 20 psec/nm-km (max)

f. Zero Dispersion Wavelength: 1290 to 1,330 nm

g. Fiber Core Diameter: 8.3 um, maximum

h. Fiber Coating Diameter: 250 +/- 15 um

i. Fiber Cladding Diameter: 125 +/- 3 um

j. Core/Cladding Concentricity: 1.0 um, maximum

k. Spot Size: 9.8 um

l. Refractive Index Difference: 0.3 +/- 0.5%

2. Mechanical Specifications:

a. Crush Resistance: 5,000 N/m, length of cable

b. Cable Outside Diameter: 11.9 mm (0.47"), nominal

c. Minimum Bending Radius:

1) Installation: 20 times the cable diameter

2) Static: 10 times the cable diameter

d. Temperature:

1) Operational: -30 C to +60 C

2) Storage: -40 C to +60 C (on reel)

3) Humidity: 0 to 100%

e. Tensile Strength:

1) Installation: 2,700 N (600 lbf)

2) Static: 600 N (135 lbf)

D. The fiber optic cable shall be Corning ALTOS series, or Engineer approved equivalent.

2.02 FIBER OPTIC CONNECTORS

A. All optical connectors shall be factory installed on optical patchcords or pigtails. No field installation of connectors shall be permitted. The singlemode connectors furnished on

optical patch cords and pigtails shall be SC Type, physical contact (PC). The multimode connectors furnished on optical patch cords and pigtails shall be ST Type. All connectors shall conform with the latest issue of EIA/TIA-568 for ST connector performance and physical characteristics. The ferrule shall be constructed from ceramic. The connectors shall meet, as a minimum, the following specifications:

1. Nominal Insertion Loss: 0.25 dB, mated pair
2. Reflectance: less than -55 dB
3. Attenuation (Average, 3 readings, 120 degree spacing): 0.4 dB, maximum @ 1300 nm
4. Mechanical Stability: 0.3 dB change, maximum
5. Tensile Stability: 0.3 dB change, maximum
6. Thermal Stability: (5 cycles, -20 degrees C to +60 degrees C), 0.4 dB change, maximum

2.03 OPTICAL PATCH CORDS AND PIGTAILS

A. The optical patch cords furnished under this Contract shall consist of a section of single fiber, jacketed cable equipped with optical connectors at both ends, of sufficient length.

1. Patch cords for connections within the fiber distribution panel (FDP) shall be equipped with approved connectors on both ends of the patch cord, as specified herein.
2. Patch cords for connections from FDP to optical multiplexer shall be equipped with the specified connector at the FDP end and a CTA approved connector at the equipment end.

B. The optical pigtails furnished under this Contract shall consist of a section of single fiber, jacketed cable of sufficient length, equipped with an approved factory installed connector at one end. The other end shall be stripped and prepared for fusion splicing. The pigtails shall be provided pre-wired to connector modules in the fiber distribution panel, as described elsewhere in this Section.

C. The approved connectors furnished as part of optical patch cords and pigtails shall meet or exceed the requirements for approved connectors specified herein.

D. The fiber portion of each patch cord and pigtail shall be a single, singlemode, jacketed fiber with optical properties identical to the OSP cable furnished under this Contract. The fiber jacket shall be a CTA-approved low smoke, low toxicity, flame retardant sheath. The jacketed fiber shall have a tensile strength in excess of twenty pounds (20 lbs).

2.04 FIBER DISTRIBUTION PANELS

A. Fiber Distribution Panels (FDPs) shall be furnished and installed at the locations shown on the Contract Drawings and shall consist of two parts: an optical splice shelf and an optical connector housing (patch panel).

1. The splice shelf shall house and protect a maximum of 144 fusion splices of OSP fibers to singlemode fiber pigtails with twelve (12) feet of pigtail slack on each fiber.
    a. The splice shelf shall house a maximum of 12 splice trays.
    b. Each splice tray shall be capable of storing and protecting a maximum or 12 fusion splices with heat shrink protection, and shall include a clear

plastic tray cover.

c. The connector shelf and splice shelf shall be Corning model CCH-04U and CCS-03U or CTA approved equivalent.

2. The optical connector housing shall house and protect a maximum of 144 connectorized strands per shelf using duplex SC connectors. If more than 144 strands are used, the Contractor shall provide additional shelves.

a. The fiber pigtail slack shall be neatly coiled and secured in a manner that does not allow the minimum operational bending radius of the pigtail to be exceeded.

b. The approved type singlemode connectors on the end of each pigtail shall screw into a sleeve securely mounted to a panel within the FDP enclosure. The patch panel shall be provided with pre-connectorized and pre-wired 6-port duplex modules. The maximum optical loss across the connection shall not exceed 0.25 dB.

3. The FDP housings shall be capable of rack mounting in EIA-310 standard 19" equipment racks, as shown on the Contract Drawings. The housing shall have OSP cable entrances with cable sheath strain relief.

2.05 FIBER OPTIC SPLICE AND SPLICE ENCLOSURE

A. All permanent and temporary optical splices in the system shall be of the fusion type method.

1. There shall be no midspan splices of the fiber optic cable, unless otherwise noted. All cables must originate and end at an optical node, fusion spliced to a fiber distribution panel or to another cable run.

2. A factory fabricated fusion splice kit containing materials necessary for quality fusion splicing shall be provided for each fiber splice.

3. Splices made with the factory fabricated single mode fusion splice kit shall be capable of achieving not more than 0.05 dB loss at 1310 nm.

4. An emergency restoration kit shall be provided to perform temporary splices. This kit shall include all necessary tools and materials to perform mechanical splices. Each mechanical splice kit shall be capable of achieving not more than 0.1 dB loss at any wavelength.

5. The Contractor shall keep a log of all splices and testing thereof, see submittals this section.

B. In the event that an outdoor splice is necessary, the Contractor shall provide the following splice closure:

1. The outdoor optical splice enclosure shall be capable of aerial, duct or buried applications.

2. The splice enclosure shall consist of an outer enclosure, an inner enclosure, and splice trays.

3. The splice enclosure shall be suitable for application in the temperature range of -40 degrees C to +70 degrees C.

4. The splice enclosure shall be capable of through, branch, or mid-span type splice locations.

5. The splice enclosure shall provide space allowing entry of fiber optic cable without

exceeding the minimum bend radius of the cable.

6. The splice enclosure shall be designed to permit selective fiber splicing (looping a backbone cable in and out while only cutting into the desired fibers).

7. The splice enclosure shall allow splicing of all fibers up to the maximum number determined by the Contractor for the fiber optic cable.

8. The outer enclosure shall be waterproof, re-enterable and shall utilize an encapsulant between the inner and outer enclosure to prevent the ingress of moisture.

9. The inner enclosure shall be designed to protect the buffer tubes and the splice trays.

10. The splice trays within the inner enclosure shall be capable of accommodating the required number of splices, including storage and protection of slack fiber.

11. The inner enclosure shall be re-enterable.

12. The splice enclosure shall include provisions to support the innerduct entry to the enclosure utilizing compression fittings and clamps, in accordance with the manufacturer's recommended practice.

2.06 FIBER SLACK ENCLOSURES

A. Fiber Slack Enclosures (FSEs) shall be provided and installed as part of this Contract, in the locations as shown on the Contract Drawings.

1. FSEs shall house and protect fiber optic cable slack in a manner which shall allow the CTA access so as to accommodate construction moves and changes to the supporting cable messenger without any disruption to the integrity of the fiber optic cable.

2. The FSE shall be a galvanized steel NEMA 3R enclosure, wall or structure mounted. The FSE's shall provide for weatherproof entry and exit of cable and innerduct from the sides and the bottom of the FSE.

3. FSEs shall be sized to accommodate a minimum of 100 feet of cable slack within the enclosure, stored in a manner that does not exceed the minimum operational bending radius of the cable at any time, however the enclosure shall not be less than 36"H x 20"W x 8"D.

4. FSEs shall have provisions for entrance of the fiber optic innerduct, including compression fittings, seals, and other incidentals required for proper installation of the innerduct. The FSE shall be designed such that the cable can be released and uncoiled from the enclosure via the front of the enclosure.

2.07 FIBER OPTIC INNERDUCT

A. The innerduct shall be provided with an integrated Figure-8 messenger cable capable of self-supported suspension for installation through the station. Innerduct without messenger shall be provided for all conduit or duct bank installation of fiber cable.

B. The innerduct shall be a flexible high density polyethylene duct manufactured in accordance with NEMA Standards Publication No. TC7 and ASTM D3485.

C. The high density polyethylene shall be of Type III, Grade P34, Class B or C, Category 5, in accordance with ASTM D1248.

D. The resin utilized in the manufacture of the duct system shall meet or exceed ASTM standards.

E. The nominal inside diameter of the duct shall be 1.25".

F. The ends of the duct shall be sealed to prevent the ingress of dirt or moisture.

G. The minimum crush resistance shall be 4203 N/m.

H. The maximum pulling tension shall be 4448 N.

I. A permanent marking shall be employed on the outside of the duct which shall show the date of manufacture and the Manufacturer's name. A numerical sequence shall be marked on the outside of the duct, at intervals of five feet, to facilitate determination of duct length and amount of duct remaining on the reel. The words "FIBER OPTIC CABLE - CHICAGO TRANSIT AUTHORITY" shall be permanently imprinted along the duct at fifteen foot intervals. All markings shall be in English.

J. The duct shall be black in color and have UV radiation protection. The inside of the duct shall have a permanent silicon emulsion prelubrication.

K. The duct shall be provided with a pull rope installed.

L. The innerduct shall be suitable for all installation methods described herein and in the Contract Drawings.

M. The integrated messenger shall be made up of 7-strand, galvanized steel, with a total diameter of 1/4". The messenger shall have a breaking strength of not less than 10,000 pounds. The nominal webbing height and width for the integrated messenger shall be .125", and .060" respectively.

PART 3 - EXECUTION

3.01 FIBER OPTIC INNERDUCT

A. The installation of the fiber optic innerduct and cable shall be conducted in a phased manner. The Contractor shall make every effort to protect the relatively delicate fiber optic cable within the innerduct during construction and installation, including protection from vandalism.

B. Clamps and supports shall be installed and spaced close enough together so that a clearance of no less than two (2) inches will be maintained between the innerduct and walls, structure members or posts and; at the same time, the innerduct shall be well outside the car clearance line when applicable. This requirement shall take into consideration tangents and curves.

C. Messenger wire of the innerduct shall be securely fastened to the supporting structure with brackets. Brackets shall be attached with bolted connections only. Mounting holes must be drilled; burning or punching holes and other methods are not permitted. Steel structures shall be drilled using a magnetic drill and the method approved by the CTA. Brackets may only be attached to locations approved by the CTA. Attaching brackets by means of welding is strictly prohibited.

D. The innerduct and messenger shall be drawn in place without injury to itself, its supports or fastenings and the tension therein shall not exceed 25% of the strength of the messenger wire at 60 degrees Fahrenheit. This tension shall be checked by a dynamometer. Messenger runs in lengths of 1,000 feet or less between deadends may be installed using one dynamometer placed in series with the messenger at the point of application of the pulling tension. With the approval of the CTA, messenger runs in lengths of 3,000 feet between deadends may be installed using two dynamometers with a shunt dynamometer to check the tension in the last span of the run in addition to the series dynamometer at the point of applying the tension. In all other respects the recommendations of the manufacturer shall be followed in the installation as to sag, loading and tension, adjusted to 60 degrees Fahrenheit ambient temperature.

E. All clamps, supports, deadends, clevises, thimbles, turnbuckles, bolts and other parts required to support the messenger innerduct shall be galvanized.

F. The Contractor shall, at all times, conduct the installation of the fiber optic innerduct in a workmanlike manner identical to installations found in the telephone industry, and in complete conformance with the recommended practices of the innerduct manufacturer. The tensile ratings, minimum bending radius, and any other fiber optic innerduct installation restriction shall not be exceeded.

G. The Contractor shall give the CTA five (5) working days notice in writing of all fiber optic innerduct installations so that authorized representative may be present, if necessary.

H. All cable runs shall be continuous from nodal site to nodal site. The innerduct shall be continuous along with the cable, except at slack enclosures, or unless specified otherwise. No splices of any kind shall be accepted between nodal sites or at locations other than approved splice points or as shown on the Contract Drawings.

I. All innerduct shall be clearly marked and tagged to identify the origin, destination, function, and CTA designated identification number. Such tags shall be of nylon or other CTA approved construction, with permanent mechanically printed markings.

3.02 FIBER OPTIC CABLE

A. The installation of the fiber optic cable within the innerduct shall be conducted in a phased manner. The Contractor shall make every effort to protect the relatively delicate fiber optic cable within the innerduct during construction and installation, including protection from vandalism.

B. The Contractor shall perform the cable installation in accordance with the CTA approved plan that was submitted to the CTA. Any deviations from the approved plan must be submitted in writing to the CTA.

C. The Contractor shall, at all times, conduct the installation of the fiber optic cable in a workmanlike manner identical to installations found in the telephone industry, and in complete conformance with the recommended practices of the fiber manufacturer. The tensile ratings, minimum bending radius, and any other fiber optic cable installation restriction shall not be exceeded.

D. The Contractor shall give the CTA five (5) working days notice in writing of all fiber optic cable installations so that authorized representative may be present, if necessary.

E. All cable runs shall be continuous from nodal site to nodal site. No splices of any kind shall be accepted between nodal sites or at locations other than approved splice points or as shown on the Contract Drawings.

F. All cable shall be clearly marked and tagged to identify the cable origin, destination, function, and CTA designated identification number. Such tags shall be of nylon or other CTA approved construction, with permanent mechanically printed markings.

G. Testing of the fiber optic cable shall be completed by the Contractor, as outlined below. The contractor shall test the fiber optic cable before he performs the work and has the liability for any damage during construction. At the completion of the tests, the Contractor shall submit Certified test reports for the CTA's approval, prior to shipping the cable. No cable shall be shipped without the CTA's approval.

1. Manufacturer's Factory Tests. The Contractor shall insure that each finished and installed fiber optic cable segment shall be traceable to the test date on file for each step in its manufacturing process.

    a. The CTA, or its authorized representative, shall have the right to make inspections and tests as are necessary to determine if the cable meets the requirements of this Specification. The CTA shall have the right to reject cable which is defective in any respect.

    b. The CTA shall be given ten (10) working days advance notice in writing of the date the cable will be ready for final testing so that the CTA may be present at the tests, if it so elects.

    c. Physical tests shall be made on samples selected at random at the place of production. Each test sample shall be taken from the accessible end of different reels. Each reel selected and the corresponding sample shall be identified. The number and lengths of samples shall be as specified for the individual test. All applicable tests for the cable materials and cable construction specified shall be performed.

    d. Optical tests shall be made on the entire length of each continuous fiber provided within each fiber optic cable. Each test shall be completed during manufacture as required, and again prior to shipping, after the cable is secured to the reel in final shipping packaged form.

    e. The Manufacturer shall provide, at the point of production, apparatus and labor for making any or all of the following tests under the supervision of the CTA, to include, but not be limited to:

        1) Tensile Strength

        2) Impact Resistance, Crushing and Flexing

        3) Optical Attenuation

        4) Optical Spectral Dispersion

        5) Optical Time Domain Reflectometry (OTDR)

2. Installed Field Tests. Testing of installed fiber optic cable shall be performed before and after installation in the innerduct and after complete installation and termination of the cable.

    a. The Contractor shall notify the CTA in writing five (5) working days in advance of the testing of the cable so that the CTA, or its representative, may be present for the tests, if the CTA so elects.

    b. Optical testing shall be performed on all fibers within each cable.

c. Testing shall be performed on the fibers, as terminated on the FDPs.

d. All necessary test equipment shall be provided by the Contractor to perform tests to include, but not be limited to, the following:

1) Optical attenuation 1,300 and 1,500 nm

2) Optical Time Domain Reflectometer (OTDR) records (labeled and identified), either photographic or computer printer/plotter output. Test shall be conducted for both directions of transmission. All OTDR tests shall be made with an OTDR approved by the CTA.

e. All testing, test equipment, and test report format shall be compatible and comply with current CTA standards.

3.03 FIBER DISTRIBUTION PANELS

A. The OSP cable shall be brought into the two FSE's adjacent to the ends of the platforms and 100 feet of cable slack shall be coiled in each FSE.

B. The OSP cable shall be run from the FSE to the FDP located in a communications room, as shown on the Contract Drawings.

C. Within the FDP, each fiber that terminates at that node, plus 100% spare fiber strands where practical, shall be fusion spliced to a singlemode fiber pigtail pre-wired to a multi-port connector module. The optical loss specifications of the fusion splice shall be identical to those described elsewhere in this Section.

D. Twelve feet of slack in each fiber pigtail shall be coiled within the FDP.

E. Fibers which do not terminate at a node shall be fusion spliced through to the outgoing cable, as shown in the Contract Drawings.

F. Six feet of slack for each strand of the through-splice shall be provided and protected in the appropriate splice trays within the FDP.

3.04 FIBER SLACK ENCLOSURE

A. Fiber slack enclosures shall be mounted on the elevated structure as shown on the Contract Drawings. The Contractor shall submit to CDOT and the CTA, for approval, a detail drawing showing the exact locations where fiber slack enclosures are to be mounted, prior to commencement of cable installation.

B. Fiber cable coiled in the FSE shall be coiled in a Figure-8 manner, and then folded over for placement in the FSE. The minimum bend radius of the cable shall not be exceeded at any time.

C. In riser applications, the cable shall be supported within the enclosure in a manner to minimize the stress caused by the downward cable on the upward cable.

D. The cable shall be secured in all FSE's to prevent the cable from spilling out of the enclosure when accessed via the front panel

3.05 FIBER OPTIC SPLICE

A. Fiber optic splicing shall be performed in a clean dust-free environment. All outside plant

splicing shall be performed in a CTA approved splicing tent or splicing van.

1. All splices shall be tested for loss and reflection. Any splice which does not meet the performance specifications described herein shall be redone, at no additional cost to the CTA.
2. All fiber optic splices shall use the fusion process.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATIONS FIBER OPTIC OUTSIDE PLANT CABLE will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATIONS FIBER OPTIC OUTSIDE PLANT CABLE must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 15 13

COMMUNICATIONS COPPER HORIZONTAL CABLING

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 specification consists of furnishing and installing COMMUNICATIONS COPPER HORIZONTAL CABLING at the locations as shown on the Contract Drawings.

B. Provide all horizontal copper cabling, terminations, patch panels, and cross-connection materials as required to interconnect all communication systems between station communication devices and locations including but not limited to:

1. Main Station Communications Room
2. Northwest Platform Communications Hub
3. Southwest Platform Communications Hub
4. Northeast Platform Communications Hub
5. Southeast Platform Communications Hub

C. Communications Horizontal Copper Cabling for this rail station shall include the following types of cables and associated station communication devices:

1. Four-pair Category 6 UTP cable
    a. Station Area CCTV Cameras
    b. Station Area DMS
    c. Station Area Telephones
    d. Station Area Intrusion Detection Sensors
    e. Station Area Touchscreen Information Signs
    f. Station Area PA IP microphones
    g. Station Area SVT
    h. Station Area AFC
    i. Station Area Vending Machines (data circuits)
    j. Elevator Machine Room communication devices
2. Four-pair Category-6 UTP OSP cable
    a. Exterior Station Area CCTV Cameras
    b. Platform and Walkway CCTV Cameras
    c. Platform DMS
3. Four-pair Category-6 shielded cable

a. Platform WAP

b. Station WAP

4. One-pair #16AWG shielded audio cable

a. Station area PA Speakers

b. Platform PA Speakers

c. Stairway PA Speakers

5. Three-pair #22AWG shielded audio cable

a. Station area PA Noise Sensor

b. Platform PA Noise Sensor

c. Stairway PA Noise Sensor

6. One-pair #18AWG instrumentation cable

a. CCTV Camera power to hubs

b. WAP power to hubs

c. Door Contacts to ITC

d. Intrusion Detection Sensor power to hubs

e. Blue Light Strobe power to hubs

f. Blue Light Strobe data to HPT

7. 25-pair Category 5e UTP OSP cable

a. Copper interconnect between Communications Hubs/Room

1.03 RELATED WORK

A. COMMUNICATIONS COPPER HORIZONTAL CABLING specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 26 50 30 - Cable and Light Tray Enclosure
2. Section 27 00 10 – Communications General Provisions
3. Section 27 32 13 – Telephone Sets
4. Section 27 32 23 – Elevator Telephones
5. Section 27 32 26 – Help Point Telephones
6. Section 27 42 16 – Dynamic Message Signs
7. Section 28 16 19 – Intrusion Detection Sensors
8. Section 28 23 16 – Security Video Terminal
9. Section 28 23 31 – CCTV Cameras

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. AFC – Automated Fare Control
2. ANSI – American National Standards Institute

3. AWG – American Wire Gauge
4. BICSI – Building Industry Consulting Services International
5. CCTV – Closed Circuit Television
6. DMS – Dynamic Message Sign
7. EIA – Electronics Industry Association
8. HPT – Help Point Telephone
9. IEEE – Institute of Electrical and Electronics Engineers
10. IP – Internet Protocol
11. ITC – Interface Terminal Cabinet
12. PA – Public Address
13. OSP – Outside Plant Cable
14. SVT – Security Video Terminal
15. TIA – Telecommunications Industry Association
16. UL – Underwriters Laboratories
17. UTP – Unshielded Twisted Pair
18. WAP – Wireless Access Point

B. Reference Standards.

1. ANSI/TIA-568-C Commercial Building Telecommunications Wiring Standard
2. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
3. ANSI/TIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
4. ANSI/TIA-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
5. ANSI/TIA-758-A Customer-Owned Outside Plant Telecommunications Infrastructure Standard
6. ANSI/TIA-1179 Healthcare Facility Telecommunications Infrastructure Standard
7. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM), current edition

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 FOUR-PAIR CATEGORY 6 UTP CABLE

A. GENERAL:

1. Four-pair Category 6 UTP Cable shall be Belden 2412, Commscope 1070A, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:
    a. Cable Type: U/UTP (unshielded twisted pair)
    b. Number of Pairs: 4
    c. Conductor Gauge: 22-24 AWG
    d. Conductor Type: solid copper
    e. Pair Colors:
        1) White/Blue Stripe & Blue
        2) White/Orange Stripe & Orange
        3) White/Green Stripe & Green
        4) White/Brown Stripe & Brown
    f. Drain Wire: n/a
2. Electrical Specifications:
    a. ANSI/TIA Category: Category 6
    b. DC Resistance Unbalance, maximum: 5%
    c. DC Resistance, maximum: 8.0 ohms / 100 meters
    d. Mutual Capacitance: 5.6 nF / 100 meters @ 1kHz
    e. Nominal Velocity of Propagation (NVP): 70%
    f. Operating Frequency, minimum: 250 MHz
    g. Operating Voltage, maximum: 80 V
    h. Transmission Standards: ANSI/TIA-568-C.2

i. Safety Voltage Rating: 300V

j. Dielectric Strength, minimum: 1500VAC; 2500VDC

3. Construction:

a. Jacket Material: PVC

b. Conductor Material: bare copper

c. Insulation Material: polyolefin

d. Separator Material: polyolefin

4. Environmental Specifications:

a. Environmental Space: non-plenum

b. Flame Test Method: CMR

c. Operating Temperature: -20 degrees C to +60 degrees C

d. Installation Temperature: 0 degrees C to +60 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.230 inches

b. Jacket Thickness: 0.020 inches

c. Pulling Tension: 25 lbs

2.02 FOUR-PAIR CATEGORY 6 UTP OSP CABLE

A. GENERAL:

1. Four-pair Category 6 UTP OSP Cable shall be Belden OSPU, Commscope 1571A, Hitachi 30180-8, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: U/UTP (unshielded twisted pair)

b. Number of Pairs: 4

c. Conductor Gauge: 22-24 AWG

d. Conductor Type: solid copper

e. Pair Colors:

1) White/Blue Stripe & Blue

2) White/Orange Stripe & Orange

3) White/Green Stripe & Green

4) White/Brown Stripe & Brown

f. Drain Wire: n/a

2. Electrical Specifications:

a. ANSI/TIA Category: Category 6

b. DC Resistance Unbalance, nominal: 3-5%

c. DC Resistance, nominal: 9 ohms / 100 meters

d. Mutual Capacitance: 3.0-6.0 nF / 100 meters @ 1kHz

e. Nominal Velocity of Propagation (NVP), nominal: 65%

f. Operating Frequency, minimum: 250 MHz

g. Operating Voltage, maximum: 80 V

h. Transmission Standards: ANSI/TIA-568-C.2

i. Safety Voltage Rating: 300V

j. Dielectric Strength, minimum: 1500VAC; 2500VDC

3. Construction:

a. Jacket Material: medium density PE (polyethylene) or polyolefin

b. Conductor Material: bare copper

c. Insulation Material: polyolefin

d. Separator Material: polyolefin

e. Flooding Compound: gel-filled or water block tape

4. Environmental Specifications:

a. Environmental Space: outdoor; direct buried, aerial, conduit

b. Operating Temperature: -40 degrees C to +60 degrees C

c. Installation Temperature: 0 degrees C to +60 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.25 inches, nominal

b. Jacket Thickness: 0.020 inches

c. Pulling Tension: 25-35 lbs

2.03 FOUR-PAIR CATEGORY 6 SHIELDED CABLE

A. GENERAL:

1. Four-pair Category 6 F/UTP Cable shall be Belden 1351A, Commscope 1271B, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: F/UTP (foil shielded cable/unshielded twisted pair)

b. Number of Pairs: 4

c. Conductor Gauge: 22-24 AWG

d. Conductor Type: solid

e. Pair Colors:

1) White/Blue Stripe & Blue

2) White/Orange Stripe & Orange

3) White/Green Stripe & Green

4) White/Brown Stripe & Brown

f. Drain Wire: tinned copper

2. Electrical Specifications:
   a. ANSI/TIA Category: Category 6
   b. DC Resistance Unbalance, maximum: 5%
   c. DC Resistance, maximum: 9.38 ohms / 100 meters
   d. Mutual Capacitance: 5.6 nF / 100 meters @ 1kHz
   e. Nominal Velocity of Propagation (NVP): 68%
   f. Operating Frequency, minimum: 250 MHz
   g. Operating Voltage, maximum: 80 V
   h. Transmission Standards: ANSI/TIA-568-C.2
   i. Safety Voltage Rating: 300V
   j. Dielectric Strength, minimum: 1500VAC; 2500VDC
3. Construction:
   a. Jacket Material: PVC
   b. Conductor Material: bare copper
   c. Insulation Material: polyolefin
   d. Separator Material: polyolefin
   e. Shield Material: aluminum/poly
4. Environmental Specifications:
   a. Environmental Space: non-plenum
   b. Flame Test Method: CMR
   c. Operating Temperature: -20 degrees C to +60 degrees C
   d. Installation Temperature: 0 degrees C to +60 degrees C
5. Mechanical Specifications:
   a. Outer Jacket Diameter: 0.285 inches
   b. Jacket Thickness: 0.020 inches
   c. Pulling Tension: 25 lbs

2.04 ONE-PAIR SHIELDED AUDIO CABLE

A. GENERAL:
   1. One-pair Audio Cable shall be Belden 9316, or Engineer approved equivalent.

B. CABLE REQUIREMENTS
   1. General Specifications:
      a. Cable Type: shielded, 100%
      b. Number of Pairs: 1
      c. Conductor Gauge: 16 AWG

d. Conductor Type: stranded 19x29

e. Pair Colors:

1) Red conductor/Black conductor

f. Drain Wire: tinned copper, 19x30 stranded, 18AWG

2. Electrical Specifications:

a. Inductance, nominal: 0.16 uH/ft (0.52496 uH/m)

b. Capacitance, conductor to conductor, nominal: 68 pF/ft (223.108 pF/m)

c. Capacitance, conductor to other conductor and shield, nominal: 121 pF/ft (397.001 pF/m)

d. Conductor DC Resistance @ 20 degrees C, nominal: 4.2 ohms/1000ft (13.780 ohms/km)

e. Shield DC Resistance @ 20 degrees C, nominal: 5.70 ohms/1000ft (18.702 ohms/km)

f. Operating voltage, maximum: 300 V RMS

3. Construction:

a. Jacket Material: PVC, UV rated

b. Conductor Material: tinned copper, 19x29 stranded

c. Insulation Material: PVC

d. Shield Material: aluminum foil-polyester tape

4. Environmental Specifications:

a. Environmental Space: non-plenum

b. Flame Test Method: UL 1685-FT4; IEEE 1202

c. Operating Temperature: -30 degrees C to +105 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.256 inches

b. Jacket Thickness: 0.037 inches

c. Pulling Tension: 40 lbs

2.05 THREE-PAIR SHIELDED AUDIO CABLE

A. GENERAL:

1. Three-pair Audio Cable shall be Belden 8777, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: shielded, 100%

b. Number of Pairs: 3

c. Conductor Gauge: 22 AWG

d. Conductor Type: stranded 7x30

e. Pair Colors:

1) Black / Red

2) Black / White

3) Black / Green

f. Drain Wire: tinned copper, 7x30 stranded, 22 AWG

2. Electrical Specifications:

a. Characteristic Impedance, nominal: 50 ohms

b. Inductance, nominal: 0.18 uH/ft (0.59058 uH/m)

c. Capacitance, conductor to conductor, nominal: 30 pF/ft (98.43 pF/m)

d. Capacitance, conductor to other conductor and shield, nominal: 55 pF/ft (180.455 pF/m)

e. Nominal Velocity of Propagation (NVP): 66%

f. Conductor DC Resistance @ 20 degrees C, nominal: 15.0 ohms/1000ft (49.215 ohms/km)

g. Shield DC Resistance @ 20 degrees C, nominal: 10.6 ohms/1000ft (34.779 ohms/km)

h. Operating voltage, maximum: 300 V RMS

3. Construction:

a. Jacket Material: PVC

b. Conductor Material: tinned copper, 7x30 stranded

c. Insulation Material: polypropylene

d. Shield Material: aluminum foil – polyester tape

4. Environmental Specifications:

a. Environmental Space: non-plenum

b. Flame Test Method: UL 1685

c. Operating Temperature: -20 degrees C to +80 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.273 inches

b. Jacket Thickness: 0.034 inches

c. Pulling Tension: 79 lbs

2.06 ONE-PAIR INSTRUMENTATION CABLE

A. GENERAL:

1. One-pair Audio Cable shall be Belden 8208, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: shielded, 73%

b. Number of Pairs: 1

c. Conductor Gauge: 18 AWG

d. Conductor Type: stranded 16x30

e. Pair Colors:

1) Red conductor/White conductor

f. Drain Wire: n/a

2. Electrical Specifications:

a. Characteristic Impedance, nominal: 44 ohms

b. Inductance, nominal: 0.20 uH/ft (0.6562 uH/m)

c. Capacitance, conductor to conductor, nominal: 46 pF/ft (150.926 pF/m)

d. Capacitance, conductor to other conductor and shield, nominal: 77 pF/ft (252.637 pF/m)

e. Conductor DC Resistance @ 20 degrees C, nominal: 6.5 ohms/1000ft (21.33 ohms/km)

f. Operating voltage, maximum: 300 V RMS

3. Construction:

a. Jacket Material: PVC

b. Conductor Material: tinned copper, 16x30 stranded

c. Insulation Material: rubber

d. Separator Material: polyester tape

e. Shield Material: tinned copper braid

4. Environmental Specifications:

a. Environmental Space: non-plenum

b. Operating Temperature: -20 degrees C to +80 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.257 inches

b. Jacket Thickness: 0.025 inches

c. Pulling Tension: 69 lbs

2.07 TWENTY-FIVE (25)-PAIR CATEGORY 5E UTP OSP CABLE

A. GENERAL:

1. 25-pair Category 5e UTP OSP Cable shall be Superior Essex 51-499-EL, or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: U/UTP (unshielded twisted pair)

b. Number of Pairs: 25

c. Conductor Gauge: 24 AWG

d. Conductor Type: solid annealed copper

2. Electrical Specifications:

a. ANSI/TIA Category: Category 5e

b. DC Resistance Unbalance, nominal: 3-5%

c. DC Resistance, nominal: 9 ohms / 100 meters

d. Mutual Capacitance: 3.0-6.0 nF / 100 meters @ 1kHz

e. Nominal Velocity of Propagation (NVP), nominal: 69%

f. Operating Frequency, minimum: 200 MHz

g. Transmission Standards: ANSI/TIA-568-C.2

h. Safety Voltage Rating: 300V

3. Construction:

a. Jacket Material: CM rated, non-halogen OSP grade

b. Conductor Material: solid annealed copper

c. Insulation Material: thermoplastic

d. Separator Material: cylindrical, flame retardant thermoplastic

e. Flooding Compound: gel-filled or water block tape

4. Environmental Specifications:

a. Environmental Space: outdoor; direct buried, aerial, conduit

b. Operating Temperature: -40 degrees C to +60 degrees C

c. Installation Temperature: -20 degrees C to +60 degrees C

5. Mechanical Specifications:

a. Outer Jacket Diameter: 0.59 inches, nominal.

PART 3 - EXECUTION

3.01 GENERAL

A. All installation shall be done in conformance with ANSI/TIA/EIA-568-C standards, BICSI methods, industry standards and manufacturer's installation guidelines.

B. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

C. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

D. In the Communications Room, cables shall be combed and dressed with Velcro ties in a manner as to prevent twists, “braiding” and crossed cables in the cable bundle from the Communications Room entrance to the respective termination point. Behind patch panels,

the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.

3.02 HORIZONTAL CABLING INSTALLATION

A. The Contractor shall install Communications Copper Horizontal Cabling as required below:

1. Install all cabling following telecommunications industry best practices, techniques, and methods that are consistent with specified data cabling and manufacturer recommendations.
2. Install cabling in continuous lengths from station communications device outlet or demarcation point to specified patch panels and/or termination blocks.
3. Terminate horizontal cabling onto modular jacks, patch panels, or termination blocks without damaging twisted pairs or jacket.
4. Pull cabling in smooth and regular motions in methods to prevent cable kinking.
5. If necessary use approved cable pulling lubricant.
6. Keep all cabling jacks, terminal contacts, and patch panels protected before and after installation with dust and moisture proof barrier materials. If wiring is terminated on patch panels, data, voice jacks prior to painting and general finish clean up, the jacks shall be protected to ensure dust, debris, moisture, and other foreign material do not settle onto jack or terminal contacts. It shall be the Contractor's responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
7. Do not bind cabling tightly together with tie-wraps or other cable ties. Wraps shall slip loosely around cables. Use Velcro wraps instead of cable ties for all bundling in the Communications Room and Hubs.
8. Pull cabling simultaneously if more than one is being installed in the same raceway/pathway.
9. Use pulling means, including but not limited to fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.
10. Install open cabling parallel and perpendicular to surfaces or structural members following surface contours where possible.
11. Do not bend cable greater than a bend radius of 1.00 inch.
12. Cable bundles brought into the Communications Room shall be routed and dressed in such a manner that prior to termination, the cables are not subject to damage and misuse such as installers walking on the bundles that are lying on the floor. Cable pulling force shall not exceed 25 pounds of pulling tension or cable manufacturer's recommended pulling tensions.
13. Group all cabling, such as CCTV, DMS, Telephone, PA, Network, etc., with their respective groups, clearly labeled as to cable number and function, in the last positions on the horizontal cabling blocks in each Communications Room and Hubs.

3.03 IDENTIFICATION

A. The Contractor shall:

1. Label cable terminations on designation strips.

2. Label all cable at each terminating point.

3. Label each port of the work area outlet.

4. Cable identification numbers shall not be duplicated.

5. Labeling convention to be coordinated with CDOT and the CTA.

6. Label data patch panels and termination blocks in the Communications Room and Hubs to match those on the corresponding voice and data outlets. The font shall be at least .125-inch in height.

7. All labels shall correspond to as-built drawings and to final test reports.

8. Post the cable schedule in a prominent location in the Communications Room and each Hub. List incoming and outgoing cables and their designations, origins, and destinations.

9. Provide electronic copy of final comprehensive schedules for project in Microsoft Excel format.

3.04 HORIZONTAL CABLING TESTING

A. Contractor shall test each cable prior to acceptance.

B. Contractor shall supply all of the required test equipment used to conduct acceptance tests.

C. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.

D. Standards Compliance and Test Requirements:

1. Copper Cabling shall meet ANSI/TIA-568-C.2 Horizontal cabling requirements.

E. Cable test documentation shall be submitted in hard copy and electronic formats. If proprietary software is used, disk or CD shall contain any necessary software application required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., software to read these files is not required. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.

F. Copper: Test reports shall include the following information for each cabling element:

1. Wire map results that indicate that 100% of the cabling has been tested for shorts, opens, miss-wires, splits, polarity reversals, transpositions, presence of AC voltage and end-to-end connectivity.

2. Length, propagation delay, and delay skew relative to the relevant limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL.

3. For Category 6 cabling: Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate the worst case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards. Any individual test that fails the relevant

performance specification shall be marked as a FAIL. Test shall also include mutual capacitance and characteristic impedance.

4. Cable manufacturer, cable model number/type, and NVP.
5. Test equipment manufacturer, model, serial number, hardware version, software version and calibration certification.
6. Cable ID and project name

G. Date of test.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATIONS COPPER HORIZONTAL CABLING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATIONS COPPER HORIZONTAL must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 15 23

COMMUNICATIONS FIBER OPTIC HORIZONTAL CABLING

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 specification consists of furnishing and installing COMMUNICATIONS FIBER OPTIC HORIZONTAL CABLING at the locations as shown on the Contract Drawings.

B. Provide all horizontal fiber optic cabling, terminations, patch panels, and cross-connection materials as required to interconnect all communication systems between station communication devices and locations including but not limited to:

1. Main Station Communications Room
2. Northwest Platform Communications Hub
3. Southwest Platform Communications Hub
4. North Center Platform Communications Hub
5. South Center Platform Communications Hub
6. Northeast Platform Communications Hub
7. Southeast Platform Communications Hub

C. Communications Horizontal Fiber Optic Cabling for this rail station shall include the following types of cables and associated station communication devices:

1. Two-strand multimode zipcord fiber optic drop cable
    a. Station Area CA Kiosks
    b. Station Area AFC End Cabinets
    c. Equipment Rooms
    d. Elevator Machine Rooms
2. Six-strand multimode fiber optic interconnect cable
    a. North Station AFC End Cabinet
    b. South Station AFC HBG End Cabinet
3. Twelve-strand pre-terminated multimode fiber optic cable
    a. Communication Hubs / Room

D. The Twelve-strand Pre-terminated Multimode Fiber Optic Cable shall be a factory manufactured cable system of loose tube outdoor rated fiber optic cables with a multi-fiber, single connection at each end of the cable segments. Each pre-terminated end shall be a mass 12-fiber MT female optical connector in a sealed environmental mating mechanical

connector. The 12-fiber MT female connector shall interface to a corresponding 12-fiber MT male connector harness within a factory pre-connectorized SC optical connector housing.

1. The pre-terminated multimode cable system shall allow end-to-end cable installation and optical commissioning without onsite fiber strand splicing or onsite fiber strand connectorization.
2. The pre-terminated multimode cable system shall extend between each Communications Hub and adjacent Communications Hubs or Room, creating a physical 12-strand cable ring:
    a. From the Main Station Communications Room
    b. To Northwest Platform Communications Hub
    c. To North Center Platform Communications Hub
    d. To Northeast Platform Communications Hub
    e. To Southeast Platform Communications Hub
    f. To South Center Platform Communications Hub
    g. To Southwest Platform Communications Hub
    h. And back to Main Station Communications Room

1.03 RELATED WORK

A. COMMUNICATIONS FIBER OPTIC HORIZONTAL CABLING specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. AFC – Automated Fare Control
2. ANSI – American National Standards Institute
3. BICSI – Building Industry Consulting Services International
4. EIA – Electronics Industry Association
5. HBG – High Barrier Gate turnstile
6. IEEE – Institute of Electrical and Electronics Engineers
7. IDF – Intermediate Distribution Frame
8. OSP – Outside Plant Cable
9. TIA – Telecommunications Industry Association
10. UL – Underwriters Laboratories

B. Reference Standards.

1. NEC Article 770 OFNR
2. ISO / IEC 11801 Generic Cabling for Customer Premises
3. ANSI/TIA-568-C Commercial Building Telecommunications Wiring Standard

4. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
5. ANSI/TIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
6. ANSI/TIA-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
7. ANSI/TIA-758-A Customer-Owned Outside Plant Telecommunications Infrastructure Standard
8. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM), current edition

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The traning for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 TWO-STRAND MULTIMODE ZIPCORD FIBER OPTIC DROP CABLE

A. GENERAL:

1. Two-strand Multimode Fiber Optic Drop Cable shall be Corning Cable Systems 002T51-31131-24 or Engineer approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: tight buffered zipcord

b. Fiber Count (number of strands): 2

c. Fiber Category: 50 um multimode (OM2)

2. Optical Specifications:

a. Fiber Type: multimode

b. Fiber Core Diameter: 50 um

c. Fiber Cladding Diameter: 125 um

d. Tight Buffered Fiber Diameter: 900 um

e. Fiber Category: OM2

f. Wavelengths: 850 nm / 1300 nm

g. Maximum Attenuation: 2.8 dB/km @ 850 nm / 1.0 dB/km @ 1300 nm

h. Minimum Overfilled Launch (OFL) Bandwidth: 700 MHz*km @ 850 nm / 500 MHz*km @1300 nm

i. Minimum Effective Modal Bandwidth (EMB): 950 MHz*km @ 850 nm / n/a @ 1300 nm

j. Serial 1 Gigabit Ethernet: 750 m @850 nm / 600 m @ 1300 nm

k. Serial 10 Gigabit Ethernet: 150 m @ 850 nm / n/a @ 1300 nm

3. Construction:

a. Outer Jacket Material: flame-retardant

b. Outer Jacket Color: orange

c. Number of Subunits: 2

d. Tensile Strength Element: dielectric strength member

e. Tight Buffer Color: blue, white

4. Environmental Specifications:

a. Environmental Space: indoor, non-plenum

b. Flame Rating: riser (OFNR)

c. Operating Temperature: -20 degrees C to +70 degrees C

d. Storage Temperature: -40 degrees C to +70 degrees C

5. Mechanical Specifications:

a. Single Tube Diameter, nominal: 0.11 inches (2.8mm)

b. Outer Jacket Diameter, nominal: 0.11 inches x 0.22 inches (2.8mm x 5.6mm)

c. Minimum Bend Radius, Installation: 2 inches

d. Minimum Bend Radius, Operation: 0.55 inches

e. Short-term Tensile Strength, maximum: 50lbf (220N)

f. Long-term Tensile Strength, maximum: 15lbf (66N)

2.02 TWELVE-STRAND PRE-TERMINATED MULTIMODE FIBER OPTIC CABLE

A. GENERAL:

1. Twelve-strand Pre-terminated Multimode Fiber Optic Cable shall be Corning Cable Systems Opti-Tip M3M312TB4D1E500F-P or Authority approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:
    a. Pre-terminated cable segments shall be available in the following lengths:
        1) 100 feet
        2) 250 feet
        3) 500 feet
        4) 1,000 feet
    b. Cable Type: single loose tube, factory pre-terminated
    c. Connection Type: mass fiber MT female optical connector with environmentally sealed threaded connector
    d. Fiber Count (number of strands): 12
    e. Fiber Category: 50 um multimode (OM3)
    f. Fiber Colors: blue, orange, green, brown, slate, white, red, black, yellow, violet, rose, aqua
2. Optical Specifications:
    a. Fiber Type: multimode
    b. Fiber Core Diameter: 50 um
    c. Fiber Cladding Diameter: 125 um
    d. Fiber Category: OM3
    e. Wavelengths: 850 nm / 1300 nm
    f. Maximum Attenuation: 3.0 dB/km @ 850 nm / 1.0 dB/km @ 1300 nm
    g. Minimum Overfilled Launch (OFL) Bandwidth: 1500 MHz*km @ 850 nm / 500 MHz*km @1300 nm
    h. Minimum Effective Modal Bandwidth (EMB): 2000 MHz*km @ 850 nm / n/a @ 1300 nm
    i. Serial 1 Gigabit Ethernet: 1000 m @850 nm / 600 m @ 1300 nm
    j. Serial 10 Gigabit Ethernet: 300 m @ 850 nm / n/a @ 1300 nm
3. Cable Connection Specifications:
    a. Cable Connector: mass fiber MT female optical connector, 12 strand
    b. Cable Connector Length: 3.47 inches, female tip to end of boot; 3.29 inches male tip to end of boot; 6.72 inches, female-male mated pair
    c. Cable Connector Outer Diameter: 0.7 inches
    d. Mateability: pinned alignment, male to female connector;
    e. Standards: EIA/TIA 568-B.3; GR-3152; IP-69K; IP-68
    f. Tensile Strength: 100 lbf
    g. Insertion Loss: 0.65dB maximum per fiber, 0.35dB nominal
    h. Reflectance: <= -20dB

i. Durability: <0.3dB change over 200 rematings, FOTP-21

4. Construction:
   a. Outer Jacket Material: polyethylene
   b. Outer Jacket Color: black
   c. Number of Subunits: 1
   d. Tensile Strength Element: dielectric strength member
   e. Water Block: water-swellable fiberglass
   f. Tube Filling Compound: gel-filled
5. Environmental Specifications:
   a. Environmental Space: outdoor
   b. Application: self-supporting, duct
   c. Operating Temperature: -40 degrees C to +70 degrees C
   d. Installation Temperature: -30 degrees C to +70 degrees C
   e. Storage Temperature: -40 degrees C to +70 degrees C
6. Mechanical Specifications:
   a. Outer Jacket Diameter, nominal: 0.32 inches x 17 inches (8.1mm x 4.5mm)
   b. Buffer Tube Diameter: 0.12 inches (3mm)
   c. Minimum Bend Radius: 3.15 inches
   d. Short-Term Tensile Strength, maximum: 300 lbf (1350 N)
   e. Long-Term Tensile Strength, maximum: 90 lbf (400 N)
   f. Crush Strength, maximum: 125 lbf/in (220 N/cm)

C. CONNECTOR REQUIREMENTS

1. Communications Hub Connector Panel shall be Corning SPH-12OTS-12E7H, or Engineer approved equivalent:
   a. 12-fiber capacity single panel wall mountable housing
   b. Construction: black, metal housing; hinged access panel
   c. Dimensions: 6.5 inches H x 6.0 inches W x 1.5 inches D
   d. Premises Connectors:
      1) Six SC-type duplex adapters, 50um multimode, OM3
      2) Standards: EIA/TIA 568-B.3; FOCIS-TIA/EIA-604-3
      3) Tensile Strength: <=0.2dB change, 15lbf; FOTP-6
      4) Insertion Loss: 0.5dB maximum per fiber, 0.2dB nominal
      5) Reflectance: <= -20dB
      6) Durability: <0.2dB change over 500 rematings, FOTP-21
   e. Field Cable Connector:
      1) One integrated mass fiber MT male optical connector, 12 strand; internal harness to SC adapters

2) Field Cable Mateability: pinned alignment

3) Standards: EIA/TIA 568-B.3; GR-3152; IP-69K; IP-68

4) Tensile Strength: 100 lbf

5) Insertion Loss: 0.65dB maximum per fiber, 0.35dB nominal

6) Reflectance: <= -20dB

7) Durability: <0.3dB change over 200 rematings, FOTP-21

2. Communications Room Connector Panel shall be Corning CC1-24OTS-24E7H, or Engineer approved equivalent:

a. 24-fiber capacity 1U panel rack mountable housing

b. Construction: black, metal housing

c. Dimensions: 1.75 inches H x 17.9 inches W x 9.7 inches D

d. Premises Connectors:

1) Twelve SC-type duplex adapters, 50um multimode, OM3

2) Standards: EIA/TIA 568-B.3; FOCIS-TIA/EIA-604-3

3) Tensile Strength: <=0.2dB change, 15lbf; FOTP-6

4) Insertion Loss: 0.5dB maximum per fiber, 0.2dB nominal

5) Reflectance: <= -20dB

6) Durability: <0.2dB change over 500 rematings, FOTP-21

e. Field Cable Connector:

1) Two integrated mass fiber MT male optical connectors, 12 strand; internal harness to SC adapters

2) Field Cable Mateability: pinned alignment

3) Standards: EIA/TIA 568-B.3; GR-3152; IP-69K; IP-68

4) Tensile Strength: 100 lbf

5) Insertion Loss: 0.65dB maximum per fiber, 0.35dB nominal

6) Reflectance: <= -20dB

7) Durability: <0.3dB change over 200 rematings, FOTP-21

2.03 SIX-STRAND MULTIMODE FIBER OPTIC INTERCONNECT CABLE

A. GENERAL:

1. Six-strand Multimode Fiber Optic Interconnect Cable shall be Corning Cable Systems FREEDM One 006T8F-31131-29 or Authority approved equivalent.

B. CABLE REQUIREMENTS

1. General Specifications:

a. Cable Type: tight buffered

b. Fiber Count (number of strands): 6

c. Fiber Category: 50 um multimode (OM2)

2. Optical Specifications:
    a. Fiber Type: multimode
    b. Fiber Core Diameter: 50 um
    c. Fiber Cladding Diameter: 125 um
    d. Tight Buffered Fiber Diameter: 900 um
    e. Fiber Category: OM2
    f. Wavelengths: 850 nm / 1300 nm
    g. Maximum Attenuation: 3.0 dB/km @ 850 nm / 1.0 dB/km @ 1300 nm
    h. Minimum Overfilled Launch (OFL) Bandwidth: 700 MHz*km @ 850 nm / 500 MHz*km @1300 nm
    i. Minimum Effective Modal Bandwidth (EMB): 950 MHz*km @ 850 nm / n/a @ 1300 nm
    j. Serial 1 Gigabit Ethernet: 750 m @850 nm / 600 m @ 1300 nm
    k. Serial 10 Gigabit Ethernet: 150 m @ 850 nm / n/a @ 1300 nm
3. Construction:
    a. Outer Jacket Material: flame-retardant, UV resistant
    b. Outer Jacket Color: black
    c. Number of Subunits: 6
    d. Tensile Strength Element: water-swellable strength member
    e. Tight Buffer Color: blue, white
4. Environmental Specifications:
    a. Environmental Space: indoor/outdoor
    b. Application: aerial, direct-buried, duct
    c. Flame Rating: riser (OFNR)
    d. Operating Temperature: -40 degrees C to +70 degrees C
    e. Installation Temperature: -10 degrees C to +60 degrees C
    f. Storage Temperature: -40 degrees C to +70 degrees C
5. Mechanical Specifications:
    a. Outer Jacket Diameter, nominal: 0.22 inches (5.6mm)
    b. Minimum Bend Radius, Installation: 3.2 inches
    c. Minimum Bend Radius, Operation: 1.1 inches
    d. Short-term Tensile Strength, maximum: 150 lbf (675N)
    e. Long-term Tensile Strength, maximum: 45 lbf (200N)

PART 3 - EXECUTION

3.01 GENERAL

A. All installation shall be done in conformance with ANSI/TIA/EIA-568-C standards, BICSI methods, industry standards and manufacturer's installation guidelines.

B. The Contractor shall ensure that the maximum pulling tensions of the specified cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities.

C. Failure to follow the appropriate guidelines shall require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.

D. In the Communications Room, cables shall be combed and dressed with Velcro ties in a manner as to prevent twists, “braiding” and crossed cables in the cable bundle from the Communications Room entrance to the respective termination point. Behind patch panels, the cable bundle shall be attached to the rear cable support bar, and shall drop out each cable in a neat, cascading manner to prevent crossed and/or interwoven cables to each patch panel port termination point.

3.02 HORIZONTAL CABLING INSTALLATION

A. The Contractor shall install Communications Fiber Optic Horizontal Cabling as required below:

1. Install all cabling following telecommunications industry best practices, techniques, and methods that are consistent with specified data cabling and manufacturer recommendations.
2. Install cabling in continuous lengths from station communications device outlet or demarcation point to specified termination panels.
3. Terminate horizontal cabling onto termination panels without damaging fiber strands or jacket.
4. Pull cabling in smooth and regular motions in methods to prevent cable kinking.
5. If necessary use approved cable pulling lubricant.
6. Keep all cabling termination connectors and patch panels protected before and after installation with dust and moisture proof barrier materials. If cabling is terminated on patch panels prior to painting and general finish clean up, the connectors shall be protected to ensure dust, debris, moisture, and other foreign material do not settle into the connectors. It shall be the Contractor’s responsibility to ensure the integrity of these protective measures throughout the life/installation of the project.
7. Do not bind cabling tightly together with tie-wraps or other cable ties. Wraps shall slip loosely around cables. Use Velcro wraps instead of cable ties for all bundling in the Communications Room and Hubs.
8. Pull cabling simultaneously if more than one is being installed in the same raceway/pathway.
9. Use pulling means, including but not limited to fish tape, cable, rope, and basket weave wire/cable grips that will not damage media or raceway.
10. Install open cabling parallel and perpendicular to surfaces or structural members following surface contours where possible.
11. Do not bend cable greater than a bend radius of 1.00 inch.

12. Cable bundles brought into the Communications Room shall be routed and dressed in such a manner that prior to termination, the cables are not subject to damage and misuse such as installers walking on the bundles that are lying on the floor. Cable pulling force shall not exceed 25 pounds of pulling tension or cable manufacturer's recommended pulling tensions.

13. Group all cabling, such as CCTV, DMS, Telephone, PA, Network, etc., with their respective groups, clearly labeled as to cable number and function, in the last positions on the horizontal cabling blocks in each Communications Room and Hubs.

3.03 IDENTIFICATION

A. The Contractor shall:

1. Label cable terminations on designation strips.
2. Label all cable at each terminating point.
3. Label each port of the work area outlet.
4. Cable identification numbers shall not be duplicated.
5. Labeling convention to be coordinated with CDOT and the CTA.
6. Label fiber patch panels in the Communications Room and Hubs to match those on the corresponding fiber outlets. The font shall be at least .125-inch in height.
7. All labels shall correspond to as-built drawings and to final test reports.
8. Post the cable schedule in a prominent location in the Communications Room and each Hub. List incoming and outgoing cables and their designations, origins, and destinations.
9. Provide electronic copy of final comprehensive schedules for project in Microsoft Excel format.

3.04 HORIZONTAL CABLING TESTING

A. Contractor shall test each cable prior to acceptance.

B. Contractor shall supply all of the required test equipment used to conduct acceptance tests.

C. Contractor shall submit acceptance documentation as defined below. No cabling installation is considered complete until test results have been completed, submitted and approved.

D. Standards Compliance and Test Requirements:

1. Optical Cabling shall meet ANSI/TIA-568-C.2 Horizontal cabling requirements.

E. Cable test documentation shall be submitted in hard copy and electronic formats. If proprietary software is used, disk or CD shall contain any necessary software application required to view test results. If the results are delivered in a standard format like Excel, Access, CSV files, etc., software to read these files is not required. Electronic reports shall be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report. Certificate shall reference traceable circuit numbers that match the electronic record.

F. Optical Test reports shall include the following information for each cabling element:

1. Power Meter and Source Loss Reports: Testing shall consist of a bi-directional, dual wave length end to end test. The system loss measurements shall be provided at 850 and 1300 nanometers for multi-mode fibers and 1310 and 1550 for single mode fibers.
2. Optical Time Domain Reflectometer (OTDR) Reports: Testing shall consist of a bi-directional end to end OTDR trace performed per TIA/EIA 455-61. The system loss measurements shall be provided at 850 and 1300 nanometers for multi-mode fibers and 1310 and 1550 for single mode fibers.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATIONS FIBER OPTIC HORIZONTAL CABLING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATIONS FIBER OPTIC HORIZONTAL CABLING must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 21 10

COMMUNICATIONS BACKBONE NETWORK

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 specification consists of furnishing and installing COMMUNICATIONS BACKBONE NETWORK at the locations as shown on the Contract Drawings.

B. The work of this Section shall consist of the furnishing, installing, and testing of a fiber optic and copper backbone network complete with optical transmission equipment, network management system interface, equipment racks, hardware and software, all as required for a fully operational system that provides all the features and functions identified herein and shown on the Contract Drawings.

C. The communications system shall accommodate present and future data, voice and video transmission requirements between the Authority’s or Chicago Transit Authority (CTA) facilities connected to right-of-way (ROW) within this Contract's geographic limits.

D. The Backbone Network is based upon a SONET OC-48 ring architecture, with SONET OC-48 sub-rings interconnected to host OC-48 nodes. The rail station fiber node and corresponding host node at the CTA’s Control Center under this contract shall be OC-48 nodes.

E. The Work of this section shall consist of the furnishing, installing, and testing of a Backbone Network for the station node and the Authority’s Control Center, complete with optical transmission equipment, Ethernet switch, network management system interface, channel banks, power supplies, digital access and cross-connect switch interface, test equipment, hardware and software, all as required for a fully operational system that provides all the features and functions identified herein and shown on the Contract Drawings.

F. The Backbone Network shall accommodate present and future data, voice and video transmission requirements between the Authority’s facilities connected to right-of-way (ROW) within this Contract's geographic limits.

G. The Fiber Optic Transmission System is based upon a SONET OC-48 ring architecture, with SONET OC-48 sub-rings interconnected to host OC-48 nodes. The rail station optical node under this contract shall be an OC-48 node.

H. The Contractor shall provide a complete SONET OC-48 optical node at the station node and the Authority’s Control Center.

I. The Contractor shall provide the necessary optical connections between the fiber optic transmission system equipment and the fiber optic outside plant, both at the station node and the Authority's Control Center at 120 N. Racine.

J. The CTA has an existing fiber optic backbone communication system, of which designated rail station nodes shall be integrated. All materials, components, equipment, installation techniques and tools shall comply with current CTA requirements and shall be 100% compatible and interchangeable with the existing CTA fiber optic backbone communication system. The existing SONET system on the Green Line is Alactel-Lucent DMXtend series.

K. The Contractor shall be responsible for providing complete and operational optical links as required to transport the optical signals to the Authority's Control Center. The complete link, including portions of existing cable or cable installed by others, shall be measured and tested for optical performance and loss by the Contractor. The Contractor shall notify the Engineer immediately if any optical link measures below the necessary optical link budget to transport the optical transmission equipment, specified elsewhere.

L. All DS-1 signals transported on the OC-48 rings shall be "dropped" at the respective OC-48 host multiplexer location and input to the DACS for DS-0 grooming. The groomed DS-1 signals shall be input back into the network for transport to the designated existing PBX for telephone circuits or to the Control Center for non-telephone circuits.

M. The Work of this section shall also consist of the furnishing, installing, and testing of the Copper Transmission System portion of the Communication System complete with channel banks, power supplies, digital access and cross-connect switch and interface, network management system interface, equipment racks, copper twisted pair cable, conduit, hardware and software, all as required for a fully operational system that provides all the features and functions identified herein and shown on the Drawings.

N. The Copper Transmission System is based upon digital channel bank architecture. Voice and data circuits at each RT station are transported to intended destinations as DS-0 channels, unless noted otherwise. DS-0 channels are multiplexed via channel banks into DS-1 data streams (24 DS-0). The DS-1 data streams are then routed to one of eight Digital Access and Cross-connect Switches (DACS).

O. The DACS shall accept the DS-1 signals from each RT station, containing mixed circuits, and "groom" or filter out the common DS-0 channels. The DACS shall then repackage the common DS-0 channels into new DS-1 signals for transport to a final destination.

P. All telephone circuits at the station node shall be routed to the South Unit PBX, groomed at the South Unit DACS, and repackaged into new DS-1's to be input into the South Unit PBX at a DS-1 rate. The South Unit PBX is an Avaya PBX at the Roosevelt/Wabash Core Node.

Q. All public address circuits shall be IP dedicated channels from the station node to the Control Center location. The PA programming shall be provided to perform digital audio and control to create public address channels to be routed to the Audio/Visual Paging System, as specified elsewhere.

R. Each SCADA RTU communication circuit from the station node shall be a dedicated IP channel from the RTU to the Control Center. The SCADA RTU shall include an internal IP communications ethernet port, interfaced to the backbone ethernet switch, and routed to the CTA's Control Center SCADA master server over the OC-48 network.

S. In addition to the channel requirements identified in the Drawings, the Contractor shall provide 30% spare channel capacity equipped for each function within each channel bank and each DACS.

1.03 RELATED WORK

A. COMMUNICATIONS BACKBONE NETWORK specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. OC-48 – Optical Carrier rate 48; (2.5 Gbps)
2. SONET – Synchronous Optical NETwork

B. Publications.

1. CB-119, Interconnection Specification for Digital Cross-Connects
2. TA-NPL-000436, Digital Synchronization Network Plan
3. TA-NWT-000253, SONET Transport System: Common Generic Criteria
4. TR-EOP-000063, Network Equipment Building System (NEBS) Generic Equipment Requirements
5. TR-TSY-000009, Asynchronous Digital Multiplexers Requirements and Objectives
6. TR-TSY-000020, Generic Requirement for Optical Fiber and Optical Fiber Cables
7. TR-TSY-000170, Digital Cross-Connect System Requirements and Objectives
8. TR-TSY-000179, Software Quality Program Generic Requirements (SQPR)
9. TR-TSY-00233, Wideband and Broadband Digital Cross Connect System Generic Requirements
10. TR-TSY-000496, SONET Add-Drop Multiplex Equipment (SONET ADM); Generic Criteria for a Unidirectional, Path Protection Switched, Self Healing Ring Implementation
11. TR-TSY-000499, Transport Systems Generic Requirements: Common Requirements.

C. Reference Standards.

1. T1.102, North American Electrical Digital Hierarchy
2. T1.105, SONET Digital Hierarchy Optical Interface Standard
3. T1.106, Digital Hierarchy Optical Interface, Singlemode
4. T1.403, Telecommunications Carrier to Customer Installation - DS-1 Metallic Interface
5. ANSI/EIA-472, Generic Specification of Fiber Optic Cables
6. ANSI/EIA-472A, Sectional Specification for Fiber Optic Communication Cable for Outside Aerial Use.
7. Military Standard 285
8. Military Standard MIL-M-9868D.

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. General: The Contractor shall submit the following items as specified herein:

1. All submittals as required in Section 27 00 10 of this Specification.
2. Single line block and system diagrams detailing the entire fiber optic backbone communications system.
    a. A block diagram shall be submitted showing interconnection between major independent elements, such as fiber optic cable, optical patch cord, fiber optic multiplexer, channel bank and distribution frames.

C. Procedure: The Contractor shall submit complete original sets (photocopies of printed material are not acceptable) of the following to the CTA for approval prior to ordering any of the equipment specified in this Section. The Contractor shall provide seven (7) copies of product literature/catalog cuts; six (6) copies of shop drawings; and three (3) copies of samples.

1. Proposed Manufacturer's detailed product data "cut-sheets" and specifications for each piece of equipment to be furnished.
2. Installation details of fiber optic cable, and all communications equipment.
3. Schematic diagrams of the individual Major and Minor loops.
4. Equipment layouts of all nodes.
5. Wiring diagrams of distribution frames, equipment racks, and the fiber optic cable.
6. A complete plan, including a syllabus, as outlined elsewhere in this Section, for providing up to twelve (12) CTA technicians with five (5) days of training in operations and maintenance of the equipment supplied under this Section.
7. Detailed testing procedures and certified copies of all test results and reports.
8. All shop drawings as detailed herein.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 SONET OC-48 ADD-DROP FIBER OPTIC MULTIPLEXERS

A. This item shall govern the furnishing and installation of SONET MSP (Multi Service Platform) OC-48/192 Digital Lightwave Multiplexers at designated locations as illustrated on the plans and as detailed in accordance with these specifications. The term Multi Service Platform (MSP) shall mean that the system supports a wide array of wideband and broadband transport, including traditional SONET transport of DS1, DS3, EC-1, OC-3, OC-12, OC-48, and OC-192 signals, as well as 10/100/1000 Mb/s LAN transport.

B. The equipment shall operate at the OC-48 or OC-192 line rate and shall be upgradeable, in-service, from OC-48 to OC-192 within the same shelf. Additionally, the equipment shall be provisionable to a bidirectional line switched ring (BLSR) at the OC-48 line rate, meeting TELCORDIA GR-1230-CORE standards. The equipment shall be capable of OC-48, OC-12, OC-3, DS-3, EC-1, DS1, 100BASE-TX and 1000BASE-LX/SX interfaces on the low speed side. The equipment proposed shall be in compliance with all applicable ANSI and IEEE standards. All equipment proposed is to be of the bidder's latest generation and technology.

C. The SONET OC-48 fiber optic multiplexers furnished under this Contract shall be configured into a network of two fibers unidirectional, path protection switched, and self-healing rings meeting TELCORDIA GR-1400-CORE standards. All components shall be expandable to provide full functionality over and above the requirements specified herein.

D. Each OC-48/192 Ring MSP shall conform to NEBS (GR-63-CORE Issue 1, including compliance to NEBS Level 3) specifying equipment physical design standards for central offices including earthquake and vibration requirements. The equipment shall be modular such that major portions can be readily replaced or upgraded in the field.

E. Modules of unlike functions shall be mechanically keyed to prevent insertion into the wrong socket or connector. All modules and assemblies shall be clearly identified with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance. Multiplexers shall have primary and redundant power feeds.

F. All external connections shall be made by means of connectors attached to a wiring harness or cable. The connectors shall be keyed to preclude improper hookups. All appropriate connectors, cable harnesses, and accessories shall be provided with the equipment.

G. The Multiplexer shall have the following additional physical design characteristics:

1. All architectures for the OC-48/192 MSP Multiplexer shall be configurable by circuit pack and software changes within the basic equipment shelf.

2. The OC-48/192 MSP Multiplexer shall be capable of terminating all service tributaries (DS3 and higher) if required at a ring node thereby providing 48 DS3 or 48 EC-1 (protected) signal interfaces. The initial shelf shall have the capability, at a later date, to terminate all 192 (protected) DS3 signal interfaces. For DS1 interfaces, the OC-48/192 MSP shall be capable of terminating at least 112 DS1s (protected), and a future capability of termination of up to 224 DS1s (protected).

3. The Multiplexer shall permit a mix of DS1, DS3, EC-1, OC-3, OC-12, OC-48, 100BASE-TX and 1000BASE-LX/SX circuit pack types on the low speed side.

4. Power converters shall be distributed and located on each individual circuit pack for improved heat dissipation and reliability.

5. The Multiplexer shall have primary and redundant power feeds.

6. The Multiplexer physical design shall support up to 4 OC-48/192 MSP Multiplexers mounted in a single 7-foot equipment bay.

7. All external connections shall be made by means of connectors attached to a wiring harness or cable. The connectors shall be keyed to preclude improper hookups.

H. The Multiplexer shall have the capability to multiplex a combination of OC-48, OC-12, OC-3, EC-1, DS-3, DS1, 100BASE-TX and 1000BASE-LX/SX signals from independent sources into a single OC-48/192 bit stream. The system shall convert the OC-48/192 bit stream into a 1310nm or 1550nm wavelength for transmission over single mode optical fibers. Each OC-48/192 Ring MSP shall be capable of remote assignment of timeslots with a granularity of STS-1 and VT1.5, and remote provisioning of that bandwidth to appropriate low speed interfaces at the remote node. Specifically, the MSP Multiplexer shall have the following Add / Drop ring capabilities:

1. An Internal Cross Connect shall be provided on the OC-48/192 MSP Multiplexer that can:

   a. add/drop up to 48 STS-1s from the OC-48 payload.

   b. add/drop up to 192 STS-1s from the OC-192 payload

   c. add/drop a single STS-1 without having to add/drop additional STS-1s at that site.

   d. add/drop individual STS-1s from any timeslot across the entire OC-48/192 payload.

   e. add/drop individual VT1.5s from up to 48 STS-1s within the OC-48/192 payload.

   f. Allow the following cross-connect types: VT1.5, STS-1, STS-3c, STS-12c and STS-48c.

   g. Allow the following cross-connects:

      1) Add/drop – UPSR, dual 0 x 1, single 0 x 1

      2) Pass-through

      3) Pass-through hairpin (VT ring closure): (The MSP shall allow multiple rings on the low-speed interfaces. The MSP shall close a low-speed ring by supporting a cross-connection between a receive port on one circuit pack and a transmit port on another circuit pack.)

      4) SONET hairpinning

      5) Ethernet multi-point

      6) Ethernet hairpinning

2. The OC-48/192 MSP Multiplexer shall also support low-speed OC-3, OC-12 and OC-48 connections that support the following hairpin cross-connects:

   a. The OC-3 low-speed shall support VT1.5, STS-1 and STS-3c for 1+1, 0 x 1 and UPSR.

   b. The OC-12 low-speed shall support VT1.5, STS-1, STS-3c and STS-12c for 1+1, 0 x 1 and UPSR.

   c. The OC-48 low-speed shall support VT1.5, STS-1, STS-3c, STS-12c and

STS-48c for 1+1, 0 x 1 and UPSR.

3. To provide more system flexibility and higher system capacity, all low-speed OC-3, OC-12 and OC-48 interface circuit packs shall have their own STS and VT switch matrix.

I. Optical interface specifications shall meet the requirements of the SONET rates and formats specifications defined by GR-253-CORE, Issue 3. Additional requirements for the optical interfaces are stated below:

1. All SONET transmitters shall meet Class I FDA Classification.
2. All SONET interfaces shall monitor the following parameters:
   a. LOF
   b. LOS
   c. LOP
   d. AIS-L
   e. RDI-L (FERF)
   f. Path AIS
   g. Path Unequipped
   h. Signal Degrade (BER)
   i. Signal Fail (BER)
3. For uniformity, all optical connections shall be done through Faceplate LC optical connectors.
4. Minimum port density for the OC-3 low-speed shall be 4 ports/circuit packs.
5. Minimum port density for the OC-12 low-speed shall be 2 ports/circuit packs.
6. For applications where fiber is limited, the vendor shall offer integrated, high-speed optics that are compatible with Passive Wave Division Multiplex filters. At least 32 wavelengths shall be offered.

J. Each multiplexer shall be suitable for mounting within a standard EIA 19" equipment rack.

K. Environmental

1. Multiplexers shall be suitable for installation in enclosed cabinets. Thermostatically controlled forced air ventilation shall be provided to maintain the operating temperature of the multiplexers within Manufacturer's Specifications throughout its normal service life under the following conditions, unless otherwise noted on the Contract Drawings:
   a. Temperature Range: -40 to + 65 ^{0}C (-40 to 149^{0}F)
   b. Humidity: 5 to 95%, non-condensing

L. Power

1. Multiplexers shall be powered from a 120VAC UPS. The MSP shall be provided with a -48 VDC power supply if required.

M. Operations, Administration, Maintenance and Provisioning (OAM&P)

1. Minimum Network Management

a. The system shall provide single ended access to integrated operations, administration, maintenance, and provisioning (OAM&P) functions using industry standard interfaces. Access to all nodes from any node in the system (via the SONET overhead) for all OAM&P functions is required. All SONET fiber extensions from the low speed side of the OC-48/192 MSP Multiplexer shall support SONET Data Communications Channel (DCC) connectivity.

b. The system shall use a three-tiered operations approach.

1) Tier 1 shall provide faceplate LEDs and Pushbuttons and provide for routine operations and maintenance.

2) Tier 2 shall provide a graphical user interface and provide for enhanced maintenance and provisioning.

3) Tier 3 shall provide OS Access and provide for remote maintenance and provisioning including alarm surveillance.

2. System Security

a. The MSP Multiplexer shall offer security against unauthorized access to the system functions by providing the following features:

1) There shall be a minimum of 4 user types.

2) The system shall allow provision-able password aging.

3) The system shall provide at least 150 user login IDs.

4) To help secure unattended or inactive sessions, the RS-232 serial port shall provide a provisionable inactivity timeout.

3. Minimum Alarm Requirements

a. Each node shall provide a local visual indication of major alarms. LEDs shall be provided on individual modules to help isolate the exact source of a trouble. The minimum alarms are as follows:

1) “A” Power Feed Failure

2) “B” Power Feed Failure

3) Critical Alarm

4) Major Alarm

5) Minor Alarm

6) Abnormal Condition

7) Near-End Activity

8) Far-End Activity

9) Circuit Pack Failure

4. Software Upgrades

a. The system shall provide an in-service software installation capability to update the generic program in local and remote systems. Upgrades shall be distributed on CD-ROMs containing the new software and an installation program. All software upgrades shall be “in-service” and not affect any provisionable parameters. For example, cross-connections shall be left unchanged by the software upgrade. To minimize down time, the software download shall take place in two stages.

1) In the first stage, the new generic software shall be downloaded into a dormant area as a compressed file.

2) In the second stage, the new generic shall be uncompressed and moved into an active space. During this process, the old release continues to run.

5. Single-Ended Maintenance and Control

   a. The MSP Multiplexer shall provide a sophisticated PC-based *user interface terminal* for message-based operations by experienced personnel.

   b. The *user interface terminal* shall permit a user to perform sophisticated system operations and access and control all MSP Multiplexers on the ring from a single location. This location shall be co-located with a ring node or optionally located at a remote control center not on the ring. A user friendly screen and associated reports shall support provisioning and monitoring activities from the central location.

   c. A Microsoft Windows-based Graphical User Interface (GUI) shall be provided on a PC to facilitate alarm collection, network provisioning, and equipment provisioning.

   d. The MSP Multiplexer shall be capable of remote software downloads of new system software to all MSP Multiplexers on the ring from a single location.

6. Commitment to the Embedded Base and Multi-Vendor Interworking:

   a. The MSP Multiplexer shall be capable of being installed with a protocol on the SONET Section DCC that permits interworking with the embedded base of that vendors equipment. Interworking shall be supported between OC-1, OC-3, OC-12, and OC-48 Multiplexers provided by that vender.

   b. In support of multi-vender interworking, the MSP Multiplexer shall implement the TID Address Resolution Protocol (TARP). TARP provides NSAP-TID translations and is the established multi-vendor standard for SONET NEs that support TL1 OS interfaces. The system shall support the TARP Data Cache (TDC) function to reduce the frequency of TARP propagation throughout the subnetwork and to improve performance.

   c. In addition, the MSP Multiplexer shall support TARP Manual Adjacency feature to enables it to operate in networks that include CMISE-based NEs which may not support TARP propagation. The system shall support user provisioning of several OSI parameters to allow users to adjust their operations network, if necessary. For example, to support Level 2 Routing in large networks, the system shall support user provisioning of NSAP area addresses and Level 2 Intermediate System (IS) functionality.

   d. The vendor shall provide examples of tests and demonstrations of multi-vender interworking.

7. Other Operations and Maintenance Requirements

   a. The Multiplexer operations interface shall use Transaction Level 1 (TL-1) messages over an X.25 interface or TL-1 over TCP/IP (or OSI).

   b. For TL1 over TCP/IP LAN the system shall comply with requirements specified in IEEE 802.3 and NSIF-AR-9806-088R11.

   c. Maintenance signaling shall include Alarm Indication Signals (AIS) and Remote Defect Indicator (RDI). Maintenance signaling shall be compliant with SONET (Telcordia Technologies GR-253) and asynchronous

(Telcordia Technologies TR-TSY- 000191) network requirements. Alarm indication signals shall include SONET line AIS, STS-1 path AIS, virtual tributary (VT) path AIS, DS3 AIS, and DS1 AIS. Remote defect indication signals shall include STS-1 path RDI and VT path RDI. Other maintenance signals shall include STS-1 path unequipped, and VT path unequipped.

d. A warning message shall be issued to the user for all service-affecting commands.

e. The MSP Multiplexer shall provide an office alarm interface via relay closures.

f. The MSP Multiplexer shall provide user-settable miscellaneous discrete interface to allow an operations system (OS) to control and monitor equipment collocated with the system through a set of input and output contact closures. Miscellaneous discrete environmental inputs can monitor conditions like open doors or high temperature, miscellaneous discrete outputs control equipment such as fans and generators. The status of the miscellaneous discrete environmental inputs shall be queried on demand via the Craft Interface Terminal. The system shall collect miscellaneous discrete alarms and automatically sends them to the operations system (OS). The system shall offer at least 18 miscellaneous discrete inputs and 4 miscellaneous discrete outputs.

g. The MSP Multiplexer shall provide full SONET performance monitoring information.

h. The MSP Multiplexer shall implement remote interface circuit pack auto-provisioning, whereby the circuit pack memories are updated automatically on the new circuit packs when failed circuit packs are replaced

i. The MSP Multiplexer shall implement remote processor auto-provisioning, whereby a new processor's memories are automatically updated with the parameters of all interface circuit packs when a failed processor is replaced.

j. The MSP Multiplexer shall provide built in test signal generation such that no external test equipment or terminal is needed for routine installation, turn-up, or repair.

k. The MSP Multiplexers shall have no periodic maintenance requirements.

l. The basic software for the MSP Multiplexer shall include the following maintenance and operations capabilities:

1) local alarms
2) local protection switching
3) local diagnostics
4) single ended operations
5) telemetry
6) loopbacks
7) software download
8) signal monitoring (LOS, threshold crossing alerts, etc.)
9) inventory reports
10) signal monitoring provisioning

11) maintenance history

N. The typical configuration for each node shall be as follows, however it is not limited to all components, materials, and labor to provide a complete and operational optical multiplexer system under this contract:

1. (1) multi-access SONET chassis
2. (1) external rack-mount, dual 120 VAC to –48 VDC power supply
3. (2) OC-48 one-port high speed line interface units, intermediate reach
4. (1) CPU – system controller unit
5. (2) 4-port Gigabit Ethernet/4-port Fast Ethernet card with sfp's
6. (2) 16 port DS-1 cards, working and protected

O. The OC-48 multiplexers provided under this Contract shall be of the same manufacturer, and shall be 100% compatible and interchangeable with the existing Alcatel/Lucent DMX/DMXtend SONET system. The OC-48 multiplexer shall be Alcatel/Lucent model DMXtend, or Engineer approved equivalent.

2.02 DIGITAL CHANNEL BANKS

A. The Contractor shall furnish and install D4 compatible PCM channel banks at the locations shown on the Drawings. The channel banks shall be fully compatible with ANSI/EIA Standard T1.102 format signal at the DS-1 level.

B. The digital channel banks shall be an integrated access multiplexer/demultiplexer.

1. As multiplexers, they shall accept as input DS-0 level voice frequency and digital data signals (9.6 kb/s to 56 kb/s) and shall perform sampling, quantizing and coding of the signal into a multiplexed Pulse Code Modulation (PCM) DS-1 level signal into an adjacent DSX jackfield. DS-1 level signals shall operate at 1.544 Mb/s and shall be compliant with Bellcore specifications (PUB 43801).
2. As demultiplexers, they shall accept a DS-1 level signal and shall output DS-0 level voice frequency and digital data signals.
3. The multiplexer shall be capable of utilizing and combining any combination of multiple DS-0 channels up to the maximum of 24 DS-0 bank shall be capable of accepting multi-port and multi-function cards, channels for high bandwidth applications (i.e. > 64kbps).

C. Each channel bank shall be capable of supporting multiple independent digroups. Each digroup shall multiplex up to twenty-four voice or data channels into an associated DS-1 bit stream.

D. Each channel bank shall be microprocessor controlled, with redundant CPU's.

E. Each channel bank shall be capable of accepting multi-port and multi-function cards.

1. Voice Frequency Interface Card:
   a. There shall be four different types of voice frequency interface multiport cards furnished under this Contract:
      1) Four-wire E&M Cards (w/Tx only option)
      2) Two-wire E&M Cards (w/Tx only option)

3) Two-wire FXO Cards

4) Two-wire FXS Cards (w/automatic ringdown option)

b. Each card shall provide a 600 Ohm interface for an analog VF circuit and shall provide bi-directional signaling indications appropriate for the type of signaling (E&M or FXO/FXS) being used in the circuit. The card type shall be permanently labeled on the front panel of the card with test access available for the Tip, Ring, Tip 1, Ring 1, E-lead and M-Lead connections. Test access shall be direct, via either bantam jacks located on the front panel of the card or a multi-pin patch cord leading to a VF patch panel equipped with 310 or bantam jacks. A handle for inserting and removing the card shall be located on the front panel. Cards shall lock into place when fully inserted into the edge connector socket.

c. Two-wire and four-wire E&M cards shall be multi-port, (8-port nominal), configurable for loop-start or ground-start, normal or inverted E&M signaling. Cards shall be transformer isolated from the circuit, with capacitive coupling so that DC talk-battery can be applied to the instrument side of the circuit.

1) Each card shall be capable of setting port parameters on a port by port basis, including the mode, the PCM coding, and the trunk conditioning.

2) Each card shall include testing and diagnostic features to allow the network management system to monitor and control loopbacks, E and M leads, and ABCD signaling bits on a port-by-port basis. Each card shall include a single 50 pin female Amphenol connector.

3) On the transmit side, the incoming VF signal level shall be adjusted to the transmission level point (TLP), sampled at a frequency of 8 kHz, and converted to 8 bit PCM words to make up a 64 kb/s signal. The incoming M-Lead status shall be detected, and M-Lead signaling bits shall be added into the outgoing bit stream.

4) On the receive side, the incoming 8 bit PCM words shall be decoded and filtered, and the recovered VF signal shall be adjusted to the appropriate TLP. Incoming signaling bits shall be decoded and interpreted to drive the E-Lead output relay.

5) Each E&M card shall include an extended transmit range of -17.5 to +14.5 dB option to support 2 wire and 4 wire modem applications.

d. E&M cards shall meet, as a minimum, the following specifications:

1) Impedance: 600 ohms

2) Transmit Level: -17.5 to +8.0 dBm, adjustable;-17.5 to +14.5 dBm, extended

3) Receive Level: -17.0 to +8.5 dBm, adjustable

4) Loss Stability: +/- 0.5 dB (end to end)

5) Idle Channel Noise: 23 dBmc0 max

6) Signal Distortion: (0 to -30 dBm0 Input): 33 dB min; (-40 dBm0 Input): 27 dB min; (-45 dBm0 Input): 22 dB min

7) Return Loss: 1,000 Hz: 28 dB min; 300 to 3,000 Hz: 23 dB min

8) Frequency Response: 300 to 3,000 Hz: -0.3 to + 3 dB; 3 to 200 Hz: 0 to 3 dB; 200 Hz: -0.3 to + 1.5 dB max; 3,400 Hz: 0 to + 3 dB

9) Operating Temperature: +5 °C to +45 °C

e. Two-wire Foreign Exchange Office (FXO) and Foreign Exchange Subscriber (FXS) Cards shall be multi-port (8-port nominal), configured for loop-start or ground-start signaling on PBX or Telco circuits. FXO cards shall be used at the office end of the circuit and FXS cards shall be used at the instrument end of the circuit. Two-wire FXO and FXS cards shall have internal hybrids with selectable network build out capacitive coupling so that DC talk-battery can be applied to the instrument side of the circuit.

1) On the transmit side, the incoming VF signal shall be adjusted to the TLP, sampled at a frequency of 8 kHz, and converted to 8 bit PCM words to make up a 64 kb/s signal.

2) On the receive side, the incoming 8 bit PCM words shall be decoded and filtered, and the recovered VF signal shall be adjusted to the appropriate TLP.

3) Each FXO and FXS card shall be capable of setting port parameters on a port by port basis, including the mode, the type, the PCM coding, and the trunk conditioning.

4) Each FXO and FXS card shall include testing and diagnostic features to allow the network management system to monitor and control loopbacks, Tip and Ring leads, and ABCD signaling bits on a port-by-port basis. Each card shall include a single 50 pin female Amphenol connector.

5) FXS cards shall detect the subscriber instrument data, applied to the Tip and Ring leads. This data shall be encoded and added into the outgoing bit stream and sent to the remote FXO card. The signaling data from the remote FXO card shall be decoded and interpreted to apply signaling to the Tip and Ring leads to the subscriber instrument.

6) The mode selections shall include Foreign Exchange Subscriber, Foreign Exchange Subscriber Defined Network (FXSDN), and Private Line Automatic Ringdown (PLAR). The type selections shall include loop start, loop forward, ground start, ground start immediate, and ground start automatic operation.

7) Each FXO and FXS card shall include testing and diagnostic features to allow the network management system to monitor and control loopbacks, Tip and Ring leads, and ABCD signaling bits on a port-by-port basis. Each card shall include a single 50 pin female Amphenol connector.

8) FXO cards shall detect the office signaling data, applied to the Tip and Ring leads. This data shall be encoded and added into the outgoing bit stream and sent to the remote FXS card. The signaling data from the remote FXS card shall be removed from the incoming bit stream, decoded and interpreted to apply signaling to the Tip and Ring leads to the office.

9) Each FXO card shall be capable of setting port parameters on a port by port basis, including the mode, the type, the PCM coding,

and the trunk conditioning.10) The mode selections shall include Foreign Exchange Office, Foreign Exchange Office Defined Network (FXODN). and Manual Ringdown (MRD). The type selections shall include loop start, loop forward, ground start, R2, and immediate R2 operation.

f. The FXO and FXS cards shall meet, as a minimum, the following requirements:

1) Impedance: 600 ohms

2) Transmit Level: -10.0 to +5.0 dBm; adjustable in 0.1 dB increments

3) Receive Level: -10.0 to +2.0 dBm; adjustable in 0.1 dB increments

4) Loss Stability: +/- 0.5 dB (end to end)

5) Idle Channel Noise: 23 dBmc max

6) Signal Distortion: (0 to -30 dBm): 0 input 33 dB min; (-40 dBm): 0 input 27 dB min; (-45 dBm): 0 input 22 dB min

7) Transhybrid Loss: (200 to 500 Hz): 20 dB; (500 to 1,000 Hz): 30 dB; (1,000 to 1,500 Hz): 35 dB; (2,500 to 3,400 Hz): 30 dB

8) Echo Return Loss: 28 dB min

9) Singing Return Loss: 20 dB min

10) Frequency Response: (200 Hz): 0 to 5dB; (300 to 3000 Hz): -0.5 to +1.5dB; (3200 Hz): -0.5 to +1.5dB; (3400 Hz): 0 to +3dB

11) Delay Distortion: 94 PAR min

12) Loop Range: 0 to 2000 ohms

13) Tip Ground Disconnect Delay: 125 to 300 msec

14) Operating Temperature: +5 °C to +45 °C

2. Data Port Cards:

a. The data port card provided shall be a multiport (5-port nominal), SRU (sub rate unit data port card).

b. Each data port shall interface with direct RS-232 serial links. Each port shall be independently programmed to operate at a data rate of 2.4, 4.8, 9.6, 19.2 or 56 kbps.

c. Each SRU card shall include testing and diagnostic features to allow the network management system to monitor and control loopbacks, local and remote, on a port-by-port basis. Each port shall support RJ48 female connectors.

3. System Timing

a. Each channel bank shall have a primary and secondary timing source; if the primary clock fails, the secondary source will automatically take over. An internal stabilized clock source shall also be included for automatic fallback if both sources fail. Each clock source shall have the capability to derive timing from three modes:

1) Free-run Mode: The clock source operates independently, as a master source. The clock shall have the capability to output a composite clock signal when operated in this mode.

2) Synchronized Mode: The clock source shall be slaved to a

composite clock (DDS) signal provided from an external source. The clock shall have the capability to output a separate composite signal (synchronized to the incoming clock). If the incoming clock signal is interrupted, the channel bank shall synchronize to the internal source.

3) Generate Mode: The clock source shall be synchronized via a clock signal derived from the framing bits in the incoming DS-1 bit stream. If the incoming DS-1 bit stream synchronization is lost, the channel bank shall synchronize to the internal source.

4. Support Equipment

   a. In addition to the equipped spare capacity defined elsewhere, the Contractor shall furnish 10% additional voice frequency interface and data port cards beyond those specifically required to be installed system-wide. The Contractor shall furnish one additional circuit card for each type of channel bank common equipment card. All support equipment cards are to be delivered at a location designated by the Engineer.

5. Construction

   a. The channel banks shall be suitable for standard 19 or 23” mounting in a standard EIA 23” equipment rack and shall be of a size such that 4 channel banks can be mounted in a single 7’ high rack.

6. Environmental Specifications

   a. The channel banks shall be capable of operating in a hardened environment. The channel banks shall meet, as a minimum, the following requirements:

      1) Temperature: -20 °C to +80 °C

      2) Humidity: 0 to 95%, non-condensing

7. Power

   a. The channel banks shall meet, as a minimum, the following requirements:

      1) Voltage: -48 VDC

      2) Current: 1.0 Amp (fully equipped)

8. Low Speed Specifications

   a. Each channel bank shall support up to 8 DS-1 signals. The DS-1 interface card shall be available in single and dual DS-1 configurations.

      1) The DS-1 input signal shall be a standard North American Digital Hierarchy format signal, and shall be fully compatible with Bell System DS-1 standards as measured at the DSX-1 and shall meet Bell/USITA TA34 requirements.

      2) Protection at the DS-1 input shall be 1:1 configuration.

9. Each channel allocated under this contract shall receive a dedicated channel from source to destination, completely non-blocked via channel banks. Hybrid/key PBX systems in place of channel banks will not be allowed.

10. Multiplexer Alarms

    a. Each channel bank shall be capable of reporting alarm and status conditions locally and remotely, in addition to diagnostic and configuration capability. The channel bank shall include multiple levels of password

protection for access to multiplexer functions, the lowest level being read-only of system parameters, the highest level being full access to configuration, diagnostics, and password management.

b. The alarm messages shall indicate status of each port on every card in the system. In addition, each channel bank shall be equipped with alarm output relay contacts for indication of major failures (affecting service) and minor failures (not affecting service). All alarms shall be transported to the Control Center, and shall be used to interface with the network management system, as specified elsewhere.

11. The channel banks shall be capable of remote diagnostics and system management. The channel banks shall be capable of network management functions by means of SNMP (simple network management protocol) traps. The channel banks shall allow user interrogation of channel bank status and operation down to the DS-0 or sub-rate channel, and physically down to each port. The remote diagnostics and system management shall be compatible with the network management system, specified elsewhere.

a. The SNMP data shall be transported to the network management system via a 4 kbps facility data link (FDL) embedded in a DS-1 extended super frame format from each channel bank. The FDL shall be extracted from each channel bank through the DACS, mapping the FDL into a DS-0 channel.

F. Ring Generators:

1. The ring generators furnished shall supply 105 VAC, 20 Hz continuous ringing rated at 15 VA, for up to 24 simultaneous ringing ports. The ring generators shall be mounted in standard EIA equipment racks or included within the channel bank chassis, as shown on the Drawings and shall be capable of generating alarm outputs to indicate a failure of the ring generator. The ring generator alarm outputs shall be interconnected to the local nodal fiber optic alarm and network management system to provide indication of ring generator failure.

2. The ring generators furnished shall meet, as a minimum, the following specifications:

a. Input Voltage: -48 VDC

b. Input Current: 600 mA, full load

c. Output Voltage: 105 VAC @ 20 Hz

d. Output Current: 15VA

3. The Contractor shall provide the required number of ring generators at each location.

G. The typical configuration shall be as follows, however it is not limited to all components, materials, and labor to provide a complete and operational channel bank system under this contract:

1. (1) channel bank chassis

2. (2) power supplies

3. (2) power converters

4. (1) ring generator

5. (2) CPU’s

6. (1) SNMP option
7. (1) 8-T1 interface card with modem
8. (2) Dual T1 cards
9. (4) DSX modules, 1 per T1
10. (6) 2-wire 8 port FXS cards
11. (1) dry contact alarm card
12. The channel banks provided under this Contract shall be 100% compatible and interchangeable with the existing Lucent/Parradyne system. The channel bank and required cards shall be Zhone model AAC-800 series, or engineer approved equivalent.

2.03 DIGITAL SIGNAL CROSSCONNECT (DSX-1) PANEL

A. The Contractor shall provide a digital signal crossconnect panel at each node as the point of demarcation for DS-1 signals between channel banks and/or OC-48 multiplexers, OC-192 multiplexers, DACS', and telephone PBX equipment.

B. The DSX shall be equipped for the required quantity of DS-1 signals (no less than 8), to be terminated on the panel.

C. The DSX shall be capable of EIA 19” rack mounting.

D. The DSX shall include the required number and length of DS-1 cables with bantam connectors.

E. The DSX shall be equipped to terminate all permanent DS-1 circuits on the rear of the panel. The front of the panel shall be equipped with IN, OUT, and TEST bantam jacks to allow for temporary patching and in-service testing of DS-1 signals.

2.04 NETWORK MANAGEMENT SYSTEM

A. The existing SONET Network Management System (NMS) at the Control Center allows remote monitoring and provisioning of equipment operation covered under the SONET optical systems.

B. The Contractor shall integrate the new fiber optic SONET nodes to the existing NMS, including any required hardware and software to add RT optical nodes.

C. The Contractor shall provide all required hardware, software, and labor to add the station communication circuits to the existing CTA digital access and cross-connect switch (DACS). The existing DACS is Eastern Research DNX-88 model. The Contractor shall also provide circuit provisioning and administering of the DACS circuits to the DACS NMS, including any required hardware and software.

D. The SONET NMS right to use licenses shall be compatible with Alcatel-Lucent Navis INC network management system.

E. The existing SONET NMS is Alcatel-Lucent NAVIS INC.

PART 3 - EXECUTION

3.01 SONET OC-48 FIBER OPTIC MULTIPLEXERS

A. The Contractor shall provide and install all equipment and material necessary to form a complete and operational OC-48 fiber optic network as specified within these documents and as shown on the Contract Drawings, in accordance with the Manufacturer's Specifications, and in compliance with the National Electrical Code (NEC) and all applicable State of Illinois and City of Chicago codes and ordinances.

1. An OC-48 multiplexer shall be installed in the node room and the CTA's Control Center.
2. Each OC-48 multiplexer shall be pre-assembled, pre-wired, and tested at the factory for the requirements of each node.
3. All OC-48 multiplexers shall be configured at the factory in the ring configuration as shown on the Contract Drawings and/or specified herein. The OC-48 system shall be operated to simulate ultimate field operation, including random generation of fault conditions with subsequent network healing. The OC-48 system shall be interfaced to the CTA's Central Core backbone as directed by the CTA.
4. All network simulation shall be documented for initial set-up, hardware and software configuration, test patterns, and test results.
5. The Contractor shall notify the CTA in writing five (5) working days in advance of the testing of the system so that the CTA, or its representative, may be present for the tests, if the CTA so elects.

3.02 DIGITAL CHANNEL BANKS

A. The Contractor shall provide and install all equipment and material necessary to form a complete and operational fiber optic network inclusive of DS-1 digital channel banks, as specified within these documents and as shown on the Drawings, in accordance with the Manufacturer's Specifications, and in compliance with the National Electrical Code (NEC) and all applicable State of Illinois and City of Chicago codes and ordinances.

1. The required quantity of channel banks shall be installed in each node as shown on the Drawings.
2. Each channel bank shall be pre-assembled, pre-wired, and tested at the factory for the requirements of each node.
3. All channel banks shall be configured at the factory in the configuration as shown on the Drawings and specified herein. The channel bank system shall be operated to simulate ultimate field operation, including random generation of fault conditions with subsequent recovery.
4. All network simulation shall be documented for initial set-up, hardware and software configuration, test patterns, and test results.
5. The Contractor shall notify the Engineer in writing 5 working days in advance of the testing of the system so that the Engineer, or its representative, may be present for the tests, if the Engineer so elects.

3.03 NETWORK MANAGEMENT SYSTEM

A. The Network Management System shall be provisioned and administered to add the necessary stations to the existing database.

1. All necessary tables or network maps shall be entered and stored in the NMS software.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATIONS BACKBONE NETWORK will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATIONS BACKBONE NETWORK must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 21 29

DATA COMMUNICATION SWITCH

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 specification consists of furnishing and installing DATA COMMUNICATION SWITCHES at the locations as shown on the Contract Drawings.

B. This section specifies the requirements for furnishing, installing, and testing of Ethernet switches at specified locations. The Work under this section includes furnishing all labor, materials, tools, equipment, and incidentals necessary to complete a fully operational system that provides all the features and functions identified herein and/or shown on the Contract Drawings.

C. The Ethernet switch shall accommodate present and future data, voice and video network requirements at Chicago Transit Authority (CTA) rail stations, wayside locations and other facilities.

D. The Contractor shall provide new Ethernet switches in the Station including all necessary hardware and software to make the switches operational and be compatible with the CTA's existing communications network. The Contractor shall be responsible for all circuit assignments, programming, and wiring within the new switches and the CTA's existing network to make these switches operational.

E. Each Ethernet switch in the Communications Room shall include:

1. 19" rack mount
2. Dual redundant 350W AC power supplies
3. (48) 10/100/1000 Ethernet ports
4. (1) 4 GbE port network module
5. (4) uplink network module slots
6. (2) multimode GbE SX SFP modules, LC connector
7. (2) singlemode GbE LH SFP modules, LC connector
8. Layer 3 IP Services feature set

F. Each Ethernet switch in the Communications Hubs shall include:

1. Din-rail backboard mount
2. Hardened environment
3. (24) 10/100 Ethernet ports
    a. (1) 8-port 10/100 base module

b. (2) 8-port 10/100 expansion modules

4. (2) 10/100/1000 Ethernet uplinks ports
5. (2) SFP-based GbE uplink ports
6. (2) rugged multimode GbE SX SFP modules, LC connector
7. 110VAC power supply
8. Layer 2 LAN Base services

G. The Communication Room Ethernet Switch shall be Cisco WS-C3560X-48T-E, or Engineer approved equivalent. The Communications Hub Ethernet Switch shall be Cisco IE-3000-8TC/IE-3000-8TM, or Engineer-approved equivalent.

1.03 RELATED WORK

A. DATA COMMUNICATION SWITCHES specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. GbE – Gigabit Ethernet
2. IP – Internet Protocol
3. LAN – Local Area Network
4. LC – Lucent Connector, optical connector licensed by Lucent Technologies
5. SFP – Small Form-factor Pluggable module

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 COMMUNICATION ROOM ETHERNET SWITCH

A. Standards

1. The switches shall comply with all of the following industry standards:

a. NEBS Criteria Levels SR-3580 - NEBS Level 3 compliant

b. UL 60950-1

c. CLEI – Common Language Equipment identifier code

B. Power

1. Input Voltage: 100 to 240 VAC, 50 or 60Hz

2. Redundant Power Supplies: 350 W max

C. Environmental

1. Operating Temperature: -5° to +45°C

2. Humidity: 5 to 95% non-condensing

D. EMC Emission/Safety Standards

1. FCC Part 15, Class A

E. Requirements:

1. Layer 3 IP Services feature set

2. (48) 10/100/1000BASE-T ports, 4 GbE ports (SFP)

3. Two multimode SFP SX modules, LC connector

4. Two singlemode SFP LH modules, LC connector

2.02 COMMUNICATION HUB ETHERNET SWITCH

A. Standards

1. The switches shall comply with all of the following industry standards:

a. NEMA TS-2

b. UL 60950-1

c. CLEI – Common Language Equipment identifier code

B. Power

1. Input Voltage: 18VDC to 60VDC

2. 85-265VAC power supply module

3. 20 W nominal
4. 24VAC to 24VDC voltage regulator in Communication Hub

C. Environmental
1. Operating Temperature: -40° to +75°C
2. Humidity: 10 to 95% non-condensing

D. EMC Emission/Safety Standards
1. FCC Part 15, Class A

E. Requirements:
1. Layer 2 LAN Based Services feature set
2. Base unit - (8) 10/100BASE-T ports, 2 GbE ports (SFP)
3. Two expansion units - (8) 10/100BASE-T ports each
4. Two rugged multimode GbE SX SFP modules, LC connectors

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall be responsible for inspecting all equipment ordered when it arrives on site. Any damaged equipment shall be returned and replaced at the Contractor's expense.

B. At the completion of the Contract, the Contractor shall perform a site inspection to verify that all equipment supplied is in operable condition and contains no physical damages. Any piece of equipment deemed inoperable should be made operable by the Contractor prior to Contract completion. The site inspection shall be performed with CTA personnel.

C. The Contractor shall ensure that all returned equipment is replaced within thirty (30) days. No schedule modifications shall be allowed due to returned equipment unless authorized in writing by CTA.

3.02 INSTALLATION

A. The Contractor shall provide and install all equipment and material necessary to form a complete and operational Ethernet network as specified within these documents and as shown on the Contract Drawings, in accordance with the Manufacturer's Specifications, and in compliance with the National Electrical Code (NEC) and all applicable State of Illinois and City of Chicago codes and ordinances.
1. All Ethernet Switches shall be installed at each work location with specified options as shown on the Contract Drawings.
2. Each Ethernet Switch shall be pre-assembled, pre-wired, and tested at the factory for the requirements of each node.
3. All Ethernet Switches shall be configured prior to installation in the configuration as shown on the Contract Drawings and specified herein. The Ethernet system shall be operated to simulate ultimate field operation, including random generation of fault conditions with subsequent network healing. Each Ethernet Switch shall also

be interfaced to the respective backbone system as shown on the Contract Drawings.

4. The equipment design and construction shall utilize the latest available techniques with a minimum number of parts, subassemblies, circuits, cards and modules to maximize standardization and commonality.

5. The equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance. The modular construction shall keep the maintenance easy and service time minimized by exchange of modules. All units shall be hot swappable which allows uninterrupted operation of system for maintenance.

6. All network simulation shall be documented for initial set-up, hardware and software configuration, test patterns, and test results.

7. The Contractor shall notify the Engineer in writing five (5) working days in advance of the testing of the system so that the Engineer, or its representative, may be present for the tests, if the Engineer so elects.

3.03 NETWORK MANAGEMENT SYSTEM INTEGRATION

A. The Ethernet Switches shall be added to the existing SNMP network management system, provisioned and administered to add the necessary stations to the existing database.

1. All necessary tables or network maps shall be entered and stored in the NMS software.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of DATA COMMUNICATION SWITCH will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of DATA COMMUNICATION SWITCH must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 22 33

COMMUNICATIONS ROOM MANAGEMENT COMPUTER

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 specification consists of furnishing and installing COMMUNICATIONS ROOM MANAGEMENT COMPUTER at the locations as shown on the Contract Drawings.

B. This section specifies the requirements for furnishing and installing of a Microsoft Windows 7 based rack-mount industrial PC to provide local maintenance support in the Communications Room. The Work under this section includes furnishing all labor, materials, tools, equipment, and incidentals necessary to complete installation of a fully operational system.

1.03 RELATED WORK

A. COMMUNICATIONS ROOM MANAGEMENT COMPUTER specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.05 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.07 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.08 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 COMMUNICATION ROOM MANAGEMENT COMPUTER

A. The PC shall have the following features:

1. Rack mounted PC two rack units high (2U), 350 w power supply
2. Rack mounted pull out KVM switch, keyboard and LCD display one rack unit high (1U)
3. Processor type: Intel core i5 processor
4. Processor speed: 3.3 GHz
5. Memory: 2GB DDR3 SDRAM
6. Media: 500GB hard-drive, DVD+/-RW/CD+/-RW Drive
7. Peripherals: USB, VGA, audio, RS-232 serial
8. Operating System: Microsoft Windows 7

B. The PC shall be a Cyber Research model N1T MX Rack Mount PC chassis with CEGE-I5-33-X single board computer.

C. The keyboard/monitor/KVM switch shall be a Cyber Research model GFA 1918B Rack-Mount folding keyboard with touchpad and 19-inch LCD monitor.

D. The communication room management computer and accessories shall be provided with operator's manuals, serial, video, and Ethernet cables to interface to each unit and the communication.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall be responsible for inspecting all equipment ordered when it arrives on site. Any damaged equipment shall be returned and replaced at the Contractor's expense.

B. At the completion of the Contract, the Contractor shall perform a site inspection to verify that all equipment supplied is in operable condition and contains no physical damages. Any piece of equipment deemed inoperable should be made operable by the Contractor prior to Contract completion. The site inspection shall be performed with CTA personnel.

C. The Contractor shall ensure that all returned equipment is replaced within thirty (30) days. No schedule modifications shall be allowed due to returned equipment unless authorized in writing by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of COMMUNICATION ROOM MANAGEMENT COMPUTER will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of COMMUNICATION ROOM MANAGEMENT COMPUTER must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 32 13

TELEPHONE SETS

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 specification consists of furnishing and installing TELEPHONE SETS at the locations as shown on the Contract Drawings.

B. General: The work of this Section consists of furnishing and installing telephones, and the necessary work and materials to interface the telephones to the CTA PBX System. The following functional areas shall receive the specified telephone type:

1. Station Equipment Rooms – Type 1 Telephone
2. Station Platforms – Type 2 Telephone
3. Customer Assistant Kiosks – Type 3 Telephone
4. Help Point Telephones / Customer Assistance (specified elsewhere) – Type 4 Telephone
5. Elevators (specified elsewhere) – Type 7 Telephone

C. Existing CTA Telephone System: The CTA operates an existing Avaya PBX Voice Network. Refer to Specification 27 31 13 – PBX Systems for more information.

D. Telephone Extension Numbers are presented in the Contract Drawings. The Contractor shall coordinate with the CTA to confirm final telephone extension number assignments to all telephones covered under this Contract.

1.03 RELATED WORK

A. TELEPHONE SETS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions
2. Section 27 05 26 – Grounding and Bonding For Communication Systems
3. Section 27 31 13 – PBX Systems
4. Section 27 32 23 – Elevator Telephones
5. Section 27 32 26 – Help Point Telephones

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. DTMF – Dual Tone Multi Frequency
2. PBX – Private Branch Exchange

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 TYPE 1 TELEPHONE – EQUIPMENT ROOM TELEPHONE

A. GENERAL:

1. Type 1 Telephones shall be Cortelco model 2554-20M or Engineer approved equivalent.

B. PHYSICAL:

1. Traditional Bell standard 2554
2. Wall mount
3. High impact plastic housing and handset
4. Metal baseplate
5. Color: Black
6. Single gong ringer
7. Fully modular

8. Ringer volume control
9. ADA compliant variable volume control on handset
10. 9 foot handset cord
11. 12 button: 0-9, #, *

C. ELECTRICAL:

1. Analog operation
2. Polarity guarded DTMF dial
3. RJ-11 modular jack, wall-plate capable
4. A-lead compatible
5. multi-contact hookswitch

D. MECHANICAL:

1. Indoor rated operation

2.02 TYPE 2 TELEPHONE - OUTDOOR TELEPHONE

A. GENERAL:

1. Type 2 Telephones shall be Gaitronics model 226-005 or Engineer approved equivalent.

B. PHYSICAL:

1. The Type 2 Telephone shall be a rugged outdoor weatherproof telephone, for use in areas subjected to extended temperature ranges, high-intensity vandalism, and abuse
2. Thick walled cast aluminum, vandal-resistant heavy duty housing
3. Protected concealed hinges
4. Spring return door
5. Sealed, heavy duty, marine quality keypad, 12 button: 0-9, #, *
6. Sealed front panel to prevent entry of contaminants
7. Extra heavy duty, sealed proximity detecting, marine quality hookswitch
8. Extra heavy duty handset with sealed transmitter and receiver caps
9. G-style 19 inch lanyard embedded armored cord with eight-hundred (800) lb. pull strength
10. Hearing aid compatible receiver
11. Dual-tone electronic ringer
12. Field selectable DTMF (tone) or pulse dialing
13. Surface or pole mount
14. Color: Gray
15. UL Listed

C. ELECTRICAL:

1. Operation: Analog, loop start
2. Minimum loop current (@48VDC): 24mA
3. Polarity guarded DTMF dial
4. RJ-11 modular jack within enclosure
5. A-lead compatible
6. Telephone line powered
7. Noise cancelling microphone
8. 4 step volume control: -6dB, 0 dB, 6 dB, 12 dB
9. Dual isolated solid state control outputs: 48VDC @125mA; 28 Vrms@80mArms
10. Non-volatile EEPROM memory

D. MECHANICAL:

1. Outdoor rated operation
2. Temperature: -20 degrees C to +60 degrees C
3. Humidity: 95% max, no condensation
4. Size: 13.50 inches H x 9.70 inches W x 6.15 inches D
5. Weight: 14.5 lbs

E. FEATURES

1. Self Monitoring and Reporting Technology
2. Interfaces to Telephone Management Application monitoring software via a central computer
3. Remote programming
4. Remote health status reporting
5. Programmable Polling
6. Email notification of faults or reports
7. Report Data:
    a. Call Type
    b. Call Direction
    c. Call Date, Time, Duration
    d. Answer Delay
    e. Termination Reason
    f. Stuck Contacts
    g. Phone Line Interruption
    h. Micro-processor Self Test

2.03 TYPE 3 TELEPHONE – CUSTOMER ATTENDANT KIOSK TELEPHONE

A. GENERAL:

1. Type 3 Telephones shall be Cortelco model 2500-20M or Engineer approved equivalent.

B. PHYSICAL:

1. Traditional Bell standard 2500
2. Desk mount
3. High impact plastic housing and handset
4. Metal baseplate
5. Color: Red
6. Double gong ringer
7. Fully modular
8. Ringer volume control
9. ADA compliant variable volume control on handset
10. 9 foot handset cord
11. 7 foot line cord
12. 12 button: 0-9, #, *

C. ELECTRICAL:

1. Analog operation
2. Polarity guarded DTMF dial
3. RJ-11 modular jack, wall-plate capable
4. A-lead compatible
5. multi-contact hookswitch

D. MECHANICAL:

1. Indoor rated operation

2.04 TYPE 4 TELEPHONE - HELP POINT TELEPHONE (CUSTOMER ASSISTANCE)

A. Refer to Specification 27 32 26 – Help Point Telephones

2.05 TYPE 5 TELEPHONE - LOCK-BOX TELEPHONE

A. GENERAL:

1. Type 5 Telephones shall be Gaitronics model 256-005 or Engineer approved equivalent.

B. PHYSICAL:

1. The Type 5 Telephone shall be a rugged outdoor weatherproof telephone, for use in areas subjected to extended temperature ranges, high-intensity vandalism, and abuse
2. High impact, glass-reinforced polyester, vandal-resistant housing
3. Protected concealed hinges

4. Spring return door
5. Sealed, heavy duty, marine quality keypad, 12 button: 0-9, #, *
6. Sealed front panel to prevent entry of contaminants
7. Extra heavy duty, sealed proximity detecting, marine quality hookswitch
8. Extra heavy duty handset with sealed transmitter and receiver caps
9. 6 foot Hytrel handset cord with noise cancelling microphone
10. Hearing aid compatible receiver
11. Dual-tone electronic ringer
12. Field selectable DTMF (tone) or pulse dialing
13. Surface or pole mount
14. Color: Gray
15. UL Listed

C. ELECTRICAL:

1. Operation: Analog, loop start
2. Minimum loop current (@48VDC): 24mA
3. Polarity guarded DTMF dial
4. RJ-11 modular jack within enclosure
5. A-lead compatible
6. Telephone line powered
7. Noise cancelling microphone
8. 4 step volume control: -6dB, 0 dB, 6 dB, 12 dB
9. Dual isolated solid state control outputs: 48VDC @125mA; 28 Vrms@80mArms
10. Non-volatile EEPROM memory

D. MECHANICAL:

1. Outdoor rated operation
2. Temperature: -20 degrees C to +60 degrees C
3. Humidity: 95% max, no condensation
4. Size: 13.20 inches H x 9.40 inches W x 7.40 inches D
5. Weight: 10 lbs

E. FEATURES

1. Self Monitoring and Reporting Technology
2. Interfaces to Telephone Management Application monitoring software via a central computer
3. Remote programming
4. Remote health status reporting
5. Programmable Polling

6. Email notification of faults or reports
7. Report Data:
    a. Call Type
    b. Call Direction
    c. Call Date, Time, Duration
    d. Answer Delay
    e. Termination Reason
    f. Stuck Contacts
    g. Phone Line Interruption
    h. Micro-processor Self Test

F. The Type 5 Telephone enclosure shall be equipped at point of manufacture with the CTA standard lock, Adams - Westlake P307779.

2.06 TELEPHONE SET CABLE

A. Provide telephone cables as follows:

1. 4-pair, unshielded twisted pair (UTP), Category-6 standard, 22AWG, polyethylene jacket, outdoor rated.

2.07 SUPPORT EQUIPMENT

A. In addition to the instruments specifically required to be installed per these Specifications and Drawings, the Contractor shall furnish five percent (5%), of each type (minimum of one), beyond those required. These instruments shall be furnished complete with housings, enclosures, protectors, and pedestals. All support equipment is to be delivered at a location designated by CDOT and the CTA.

2.08 PBX INTERFACE

A. Refer to Specification 27 31 13 – PBX Systems for requirements to interface telephone sets provided under this section with the existing PBX voice network.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall provide all equipment, hardware, accessories, terminal blocks, protector blocks, cabinets, conduits, raceways, cable trays, and wire required for completion of the installation of the telephone instruments defined in this Section. In the Main Station Communications Room, the Contractor shall make all necessary connections and cross-connections as required for interface to the fiber optic backbone; including cross connections to the primary switching equipment at the Control Center or other host node. Installation of all telephones shall be in accordance with approved Contractor Drawings and consistent with industry standard telephone practices. Installation of all telephones shall be consistent from site to site to provide uniformity in telephone installations.

1. Telephone Instrument Installation: Each telephone instrument shall have at minimum, a dedicated Category-6 four-pair UTP cable from the telephone location to the assigned termination block in the respective Communications Hub and/or on the wallfield block in the Communications Room.
2. Telephone instruments installed on the platform levels shall be Type 2 Telephones with a two pair protector block, as specified elsewhere, mounted within.
3. All telephone types shall terminate on a protected block in the Communications Room.
4. Communication Room Installation:
    a. All telephone instruments, connecting blocks, and terminals shall be labeled with extension numbers.
    b. Following completion of the installation of all telephones, the Contractor shall inspect all equipment and wiring to verify that all mechanical connections are made and properly secured, all hardware is installed in its proper location and is properly terminated. This inspection shall include conductor and shield continuity and isolation verification of all installation wiring. This testing shall be accomplished from the wallfield in the Communications Room as well as testing from any local termination in the vicinity of an instrument. Data sheets containing evidence of such inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be delivered to the CTA for approval. The Contractor shall request from and shall receive approval of such inspection certification before proceeding with further testing.
5. Install in accordance with the Manufacturer's recommended installation procedures, approved Shop Drawings, and in the locations indicated on the Contract Drawings for telephones as follows:
    a. Single line 2500 telephone desk sets, Type 3, shall be installed in all Kiosks.
    b. Single line 2554 telephone wall sets, Type 1, shall be installed in all, unless otherwise noted:
        1) Communications Rooms
        2) Electrical Rooms
        3) Mechanical Rooms
        4) Elevator Machine Rooms
    c. Lock-Box Telephones, Type V, shall be installed at, unless otherwise noted :
        1) The Fare Collection Array
6. All locations shall be field verified by the Contractor, referenced to the Contract Drawings, and approved by the CTA.

3.02 GROUNDING

A. Grounding will be provided for each unit installed in accordance with sections specified elsewhere.

3.03 LOCAL FIELD ACCEPTANCE TESTS

A. Contractor shall perform Local Field Acceptance Tests in accordance with the Manufacturer's approved test procedures, and furnish a report of each test to the CTA. As part of the Local Field Acceptance Test, the Contractor shall check and verify continuity from each telephone location to the Frame Block in the Communication room.

3.04 PBX INTERFACE

A. Refer to Specification 27 31 13 – PBX Systems for requirements to interface telephone sets provided under this section with the existing PBX voice network.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TELEPHONE SETS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TELEPHONE SETS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 32 26

HELP POINT TELEPHONE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This specification consists of furnishing and installing HELP POINT TELEPHONE at the locations as shown on the Contract Drawings.

B. General: The work of this Section consists of furnishing and installing Help Point Telephones, and the necessary work and materials to interface the telephones to the CTA PBX System. The following functional areas shall receive the specified telephone type:

1. Help Point Telephones / Customer Assistance – Type 4 Telephone

C. Help Point Telephones replace the functionality of the traditional CA (customer assistance) pushbutton in addition to providing a direct two-way conversation capability between patrons in need of assistance and CTA personnel.

D. The Type 4 Telephone shall incorporate a one button, auto-dial function. The button shall activate one to three an auto-dial programmable numbers. The large palm-size red button shall be identified "HELP" , with associated Braille markings, and shall be programmed to dial the local Customer Assistant kiosk and then the CTA's Control Center if the kiosk does not answer. In addition, via the integral relays, the Help Point Telephone shall trigger a local Blue Light into strobe flashing mode to indicate and locate an assistance call in progress and trigger a Public Address System audio and visual text message to broadcast a message that a customer needs assistance.

E. The flush mount Type 4 Telephone shall be installed in a custom designed cavity to accommodate the telephone unit on the exterior wall of each CA Kiosk, as shown on the Contract Drawings.

F. The surface mount Type 4 Telephone shall be installed on the platform canopy support plates as shown on the Contract Drawings. The Contractor shall coordinate installation of the telephones and conduits with the Architectural plans. All conduit shall be hidden, to the extent possible.

G. Existing CTA Telephone System: The CTA operates an existing Avaya PBX Voice Network. Refer to Specification 27 31 13 – PBX Systems for more information.

H. Telephone Extension Numbers are presented in the Contract Drawings. The Contractor shall coordinate with the CTA to confirm final telephone extension number assignments to all telephones covered under this Contract

1.03 RELATED WORK

A. TELEPHONE SETS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions
2. Section 27 05 26 – Grounding and Bonding For Communication Systems
3. Section 27 31 13 – PBX Systems
4. Section 27 32 13 – Telephone Sets

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. DTMF – Dual Tone Multi Frequency
2. PBX – Private Branch Exchange

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 TYPE 4 TELEPHONE - HELP POINT TELEPHONE (CUSTOMER ASSISTANCE)

A. GENERAL:

1. Type 4 Telephones shall be provided in surface mount and flush mount designs.
2. Surface mount Type 4 Telephones shall be Gaitronics model 393AL-001 or Engineer approved equivalent.

3. Flush mount Type 4 Telephones shall be Gaitronics model 397-001 or Engineer approved equivalent.

B. PHYSICAL:

1. The Type 4 Telephone shall be a rugged outdoor weather resistant telephone, for use in areas subjected to extended temperature ranges, high-intensity vandalism, and abuse
2. Thick walled cast aluminum enclosure for surface mount unit
3. Large palm size activation pushbutton for assistance
4. Sealed front panel to prevent entry of contaminants
5. Auto answer with silent monitoring
6. 2 programmable auxiliary relays outputs
7. LED light for call received indication
8. Dual-tone electronic ringer
9. Autodial programming, 3 number rollover
10. Field selectable DTMF (tone) or pulse dialing
11. Surface mount unit color: Epoxy Safety Yellow Finish
12. Flush mount unit color: Stainless Steel 14 gauge Type-304 brushed front panel; 16 gauge cold rolled steel, black back enclosure
13. ADA compliant
14. UL Listed

C. ELECTRICAL:

1. Operation: Analog; loop start, central office, or analog station port (PBX)
2. Minimum loop current (@48VDC): 24mA
3. DTMF signaling, 100ms tone
4. Audio output: 1 kHz tone @ 87 +/- 3 dBspl @ 1 meter with 40mA current
5. RJ-11 modular jack within enclosure
6. A-lead compatible
7. Telephone line powered
8. Noise cancelling microphone
9. 4 step volume control: -6dB, 0 dB, 6 dB, 12 dB
10. Dual isolated solid state control relay outputs: 48VDC @125mA; 28 Vrms@80mArms
11. Non-volatile EEPROM memory

D. MECHANICAL:

1. Outdoor rated operation
2. Temperature: -20 degrees C to +60 degrees C
3. Humidity: 95% max, no condensation

4. Size:
    a. Surface mount unit: 9.50 inches H x 8.0 inches W x 4.0 inches D
    b. Flush mount unit: 12.0 inches H x 10.0 inches W front panel; 2.38 inches D back box
5. Weight:
    a. Surface mount unit: 7.8 lbs
    b. Flush mount unit: 6.5 lbs

E. FEATURES

1. Self Monitoring and Reporting Technology
2. Interfaces to Telephone Management Application monitoring software via a central computer
3. Remote programming
4. Remote health status reporting
5. Programmable Polling
6. Email notification of faults or reports
7. Report Data:
    a. Line Integrity
    b. Microprocessor Health
    c. Stuck Buttons
    d. Microphone Integrity
    e. Speaker Integrity
    f. Line Interrupt / Power Failure

2.02 BLUE LIGHT BEACON / STROBE

A. GENERAL:

1. Each Type 4 Telephone installation shall include a Blue Light beacon / strobe in the general proximity of the Help Point Telephone. The Blue Light locations shall be as shown on the Contract Drawings and shall be coordinated with Architectural Plans.
2. The Blue Light is intended to visually identify a Help Point Telephone location from a reasonable distance for patrons to request assistance.
3. The Blue Light shall be interfaced with the HPT via integrated relay within the HPT.
4. The Blue Light shall provide a continuous illumination beacon function to aid in locating the HPT.
5. The Blue Light shall provide a strobe or flashing illumination function to visually indicate a patron has requested assistance.
6. The Blue Light strobe shall be automatically activated when the HPT help button is pressed, and shall deactivate when the call is terminated.

B. PHYSICAL:

1. The Blue Light shall be a low voltage LED based light source.

2. Light source: Single white LED; 347 lumens
3. Light output: 43 candela
4. LED life: 100,000 hour operation
5. Dome:
    a. polycarbonate refractor
    b. color: blue
    c. prismatic design to distribute light in a horizontal pattern
    d. weather and vandal resistant

C. ELECTRICAL:

1. Input voltage range: 10-28 VDC
2. Input voltage: 12VDC, 24VDC, nominal
3. 3 wire connection:
    a. System On/Steady State: Red +VDC
    b. Ground: Black –VDC
    c. Flashing: White +VDC
4. Steady state mode:
    a. 324mA @ 10VDC
    b. 273 mA @ 12 VDC
    c. 144 mA @ 24 VDC
    d. 125 mA @ 28 VDC
5. Flashing Mode:
    a. 772 mA max / 2 mA min / 189 mA ave @10VDC
    b. 552 mA max / 2 mA min / 133 mA ave @12VDC
    c. 272 mA max / 3 mA min / 68 mA ave @24VDC
    d. 239 mA max / 3 mA min / 61 mA ave @28VDC

D. MECHANICAL:

1. NEMA 4X outdoor rated operation
2. Lighting element fully encapsulated in urethane material
3. Temperature: -40 degrees C to +65 degrees C
4. Size: 5.25 inches H x 5.5 inches Diameter
5. Weight: 2 lbs
6. ½ inch female pipe mount

E. FEATURES

1. Steady burn mode: light shall be continuously active
2. Programmable flash modes:
    a. Single flash – 60 flashes per minute

b. Single flash – 150 flashes per minute

c. Single flash – 375 flashes per minute

d. Double flash – 125 flashes per minute

e. Double flash – 250 flashes per minute

f. Multi flash – 75 flashes per minute

g. Multi flash – 150 flashes per minute

2.03 TELEPHONE SET CABLE

A. Provide telephone cables as follows:

1. 4-pair, unshielded twisted pair (UTP), Category-6 standard, 22AWG, polyethylene jacket, outdoor rated.

2.04 SUPPORT EQUIPMENT

A. In addition to the instruments specifically required to be installed per these Specifications and Drawings, the Contractor shall furnish five percent (5%), of each type (minimum of one), beyond those required. These instruments shall be furnished complete with housings, enclosures, protectors, and pedestals. All support equipment is to be delivered at a location designated by CDOT and the CTA.

2.05 PBX INTERFACE

A. Refer to Specification 27 31 13 – PBX Systems for requirements to interface telephone sets provided under this section with the existing PBX voice network.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall provide all equipment, hardware, accessories, terminal blocks, protector blocks, cabinets, conduits, raceways, cable trays, and wire required for completion of the installation of the telephone instruments defined in this Section. In the Main Station Communications Room, the Contractor shall make all necessary connections and cross-connections as required for interface to the fiber optic backbone; including cross connections to the primary switching equipment at the Control Center or other host node. Installation of all telephones shall be in accordance with approved Contractor Drawings and consistent with industry standard telephone practices. Installation of all telephones shall be consistent from site to site to provide uniformity in telephone installations.

1. Telephone Instrument Installation: Each telephone instrument shall have at minimum, a dedicated Category-6 four-pair UTP cable from the telephone location to the assigned termination block in the respective Communications Hub and/or on the wallfield block in the Communications Room.

2. Telephone instruments installed on the platform levels shall be Type 4 Telephones with a two pair protector block, as specified elsewhere, mounted within.

3. All telephone types shall terminate on a protected block in the Communications Room.

4. Communication Room Installation:

   a. All telephone instruments, connecting blocks, and terminals shall be labeled with extension numbers.

   b. Following completion of the installation of all telephones, the Contractor shall inspect all equipment and wiring to verify that all mechanical connections are made and properly secured, all hardware is installed in its proper location and is properly terminated. This inspection shall include conductor and shield continuity and isolation verification of all installation wiring. This testing shall be accomplished from the wallfield in the Communications Room as well as testing from any local termination in the vicinity of an instrument. Data sheets containing evidence of such inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be delivered to the Authority for approval. The Contractor shall request from and shall receive approval of such inspection certification before proceeding with further testing.

5. Install in accordance with the Manufacturer's recommended installation procedures, approved Shop Drawings, and in the locations indicated on the Contract Drawings for telephones as follows:

   a. Flush mount Type 4 Telephones shall be installed within flush cavities within Kiosk exterior walls.

   b. Surface mount Type 4 Telephones shall be installed on the platform as shown on the Contract Drawings.

6. All locations shall be field verified by the Contractor, referenced to the Contract Drawings, and approved by the Authority.

3.02 GROUNDING

A. Grounding will be provided for each unit installed in accordance with sections specified elsewhere.

3.03 LOCAL FIELD ACCEPTANCE TESTS

A. Contractor shall perform Local Field Acceptance Tests in accordance with the Manufacturer's approved test procedures, and furnish a report of each test to the CTA. As part of the Local Field Acceptance Test, the Contractor shall check and verify continuity from each telephone location to the Frame Block in the Communication room.

3.04 PBX INTERFACE

A. Refer to Specification 27 31 13 – PBX Systems for requirements to interface telephone sets provided under this section with the existing PBX voice network.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of HELP POINT TELEPHONE will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of HELP POINT TELEPHONE must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 42 16

DYNAMIC MESSAGE SIGN

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 specification consists of furnishing and installing DYNAMIC MESSAGE SIGNS at the locations as shown on the Contract Drawings.

B. The Dynamic Message Signs are part of the station's Public Address system. DMS provide visual text display of PA messages for the station patrons, including automated Train Tracker real-time train arrival information, customer assistance requests, and train arrival safety and courtesy messages, as well as emergency and routine transit information messages from the local CA and/or the Authority's Control Center.

C. The DMS shall be an LCD based digital display with embedded computer, connected to the station's Local Area Network for connection to and control by the Public Address system.

1.03 RELATED WORK

A. DYNAMIC MESSAGE SIGNS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. ADA – Americans with Disabilities Act
2. CA – Customer Assistant
3. DMS – Dynamic Message Sign
4. IP – Internet Protocol
5. LAN – Local area Network
6. PA – Public Address

B. Publications.

1. ADA – Americans with Disabilities Act
2. ANSI/NFPA 130-2010, Fixed Guideway Transit Systems

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. For the DMS provided, submit the following:

1. Manufacturer's specifications (catalog cut sheets)
2. Factory Acceptance Test Procedures
3. Factory Acceptance Test Reports - a certified copy for DMS, demonstrating successful completion of the factory acceptance tests and compliance with the specifications.
4. A detailed schematic diagram showing PA system components with DMS and local area network.
5. Local Field Acceptance Test Procedures for approval by the Authority.

C. Local Field Acceptance Test Reports for each installation showing satisfactory operation and performance to meet specifications.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 DYNAMIC MESSAGE SIGN

A. GENERAL:

1. The Dynamic Message Sign shall be Teleste Displays, or Authority approved equivalent.

B. PHYSICAL:

1. Display: LED backlit LCD panel
2. Display Area: 38” diagonal display

3. Aspect Ratio: 7:2
4. Resolution: 1920 x 502
5. Front window: 6mm anti-reflective, hardened glass
6. Brightness: 1000 cd/m^2
7. LED backlight life: 50,000 hours
8. Remote Monitoring:
    a. Screen activity
    b. Performance
    c. Internal temperature
    d. Fan performance
    e. Remote on/off
    f. Remote reset

C. ELECTRICAL:
1. Power Input: 110-240VAC, 50-60 Hz
2. Power Consumption: 300W maximum

D. MECHANICAL:
1. Environmental Space: outdoor rated operation, IP65
2. Thermal Management:
    a. (4) airflow temperature monitoring sensors
    b. (1) internal display sensor
    c. (1) internal enclosure sensor
    d. (2) air circulation sensors
3. Temperature: -5 degrees C to + 40 degrees C
4. Relative Humidity: 90%, non-condensing
5. Dimensions: 44” W x 19” H x 10” D
6. Weight: 91 lbs maximum
7. Color: Black

E. EMBEDDED COMPUTER
1. Processor: Intel i5 processor
2. Memory: 2GB DDR3 1066 Non-ECC DIMM
3. Motherboard: Mini ITX STD Base
4. Hard Drive: 8GB solid state drive
5. USB Ports: (4) USB 2.0
6. Ethernet Port: (2) RJ-45 100/1000Mbps
7. Video: Intel QM57 express chipset
8. LVDS: integrated LVDS panel drive

9. Serial Port: (2) D-sub RS-232
10. Operating System: Linux Ubunto
11. Cooling Fan: CPU cooling fan

PART 3 - EXECUTION

3.01 INSTALLATION

A. The DMS shall be installed at the locations as shown on the Contract Drawings.

B. The DMS shall be installed in accordance with the manufacturer's installation recommendations and industry best practices.

C. The DMS network connection shall be via Category-6 cable to the corresponding network switch in the Communications Room / Hub.

3.02 INSPECTION

A. Following completion of the installation of all DMS equipment at the station, inspect equipment wiring to verify that all electrical and mechanical connections are made and properly secured, all hardware is installed in its proper location, and all wiring is properly terminated. This inspection shall include conductor and/or shield continuity and isolation verification of all installation wiring.

3.03 TESTING

A. Factory testing:

1. All DMS system equipment shall be tested at the manufacturing location using the production inspection and testing procedures in normal use by the manufacturer. Provide test results of waterproof enclosure, as well as vibration and physical shock resistance of enclosure. Certification of the testing shall be provided to the Authority.

B. Installation Testing:

1. Test the DMS system equipment under electrical power following approval of the installation inspection by the Authority. Installation testing shall demonstrate the full functional capability of the equipment, and may involve the use of dummy content and other testing equipment and devices as temporary substitutes as long as the installation of the network throughout the station is incomplete.

C. System Testing:

1. Test each DMS in the station once installation is complete and the Engineer has approved the inspection certification. System testing shall address at minimum:

a. Functional testing of each equipment item installed

b. Demonstration of visual messaging on DMS for automated messaging initiated locally and live and automated messaging initiated remotely from the Authority's Control Center.

D. Integration Testing:

1. Integration testing of the complete PA System shall follow completion of all contracted installation and system testing work, including station and Control Center based system tests. DMS shall be part of the PA System Integration testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of DYNAMIC MESSAGE SIGN will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of DYNAMIC MESSAGE SIGN must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 51 16

PUBLIC ADDRESS SYSTEM

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 specification consists of furnishing and installing PUBLIC ADDRESS SYSTEM at the locations as shown on the Contract Drawings.

B. Provide Public Address System in accordance with requirements of the Contract Documents. Work shall be required to install new digital Public Address (PA) system equipment including installation of Dynamic Message Signs, specified elsewhere. Configuration and programming of the existing Head-end PA equipment in operation at the CTA Control Center shall be the responsibility of the Contractor.

C. The station PA control equipment shall be 100% compatible and interchangeable with the existing IED Globalcom PA head-end System at the Control Center.

D. The new public address system shall provide the formatting of custom, synchronized audio messages with associated visual messages and the selection of prerecorded synchronized audio with visual messages resident at the Rail Station, and shall be individually addressable both locally from the CA Kiosk PA Microphone Console and remotely from the Control Center.

E. Rail Stations not included as part of this contract but part of the system-wide PA Head-end shall continue to operate as before with no modification to the Rail Station PA equipment.

F. The Contractor shall furnish and install PA system equipment, which shall provide operation of synchronous audio/visual, ADA compliant PA systems including, but not limited to, the following:

1. Select Call Address Codes, Control and/or message storage equipment
2. Audio mixer - w/ auto priority
3. Programmable Dynamic Message Signs
4. CA Kiosk microphone and control console equipment
5. Sidetone audio feedback to Control Center
6. Misc. raceways, cable and connectors
7. PA audio channel uplink and downlink
8. Ambient noise level sensing and adjustment

G. The Contractor shall furnish, install, test and place in operation all of the systems, equipment, devices, items and functions required to provide a complete operational Public Address system at this Rail Station. The work done shall be in accordance with this

Specification and in conformity with the designs, layouts and descriptions shown on the Contract Drawings.

H. The Contractor shall be responsible for providing all wiring and cabling necessary for a complete and fully operational Public Address System. The Contractor shall provide all conduit, backboxes and junction boxes. 115 VAC power is required at each DMS. The Contractor shall provide and install raceways, cables and hardware necessary to:

1. Supply power from the Rail Station's power distribution panels in the Communications Room or Electrical Room.

I. Local Operation:

1. Locally pre-recorded train arrival messages and customer assistance request messages are stored in station memory and triggered automatically for playback by track circuits or activated HPT buttons.

2. Audio input shall be by means of a counter-top microphone station console. The microphone station console shall be equipped with a hand held microphone, a vandal/moisture-proof 12 button numeric keypad (0-9, #, *), busy/ready indicator lights, and a vandal-proof LCD display to indicate and prompt user for information. The microphone cable shall be constructed of tinsel wire, medical grade coiling jacket and be terminated with a strain relief into the console. The microphone station console shall be provided at each CA Kiosk. A lock-box microphone station shall be provided at Center Station and on North Platform and South Platform. The counter-top console shall be constructed of steel with integral microphone holder and sloped front.

3. This station is divided into separate zones as shown on the Drawings.

4. Each zone has a dedicated power amplifier channel. Current sensing fault detectors and monitorailest circuit card inputs to the system processor monitors the operational status of these amplifiers and the speaker chain. If an amplifier fails, a hot spare amplifier is immediately substituted for the failed unit. The switching of the input as well as the output will avoid loss of PA coverage and zone specific messages.

5. Any combination of zone control shall be provided, including single zone, multiple zones, and all zones. Zone control shall be addressable in the same way that the station control is addressable. The integrated controller shall manage all audio routing and zone controls.

6. Each zone shall include an ambient noise/sidetone microphone that measures the surrounding noise levels before and during an audio announcement. The noise data gathered by the ambient noise interface card shall be analyzed by the system to adjust the overall audio level accordingly. When the noise level exceeds a preset threshold value, messages shall be preempted and held until the ambient level drops to a specified level, at which time the message shall be replayed in its entirety. Resident "Train Arrival" messages shall always play immediately upon activation.

7. The station PA System has been designed to provide adequate sound levels to its coverage area. Speakers are located throughout the platform area, station areas, and walkway. The volume level of the installed speakers shall be adjusted to 15 to 20 dB higher than the average background noise but not to exceed 95 dB at the ear level. Each speaker shall have an externally adjustable multi-tap transformer for control of individual speaker volume levels. The control system shall be capable of adjusting PA levels based on time of day, including a minimal operation of single speaker Zones 9-12 during extreme quiet periods (such as late at night).

8. The station PA control equipment interfaces with the CA and the Control Center operators to provide PA functions at the station. The PA system shall be provided with logic inputs to receive contact closures from track signal circuits to trigger train arrival messages, and logic outputs to report system equipment malfunctions and system control/sign malfunction to the station SCADA system.

9. "Requests for Customer Assistance" shall be provided via the Help Point Telephone, specified elsewhere. When the HPT button is activated locally, the HPT relays shall trigger a local blue light strobe. The HPT relays shall also trigger a resident pre-canned message in the PA System, via the SCADA System I/O. The PA System shall contain provisions for 12 resident message circuits to be triggered by external devices. The Contractor shall connect the newly installed HPT buttons through the SCADA RTU to the new PA system equipment.

10. Each station shall be provided with LCD display panel Dynamic Message Signs, specified elsewhere. The PA System shall provide ADA compliant messaging for synchronizing audio broadcast messages with visual text messages. The DMS' shall be grouped into the appropriate "PA Zone" coverage provided for the existing audio system. The signs shall be further divided into sub-zones allowing directional display. Each sign face shall have a unique address to allow for message display on a single sign display. The new integrated station control system shall be capable of supporting dynamically controlled scrolling of the message signs.

11. The operation of the PA control equipment at the Rail Station shall be managed at all times by a priority function. The system shall use priorities to manage users in the system, allowing the higher priority users to preempt lower priority users in order to make an audio/visual page, and preventing simultaneous PA. User priorities shall be user defined by the CTA, but shall initially be assigned as follows:

    a. First Priority (Rail Station): Rail Supervisor Booth (n/a here)

    b. Second Priority (Rail Station): Train Arrival Triggers

    c. Third Priority: Control Center Rail Operators

    d. Fourth Priority: Station Customer Assistant Kiosks

    e. Fifth Priority: (Where Applicable) Bus Supervisor

    f. Sixth Priority: Request for Customer Assistance HPT Buttons

    g. Shall support (6) additional priority levels for future assignment.

12. PA control consoles shall be digitally polled for supervision.

13. The system shall support and individually annunciate multiple levels of supervision. Internal diagnostics of hardware and firmware shall provide card failure identification. The new integrated card frame system shall be compatible with on-line diagnostics, programming and adjustments from the Control Center along with on-line network support and system diagnostics with the Head-end System.

14. All operational programming and system adjustments shall be software controllable with software password protection. The user for operational control and adjustments shall customize password access rights.

1.03 RELATED WORK

A. PUBLIC ADDRESS SYSTEM specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. PA – Public Address

B. Reference Standards.

1. ANSI/NFPA 130-2010, Fixed Guideway Transit Systems
2. ANSI/EIA 310-D-1992, Racks, Panels and Associated Equipment
3. EIA/TIA-568: "Commercial Building Telecommunications Cabling Standard"
4. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. General: For the equipment provided, submit the following:

1. Manufacturer's specifications (catalog cut sheets) for each product to be provided.
2. Factory Acceptance Test Procedures for each product.
3. Factory Acceptance Test Reports - a certified copy for each item, demonstrating successful completion of the factory acceptance tests and compliance with the specifications.
4. A detailed schematic diagram showing existing PA system and equipment, new PA system equipment and interface equipment.
5. Local Field Acceptance Test Procedures for approval by the CTA.
6. Local Field Acceptance Test Reports for each installation showing satisfactory operation and performance to meet specifications.

C. Staged Plan: Provide a fully staged plan to accomplish a smooth and orderly integration of the PA System for approval by the CTA.

D. Data Sheets: Data sheets containing evidence of each installation inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be submitted to the CTA for approval. The Contractor shall receive approval of such inspection certification before applying power to the PA equipment covered by such certification.

E. Test Plan and Procedures: Provide a Test Plan and Procedures in accordance with the following:

1. The purpose of test documentation is to demonstrate progressively that the

technical requirements have been met for the corresponding design phase. The documents defining the tests shall be produced alongside the corresponding design documentation.

2. System Integration and Software Integration Tests shall include logic diagrams for 1) prerecording audio messages at the Control Center, 2) creating corresponding text messages; and if applicable to the Contractor's design, 3) down loading text messages to the signage at Rail Stations, and 4) sending the tag along with prerecorded audio so that the corresponding message will be selected and displayed on the VMS and associated procedures to verify that all code has been tested.

3. To ensure that the validation of the software is adequate, the Contractor shall provide the test data for use at the System Integration Test Phase. The Contractor shall map this data to the individual software items to be tested.

4. Following the completion of each set of tests, the Contractor shall submit a test report. The test report shall list all the test results, including version details, metrics, unexplained occurrences, incidents of non-conformance to the test specification, reasons noted, and corrective actions, if any.

5. Documents shall be submitted to the CTA for review and approval during the phases indicated. A phase shall not be completed unless the required documentation has been reviewed with approval by the CTA.

6. Any changes to the software, up to the Site Acceptance phase, shall require a corresponding change to the documentation. All design and test documentation shall be kept up to date. Beyond Site Acceptance, software design documentation shall also be kept up to date. Beyond Site Acceptance, test documents (e.g.., Software Module Test Specification) shall be updated by way of an addendum to the original document which covers new or modified tests required.

7. Within sixty (60) days of review and acceptance of the Detailed Design Specification, the Contractor shall submit to the CTA for review, a preliminary master inventory and approval, a detailed version of the above mentioned inventory.

F. Shop Drawings: Drawings shall be submitted prior to installation for review and approval by the CTA. Work shall not commence at the Rail Station until the submitted drawings are approved.

1. The approved drawings shall be marked by the Contractor during installation to reflect the final installation. The marked-up drawings shall be submitted as part of the final acceptance of the installation.

2. The types of drawings to be provided as part of this Contract shall include the following:

a. Drawings showing typical existing PA equipment and/or cabinet, replacement of PA subsystem equipment and installation of new PA equipment with wiring in existing PA speakers.

b. Drawings showing the arrangement of distribution panels or frames, at station Communications Rooms, Control Center, etc.

c. Drawings showing temporary work required that will not remain as part of the completed work.

d. Drawings that indicate cable routing and identify cable make-up. These drawings, when depicting internal cable routings within buildings, shall show building floor plans, identify conduit, duct or raceway locations and

shall indicate the required sizes of all such conduit, ductwork and cables.

3. The Contractor shall design wiring diagrams and final circuit drawings for equipment being furnished by the Contractor and for any changes to existing equipment as required by the Contract Documents. The Contractor shall be solely responsible for the correctness of the wiring diagrams and final circuit drawings being designed and for the correctness of any existing drawings being reused as part of a complete working system.

4. The Contractor shall check drawings and final tracings for both form and content prior to submittal. Points to be checked shall include:

   a. Conformance to the specifications.

   b. Logical grouping and arrangement of subject matter.

   c. Accuracy.

   d. Legibility.

   e. Neatness.

   f. Line quality.

   g. Lettering quality

   h. Reproduction quality.

   i. Inclusion of Contract specified interfaces with related contracts

5. The effective date and identification number, to be inscribed on the final tracings, will be furnished by the CTA prior to the time the tracings reach the as-built stage and are ready for final processing by the Contractor. This will only occur with acceptance of the project and after the punch list is completely satisfied.

6. Approval of drawings and tracings will be at the discretion of the CTA. The CTA will consider the same points listed above, with the basic criteria for obtaining approval being that the drawings are easy to read, understand and use.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 RAIL STATION CONTROL AND AMPLIFICATION EQUIPMENT

A. Integrated PA Controller (PAC) Unit

1. The Contractor shall furnish and install Rail Station digital PA system control equipment. The equipment shall be a card frame, microprocessor controlled, modular system at each station.

2. The following summarizes the general operating parameters and functions within which the combined units shall perform in an operating unit:

   a. The Rail Station PA System equipment shall provide a passenger station with the facilities for selective control of platform speaker announcements to the patrons either locally from the CA (or Supervisor Booth), or remotely from the Control Center.

   b. Each PA Zone can have a total of 4 different audio page inputs. Any combination of zone control and audio routing are provided including single zone, multiple zone and all zones, through address programming.

      1) CA

      2) Platform Supervisor

      3) Control Center

      4) Playback Audio From Digital Audio Storage Unit

   c. The Rail Station PA System Equipment shall incorporate priorities on a lockout basis, which ensures a higher priority user access to station PA at all times over a lower priority user. The priorities at the Rail Stations are as follows:

      1) Rail Supervisor Booth (for Rail Stations)

      2) Train Arrival Trigger Circuits

      3) Control Center Rail Operators

      4) CA Kiosk

      5) Bus Supervisor (Where Applicable)

      6) Customer Assistant Request Buttons

      7) Provide (6) priority levels for future assignment

   d. The Control Center operator may be denied access to a particular Rail Station PA system if the Rail Platform Supervisor at that station is using the PA system. The Station CA has the lowest priority and must wait until either the Rail Platform Supervisor or the Control Center is finished.

   e. The existing Control Center equipment has the ability to address and page individual stations, groups of stations, branch lines, route line or the entire RT system. A continuous display of station status on the GUI indicates when a station is either free for selection, successfully addressed, malfunctioning, or being paged locally by a Supervisor.

   f. Each Rail Station control unit shall have its own station address code and will respond with a unique station verification code sent back to the headend equipment on the PAC data circuit after it has received the correct address. The Head End Equipment in the Control Center shall acknowledge the corresponding station by indicating a status icon on the GUI, which then indicates to the operator that this station has indeed been addressed.

   g. The addressed Rail Station control unit(s) will close the audio path from the

downlink (talk out) automatically upon receiving the station select code. The station is then selected, allowing the user to page the station with a composite Audio/Visual message.

h. Each Rail Station control unit shall have a unique sidetone code and will connect the audio path from a new PA sidetone microphone on the platform to the uplink (talk back) when this code has been received. This will permit the Control Center operator to monitor (receive) the voice announcement being transmitted by platform or station area speakers.

i. To release the remote units selected by the Control Center operator, the operator clicks an icon, which results in a common reset to be transmitted to all Rail Stations on the PAC data circuit.

j. The system shall be capable of storing at least (30) minutes of eleven (11) kHZ, (16) bit PCM audio with less than 0.05 % THD and a maximum dynamic range of 96 dB. All message storage shall be by means of solid-state memory, appropriately sized for the application. Disk drives shall not be used for Rail Station message storage. The stored messages at the Rail Station, shall contain audio and video page messaging. Each audio/visual message shall be accessed locally or remotely by a unique message select address code. Both audio and video message segments shall play simultaneously at the station speakers and DMS.

k. Distribution, cable and protocol conversion equipment shall be the responsibility of the Contractor to cause the field equipment to communicate with the existing Control Center Head End Equipment.

l. Communication with the Control Center PA Head End Equipment shall be via the 10/100BaseTX Ethernet connection.

B. System Control Equipment Mainframe

1. The mainframe is a computer controlled, modular, four bus audio system all in one mainframe. By the selection of function cards, it can provide multi-channel equalization, multi-channel audio zone mapping, multi-channel noise sensing and compensation, multi-channel monitoring and testing, logic sensing, logic outputs, form C relay closures, variable voltage sensing, variable voltage outputs, signal generation, and analysis.

2. The mainframe provides a housing for and connections to and between the motherboard, the power supplies, CPU components, and the function cards. It has slots for a total of 24 function cards.

3. Input and output connection is easy through the use of plug-in rear panel compression-type screw terminal connectors. The system can be powered from a 120 VAC line, with any line frequency from 50 to 400 Hz.

4. The mainframe mounts in a standard 19" equipment rack.

5. Electrical:

   a. Input Voltage Range: 90 VAC - 130 VAC

   b. Input Frequency: 50 Hz - 400 Hz

   c. Fuse (120 VAC): 5 mm X 20 mm, 5 A slow blow

6. Connectors:

   a. RS232, RS422 IN, RS485 IN: DB9 PC Mount Female AMP 205734-1, or equivalent

b. RS422 OUT, RS485 OUT: DB9 PC Mount Male AMP 205733-1, or equivalent

c. Input/Output Terminal Block, Female: Phoenix 1803374

d. Mating Screw Terminal Connector, Male: Phoenix 1803375

7. Mechanical (maximum overall dimensions as viewed from the front):

a. Height: (17.8 cm) 7.00"

b. Width: (48.3 cm) 19.0"

c. Depth Without Power Cord: (41.7 cm) 16.4"

d. Additional depth allowance-Power Cord: (5.1 cm) 2.5"

e. Weight: (9344 gm) 20.6 lb

8. Environmental:

a. Operating Temperature: (32°F - +104°F)/0°C - +40°C

b. Storage Temperature: (–40°F - +158°F)/–40°C - +70°C

C. Communications Processor

1. The Communications Processor is the equivalent of having a PC residing within the mainframe. It adds interfacing for VGA, keyboard, PS/2 mouse, Ethernet, RS485, and RS232. These connections are made on the rear of the mainframe. This unit is the interface to the digital message signs and the CSU/DSU units.

2. The unit shall be an IED 1100ACS or approved equal.

D. Power Supplies

1. They are dual output, +15 V, 4 A; –15 V, 4 A, 120 W, switch mode power supplies.

2. The input voltage range is 90 VAC to 130 VAC. Power limiting prevents damage due to overloads and short circuits.

3. The power supplies have two modes. They can either be main supplies or backup supplies, but only one or the other at any given time. A main/backup switch bit from the CPU sets it in one or the other mode. As a main supply either has regulated output voltages of +15 VDC and –15 VDC.

4. As a backup supply the regulated output voltages are +14.5 VDC and – 14.5 VDC.

5. A green LED Supply Active indicator shows the status of the power supply. It lights only when the unit is supplying current. It will not light when the supply is idling, or when the supply is in the Backup mode.

6. These units shall be an IED 8102PS or approved equal.

E. 4-Channel Digital Signal Processing Card

1. At each station a 4-channel digital signal-processing card, which provides the functions of parametric equalization, compression, and limiting. (required for a total of 4 PA Zones) shall be provided. Each channel shall provide 9 bands of parametric equalization. The card has an on-board microcontroller (MCU) that sets up the signal processing functions for EQ, filters, compression and limiting. Each channel of parametric EQ contains nine filters or configurable bands. The EQ filters, compression parameters, and limiting parameters are all controllable via software.

2. The card has on-board non-volatile memory that can store signal processing

parameters.

F. Signal Analysis Card

1. The Signal Analysis Card has 2 balanced input channels, the Audio Monitor Bus and the Audio Test Bus. The Audio Monitor bus contains signals to be routed to the DSP for monitoring and audibly monitored by a monitor speaker. The Audio Test Bus and Audio Monitor Bus contain test signals returning from the test points for comparison and analysis. The on-board processing of the signals is per-formed in the digital domain (DSP). The signal processing includes filtering, amplitude measurement, frequency measurement, and delay measurement, among others. The sampling rate is 44.1 kHz. An internal test tone generator is included which generates any test tone frequency between 20 Hz and 20 kHz for use in testing the system on the Audio Test Signal Bus. The Monitor Output and Audio Test Signal Bus are balanced out-puts capable of driving long lines.

G. Audio Input/Output Cards

1. Two audio input/output cards are required per station and used for line level inputs including pre-amplified sidetone audio, downlink audio from the Control Center and audio messages from the digital record/playback card. The audio outputs are used for the up-link audio, supervisor's booth audio and audio messages to the digital record/playback card.

2. The Audio Input/Output Card has four differential, electronically balanced inputs that can be switched to any of four buses, or straight through to its own output. It has four outputs with balanced line drivers. Any output can take audio from any of the four unbalanced audio buses, but two inputs cannot be switched to the same bus. Each output has a digitally controlled amplifier (DCA), which is controlled by the onboard microcontroller (MCU). These DCAs have an adjustment range of 127 dB in 0.5 dB steps, 31.5 dB gain through 95.5 dB attenuation. All switching is done under software control. Four buses, which run the length of the motherboard, make it possible to source audio to/from other cards.

3. An Audio Test Signal Bus with a balanced input can be switched under software control to any output. The test tone will check the DCA, the output, and the MCU. This feature is used in conjunction with monitorailest cards and the signal analysis card to test audio points in the system with the Monitorailest System. This feature also allows test tones to be introduced into output zones for testing of amplifier and speaker lines downstream of this card. A green LED located on the front edge of the card is illuminated when the MCU is running.

H. Audio Level Control (4 Channel Ambient Noise Interface Card)

1. Four Audio level control inputs are required, one for each PA zone, to analyze the respective zone ambient noise level and automatically adjusts the zone audio page level in direct proportion to the ambient noise. When the ambient monitored noise exceeds a certain pre-set threshold level the Central Processing Unit is programmed to have the Digital Record/Playback Card store messages in a queued memory until the noise subsides before playback. The unit shall meet the following criteria:

a. The Ambient Noise Input Card shall have 4 inputs to accept the outputs of Ambient Noise Sensor Remote Sensors which are DC levels proportional to the sensed ambient sound pressure levels (SPL) in a given location. These voltages are scaled and sent to an A/D converter and then to the on-board microcontroller (MCU) to be measured and processed. Source selection is controlled by the MCU. The audio inputs are fed through a

speech bandpass filter and to an RMS to DC Converter that produces DC voltages proportional to the input audio levels. These voltages are scaled and sent to an A/D converter and then to the on-board microcontroller (MCU) to be measured and processed.

b. The unit shall be the IED Model T9040NLR or approved equal.

I. 8 Channel Monitor / Test Card

1. At each Station, an 8-channel tone monitor card (required to monitor a total of 4 PA Zone Audio paths) is required. These units provide monitoring of audio amplifier output circuits or speaker circuits, initiate system visual and contact closures for shorted line, open line and amplifier status failures. The unit will automatically initiate switching of a failed amplifier circuit to a functioning circuit.

2. The Monitor/Test Card has 8 balanced audio input channels that can be switched through a digitally controlled amplifier (DCA) for level control, and then routed to the balanced audio monitor bus and/or audio test bus.

3. The audio output driver is balanced and floating and is designed to drive long lines without high frequency rolloff. The output bus selector makes use of a relay to switch the inputs to the audio test bus, and a solid-state switch for switching inputs to the audio monitor bus. Although the switching speed is relatively slow, the relay maintains the low impedance of the audio driver, allowing the audio test bus output to drive long lines with minimal high frequency rolloff. The solid-state switch used for the audio monitor output is a fast switch, but its added impedance introduces high frequency rolloff, limiting this bus to internal chassis routing only.

4. The input can accept a signal anywhere in the range between a 70 V line (using maximum attenuation) and –40 dBu (using maximum gain). The on-board gain control has a range of 30 dB of gain to 17 dB of attenuation.

5. The card can also select for a test signal appearing on any of the 4 internal audio routing buses, making it possible to test signals from other cards in the system. The test tone, which is eventually routed to the card, is normally generated by the Signal Analysis Card, but can also be generated externally with the right hardware and software.

6. All routing gain control, and testing is under the control of an on-board microcontroller (MCU), which communicates with the system CPU and Signal Analysis Card via an I 2 C bus. A reset line allows the MCU to be reset by the system CPU, if necessary.

J. Dual Current Sensing Speaker Load Sensor w/Ground Fault Detection

1. The Dual Channel, Current Sensing Load Sensor with Ground Fault Detection module is used in conjunction with the Monitorailest system to monitor the current being drawn by a speaker circuit. When connected to a balanced, floating amplifier output it can detect a ground fault on either side of a speaker line.

2. The unit is a current to voltage conversion device that is wired in series with loudspeakers connected to a power amplifier output. The audio monitor output terminals are normally connected to the input of a monitorailest card.

3. The unit shall be an IED Model 596GS or approved equal.

K. 8-Input / 8-Output Logic Cards

1. The logic cards are used for inputs from track switches, customer assistance buttons, etc. and outputs to the SCADA for fault annunciation, relay activation, etc. Two cards are required per station.

2. The logic card has 8 logic in-puts that can be set up as a group by software and used individually to sense either a logic ‘high’ or a logic ‘low’. The sensed conditions are configured by the system CPU, depending upon the system setup.

3. The card also has 8 high current logic outputs. Individual control signals for the logic outputs are transmitted from the system CPU card. Each logic output can sink to ground up to 250 mA from external source voltages up to 45 VDC. The output circuit is designed to drive inductive loads, with an internal diode to clamp the output to 45 VDC.

4. These units shall be an IED Model 8088LIO or approved equal.

L. Microphone Console Control Card

1. The Microphone Console Control Card includes a 307 kHz oscillator, and a detector circuit to demodulate the control signals from each of the microphone stations. The signal is then converted to serial format and sent to the on-board microcontroller (MCU), which in turn communicates with the CPU card through an I 2 C bus on the motherboard. Also included on board is a voltage converter circuit which converts the ± 15 V supplies to +30 V at 0.5 A for phantom powering of the microphone stations.

2. There are three LED indicators located on the front edge of the card. The upper (red) LED indicates an MCU fault when lit. The center (green) LED indicates the presence of 30 VDC phantom power when lit. The lower (green) LED indicates MCU running when lit. +30 VDC and Ground test points are located on the front edge of the circuit card to allow monitoring of the +30 VDC output voltage.

M. Preamplifier/Driver Mainframe

1. The unit has 10 function card slots and 2 power supply (5030) slots for powering higher current applications such as 5232Q and multiple cards with 208S outputs. The processing and power supply cards make connection to the mainframe by card edge connectors located on the motherboard, which forms the rear panel of the mainframe.

2. Each processing card slot also has associated with it a 15-position screw terminal connector for making the necessary input, output and external control connections. The motherboard provides all inter-card connections between processing cards, expansion cards, and power supply cards, as well as connections to system ground, trimpots, phantom power, and AC power, thereby eliminating the need for any direct wiring to individual cards. Also located on the Mainframe motherboard is the AC power cord connector, and locations for up to 5 gain set trimpots for each processing card slot, as needed.

3. The mainframes are designed for mounting in a standard 19" equipment rack. They occupy 3 1/2" of rack space. A hinged, semitransparent smoke-colored plexiglass cover is provided for appearance and as a dust cover which permits observation of any indicator lights.

N. Line Driver Card

1. This card is used as a line driver for audio on the up-link to the Control Center. Each card has one balanced input to one output. Output Modules, with balanced floating outputs, are used as drivers for the external loads.

O. Audio Input/Output Preamplifier Card

1. At the stations the audio from each PA Zone sidetone microphone unit is preamplified in a 2-channel input - 2-channel output preamplifier card. The sidetone

audio is routed through a multi-channel audio I/O card. The selected PA Zone is programmed to be sent back to the PA Headend at the Control Center.

2. Each of the two cards required has two independent channels, each having a balanced input and a balanced, floating output.

P. Configuration & Operation Software

1. The software shall be utilized to configure the card complement included for the system. It shall configure system inputs/outputs, PA priorities/routing and communications protocol between station devices.

2. Operationally the software shall control monitorailest functions, alarm notifications, ambient noise analysis, digital audio recording and digital audio playback.

3. The software shall be IED Navigator or approved equal.

Q. Audio Power Amplifiers

1. Each Station shall be equipped with a card frame amplifier system as part of the new Digital Audio/Visual PA System. (4) four channels of amplification shall be furnished for each station.

2. An amplifier switching system will automatically transfer the functions of a failed amplifier to a hot spare amplifier. Each zone audio speaker circuit shall be a 70.7 V line. The amplifiers shall be equipped with a blower fan if required for continuous operation.

3. Power Amplifier Mainframe

a. The Power Amplifier Mainframe is designed to house, supply power to, provide connections to, and cool the Power amplifier Cards. The Mainframe is for 120 VAC operation. All connections are available on the rear panels of the Mainframes. Input connections are made to plug-in lugless compression-type screw terminal connectors, as are the Monitor Output and Logic Output connections. The main output terminals are 5-way banana jacks on ¾" centers. They will accept separate banana plugs, a standard dual banana plug, spade lugs, tip plugs, or bare wire ends.

b. The Mainframe holds up to (8) 200 W power amplifier cards, for a maximum of 1600 W per mainframe. The power amplifier cards shall be state-of-the-art output transformerless design.

c. Seven inches of rack space is required in a standard 19" equipment rack, allowing space for airflow. Four cooling fans are provided. Each cools two power amplifier cards. The front door is smoke colored polycarbonate, which allows the LED indicators to be seen while providing a clean attractive appearance to the rack front.

d. The unit shall be an IED T9160TL or approved equal.

e. Maximum Number of Amplifier Cards: 9 Cards

f. AC Power Cord for 120 VAC operation: Belden 17250

g. Maximum AC Power Input: 2000 W

h. Front Door: Smoke-colored polycarbonate with aluminum bottom hinge and dual latches

i. Size, overall: 19" W x 7" H x 16.2"D (48.3 cm W x 17.8 cm H x 41.2 cm D)

j. Mounting Depth (rack depth): (44.5 cm) 17.2"

k. Weight: (4.3 kg) 9.5 lb

l. Cooling: 4 fans

4. 70 V, 200 W Power Amplifier Card

a. Each station shall be equipped with (4) four Power Amplifier Cards plus (1) hot spare. The Amplifier Card is a high performance Class D (switching mode) design that delivers 200 W into a 70 Volt line (25 W). Switching mode coupled with high voltage power MOSFET output devices make it possible to eliminate the heavy, costly, bulky transformers. The bridge configuration of the output stage of the amplifier provides a balanced output and at the same time reduces voltage stress on the output devices by 50% for increased reliability. Other advantages include stability under all load conditions (phase angles of 0 to 360 degrees). Switching mode operation also simplifies the complete isolation of the output stage, virtually eliminating internal ground loop problems.

b. The output stage is never driven into clipping. Instead, voltage limiting (clipping) is accomplished in a low level stage. The effect is softer and less harsh than output clipping, sounding much like a good limiter. Clipping occurs only above 100 V peak. In addition, current limiting maintains the output current below the maximum capability of the amplifier (4.0 A peak).

c. A true differential (balanced) input stage is employed, allowing either input side (+ or –) to be grounded with no change in gain. Of course, balanced operation is preferred for its excellent common mode rejection performance. The amplifier has a stepped attenuator that is controlled by a six-pole DIP switch located on the front edge of the circuit card. Attenuation of the input signal may be adjusted over the range of 0 to 63 dB in one dB steps. Accuracy is ± h is ‘On’ and that the amplifier is operational.

d. In addition to the main output, two other outputs are furnished. One is a monitor output for connecting a high impedance monitoring device. It is directly in parallel with the Main Output. The other output is a logic signal that provides fault indication. The logic output is +5 V when the amplifier card is on and operational. It is 0 V when the amplifier card is in a fault condition. The fault indicator output appears at the terminal marked LOGIC with reference to ground, and is accessible at the rear of the mainframe.

e. Over current protection is provided by a 3 A slow blow fuse. The Power Amplifier Card shall have output-transformer less design.0.2 dB for the first 31 dB. Also located on the front edge of the card is the power ON/OFF switch.

f. Three LED indicators are provided. They are located on the upper front of the circuit card. The upper red LED indicates clipping. It lights when the signal exceeds 100 V peak or 4.0 A peak. The center yellow LED indicates signal presence, and turns on when there is sufficient input signal to produce an output of 1.5 V peak or greater. The bottom red LED indicates that the power switch.

g. These units shall be an IED T6472 or approved equal.

R. Backup Power Amplifier Switching System

1. The backup power amplifier switching automatically replaces a failed amplifier with a hot spare amplifier. A failed amplifier shall immediately initiate switching via the backup system to reroute the input and output connections of the failed amp to the hot spare amp. Switching shall occur immediately and result in no loss of zone

capacity, or change in normal zone program activity. Transfer of the load to another zone or combining sources or zones is not acceptable. The failed amplifier shall be reported to the monitor test system for fault notification.

S. AMBIENT NOISE REMOTE SENSOR

1. Outdoor type Ambient Noise Sensor Units shall be installed at each Station. These units, shall monitor ambient noise levels and transmit information to the Ambient Noise Interface Card in the equipment rack as a varying DC waveform. The unit consists of an omni-directional condenser microphone, a preamplifier and an analog conversion module. The units shall be installed in weatherproof stainless steel enclosures.
2. The units shall be IED 540GS Remote Sensor or approved equal.

T. SIDETONE MICROPHONE:

1. Outdoor type Sidetone Microphone(s) shall be installed at each Station. These units shall monitor page audio sidetone. The units shall include a dynamic microphone element and associated impedance matching module. The microphones shall be installed in weatherproof stainless steel enclosures and meet the following criteria:
    a. Size: 3" x 4" x 3.5" (approx.)
    b. Weight: 2 lbs. (approx.)
    c. Connection: XLR connector
    d. Plating: Gold
    e. Source Impedance: 200 Ohm
    f. Microphone type: Dynamic
    g. Freq. Response: 200-7.5 kHz
    h. Sensitivity: 4.0 mv/PA
    i. Enclosure type: Stainless Steel
2. The units shall be DBI LZM-WP or approved equal.

U. STATION PA CONTROL CONSOLE:

1. Each Rail Station Customer Assistant shelters and Platform Supervisor's Booth shall be equipped with a new desktop PA Control Console for initiating local audio and visual public address announcements. The desktop console shall be equipped as follows:
2. Input for an existing hand held PA microphone with preamplifier:
    a. Impedance: 150 ohms
    b. Frequency Response: 100 to 6,000 Hz
    c. Sensitivity: E.I.A. -154 dB
    d. Output: -60 dB with reference to 0 dB
3. Liquid crystal display shall display information associated with preprogrammed resident public address announcements selected locally from console keypad. The LCD display is used to indicate and prompt the user for information, and to show progress.
4. Busy and ready LED indicators shall be visible on the front panel. The red Busy

LED indicates when the portion of the system requested is in use. The green Ready LED indicates when the desired portion of the system is available for an action or an announcement.

5. Console Keypad: Heavy-duty vandal-proof 12-button touch-tone telephone type keypad (0-9, #, *).

6. The console housing shall be tamperproof and constructed of stainless steel. The console shall include a lockable base for attachment to counter or wall. When inserted in it's lockable base the unit will have provisions for a CTA lock to be used for security. The base will also protect incoming cables and connectors from vandalism.

7. The audio section of the microphone stations includes a balanced differential line receiver, a compressor, and a balanced line driver output which is capable of driving extremely long lines of shielded twisted pair cable without significant high frequency rolloff. A test oscillator is built into the microphone station. It can be switched into the audio section, either by a specific keypad entry at the microphone station or by an entry at the main computer.

8. Ethernet IP communications / POE Power

9. The unit shall be IED 528 PA Control Console or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all system equipment in accordance with all Contract requirements, with approved Contractor Drawings and consistent with good commercial practices.

3.02 STATION INSTALLATION

A. Furnish and install PA Control Consoles with security mounting hardware, monitor sidetone microphones/speakers, control switches, variable message signs, and all wiring and wiring devices required to complete each station installation of the PA system throughout the station. Cable distribution to the various station and platform components shall utilize conduit. Shield continuity for shielded cable shall be maintained throughout each run and the shield grounding shall be accomplished only at the communication room end of each shielded cable run.

B. Furnish all PA system rackable equipment with sufficient hardware to install the equipment in new racks or cabinets. Any and all existing PA control equipment shall be removed and replaced with new PA select call and control equipment. Existing Bayly PA equipment rack and/or cabinet shall be individually boxed, labeled, identified, and shipped to CTA.

C. Verification of Conditions: Examine the areas to receive the work and the conditions under which the work would be performed. The Contractor shall remedy any conditions detrimental to the proper and timely completion of the work.

D. In the event raceways need to be extended, rerouted or modified, the Contractor shall accommodate such work using materials and methods outlined in Electrical Sections.

E. All exposed raceways shall follow the facility building lines and shall be installed as inconspicuous as possible. All junction and pull boxes shall be installed as inconspicuous as possible. Contractor shall place sleeves and inserts in walls and partitions for the

passage or support of raceways. Sleeves and inserts shall be hot dipped galvanized. Openings shall be patched and painted after the raceway work is completed. All new raceways shall be painted to match existing.

F. Upon completion of the work, repair surfaces that have been permanently stained, marred or otherwise damaged. Replace work that is damaged or cannot be adequately cleaned as directed.

G. Upon completion of work, remove unused materials, debris, containers and equipment from the project site. Clean the work as recommended by the manufacturer.

3.03 CONTROL CENTER INSTALLATION

A. Furnish and install all equipment, including audio bridges, cables and blocks, as required, in the Control Center to provide related equipment necessary for supporting the new PA system installed at Rail Stations. CTA forces will provide modified software system as described herein, for addressing and PA control of station's PA system.

3.04 GROUNDING

A. Grounding of all the equipment shall be provided as required by the Manufacturer's Specifications and Section 27 05 26, Grounding and Bonding, and shall be approved by the Engineer.

3.05 INSTALLATION INSPECTION

A. Following completion of the installation of all PA equipment at a site, inspect equipment wiring to verify that all electrical and mechanical connections are made and properly secured, all hardware is installed in its proper location, and all wiring is properly terminated. This inspection shall include conductor and shield continuity and isolation verification of all installation wiring.

3.06 TESTING REQUIREMENTS

A. Perform testing as follows:

1. Factory testing: All PA system equipment including DMS and materials shall be tested at the manufacturing location using the production inspection and testing procedures in normal use by the producer. Provide test results of waterproof PA cabinet enclosure, as well as vibration and physical shock resistance of enclosure. Certification of the testing shall be provided to the Engineer.

B. Installation Testing:

1. Test the cabinet mounted and/or rack-mounted Audio/Visual PA system equipment under electrical power following approval of the installation inspection by the Engineer. Installation testing shall demonstrate the full functional capability of the equipment, and may involve the use of dummy loads and other testing equipment and devices as temporary substitutes as long as the installation of handsets and speakers throughout the station is incomplete.

2. Test the DMS.

C. System Testing: Test the audio/visual PA system in each station once installation is

complete and the Engineer has approved the inspection certification. System testing shall address at minimum:

1. Functional testing of each equipment item installed.
2. Message quality at each speaker location in each speaker chain, using inputs from each of the available sources of announcements.
3. Demonstrate that audio level at ear level shall not exceed 95 dB at any point in the station with the system control settings at operational maximum output.
4. Demonstration of PA system user priority functions.
5. Demonstration of all system control functions available at the station.
6. Demonstration of all system control functions at the Controls Center.
7. Demonstration of visual messaging on PA signs from messaging initiated locally from Customer Assistant shelters and Supervisor Booth and initiated remotely from the CTA Control Center.
8. Demonstration of the programmable display effects including ASCII characters and bit map graphics as defined in Subparagraph 2.05.D.6 from the control center administration server.

D. Integration Testing:

1. Integration testing of the complete Audio/Visual PA System shall follow completion of all contracted installation and system testing work, including station and Control Center based system tests. Integration testing shall consist of exercising the overall PA system from the Control Center as well as from local control points to verify all interlocks, panel-lamp indications, GUI map/screen station and PA display indications, priority definitions, and a sample of distortion readings at various Rail Stations to check the entire system, including all interface levels to and from the carrier system. Levels and distortion readings shall be taken at random locations defined by the Engineer or the Engineer's representative on the scene at the time of testing.
2. Test the equipment after installation to determine if it operates when its assigned code(s) are transmitted from the Control Center using associated signaling system, while rejecting all codes other than the assigned code(s). The Audio/Visual PA System shall respond to each of its codes by sending out its respective verification code on the uplink. The system shall broadcast audio upon receiving the push-to-talk code and the announcement sidetone shall be sent back to the uplink upon receiving its respective sidetone amplifier code. Test each of the addressable DMS for proper messaging, displays, etc.
3. Demonstrate that, upon receiving the turnoff code, the PA system returns to its normal standby status. The system will also operate locally when the output audio and push-to-talk activation is made from an external microphone and preamplifier wired to the Agent's and Supervisor's microphone input ports. An operational test of the PA system priority shall be made to demonstrate that a station page initiated from the Control Center seizes control of the PA system away from the local station CA but not vice-versa. A similar test of the Supervisor's page priority over that of the Control Center Controller or CA's page shall also be demonstrated.

E. Test Support: Provide test support upon request by the Engineer to assist in additional testing of the PA system or equipment after its acceptance by the CTA.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of PUBLIC ADDRESS SYSTEM will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of PUBLIC ADDRESS SYSTEM must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 27 51 17

PUBLIC ADDRESS SPEAKERS

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 specification consists of furnishing and installing PUBLIC ADDRESS SPEAKERS at the locations as shown on the Contract Drawings.

B. All speakers to be provided shall be in coordination with and be part of the turn-key PA System in Section 27 51 16.

C. Platform tube light tray speakers and walkway light tray speakers shall be Type 1 all-environment enclosed speakers. Type 1 speakers shall be Bogen model A2T or Engineer approved equivalent.

D. Platform speakers in the split platform canopies shall be Type 3 all-environment speakers. Type 3 speakers shall be Bogen model A6T or Engineer approved equivalent.

E. All exposed Type 3 platform speakers and surface brackets on the north split platform and the south split platform shall be white in color.

F. All recessed Type 1 tube platform speakers and brackets in the integral light tray shall be black in color.

G. All recessed Type 1 walkway speakers and brackets in the integral light tray shall be black in color.

H. Station area speakers shall be Type 2 or shallow Type 2A ceiling mounted environmental speakers, recessed in removable ceiling tiles. Type 2 speakers shall be Bogen model OCS1 or Engineer approved equivalent. Type 2A speakers shall be Atlas model C10AT72 or Engineer approved equivalent.

I. All station area Type 2 speaker baffles shall be stainless steel with #4 brushed finish.

J. The station PA System in Section 27 51 16 has been designed to provide adequate sound levels to its coverage area. Speakers are located throughout the platform area, station area, and walkways. The speaker volume shall be adjusted to 85dBspl, nominal at the ear level, at 15 to 20 dB higher than the average background noise but not to exceed 95 dB at the ear level. Each speaker shall have an externally adjustable multi-tap transformer for control of individual speaker volume levels.

1.03 RELATED WORK

A. PUBLIC ADDRESS SPEAKERS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 26 50 30 - Cable and Light Tray Enclosure
2. Section 27 00 10 – Communications General Provisions
3. Section 27 51 16 – PA System

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. ABS - Acrylonitrile butadiene styrene thermoplastic
2. dB – Decibel
3. dBspl – Decibel, sound pressure level
4. Hz – Hertz
5. kHz - Kilohertz
6. PA – Public Address
7. UL – Underwriters Laboratories
8. W - Watt

B. Reference Standards.

1. ANSI/NFPA 130-1993 - Fixed Guideway Transit Systems
2. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications
3. Mil-Std-810E – Test Methods for Temperature, Humidity, Ultraviolet light, and Salt Spray.
4. UL-2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. In addition to the submittals required in Specification 27 00 10 – Communications General Provisions, Section 1.06, the following shall be submitted:

1. A detailed schematic diagram showing existing PA system and equipment, new A/V-PA system equipment and interface equipment.
2. Local Field Acceptance Test Procedures for approval by CDOT and the CTA.
3. Local Field Acceptance Test Reports for each installation showing satisfactory operation and performance to meet specifications.

4. Test Reports containing evidence of each installation inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be submitted to CDOT and the CTA for approval. The Contractor shall receive approval of such inspection certification before applying power to the paging equipment covered by such certification.

C. Shop Drawings shall be submitted prior to installation for review and approval by CDOT and the CTA. Work shall not commence at the RT station until the submitted drawings are approved.

1. The approved drawings shall be marked by the Contractor during installation to reflect the final installation. The marked-up drawings shall be submitted as part of the final acceptance of the installation.

D. The Contractor shall design wiring diagrams and final circuit drawings for equipment being furnished by the Contractor and for any approved changes to equipment in the Contract Documents. The Contractor shall be solely responsible for the correctness of the wiring diagrams and final circuit drawings being designed and for the correctness of any existing drawings being reused as part of a complete working system

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

B. In addition to the System Warranty period identified in Specification Item 27 00 10 - Communications General Provisions, Section 1.08, each speaker shall include a manufacturer material warranty of 5 years, transferable to the CTA after Final Acceptance by CDOT.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 TYPE 1 SPEAKER

A. GENERAL:

1. Type 1 speakers shall be Bogen model A2T or Engineer approved equivalent.

B. ENVIRONMENTAL:

1. Weather-tight, fully sealed enclosure

2. Rated for operation in any weather, including but not limited to, extreme heat and cold, constant humidity, ice, snow, rain, sun/ultraviolet light, wind and salt spray.

3. Compliant with Mil-Std-810E
4. High density polypropylene enclosure with UV inhibitors

C. ACOUSTICAL:

1. Sensitivity: 88 dBspl (1Watt@1 meter)
2. Dispersion Angle: 80 degrees
3. Frequency Response: 55 Hz – 20 kHz (half-space response)
4. Coaxial design:
    a. 6 inch low frequency transducer, metal alloy cone with deep anodized surface treatment for rigidity and corrosion resistance (paper or plastic cones will not be allowed)
    b. Voice coil centered in a high gauss, low viscosity magnetic fluid to prevent corrosion in the magnet gap and allow for heat transfer under high power input
    c. Compounded rubber cone gasket to withstand all environmental conditions
    d. ½ inch high frequency transducer, environmental polycarbonate diaphragm
    e. low viscosity magnetic fluid to dampen the voice coil and allow for heat transfer under high power input

D. ELECTRICAL:

1. 70-volt rated operation
2. Integrated power transformer with 4W, 8W, and 16W power taps
3. Gold-plated, rust-proof barrier terminal screws

E. PHYSICAL:

1. Surface mount, fully sealed enclosure for installation via bracket on poles, walls, or other exterior surfaces, as well as installation within light trays or above ceilings designed to produce a recessed speaker mount installation.
2. Dimensions: 8 inches Diameter (round) x 8-1/4 inches Deep, maximum
3. Weight: 10 lbs, nominal
4. Side mount threaded bolt taps, 5/16-18 thread, for mounting to the speaker bracket. Mounting bolts shall be tamper-resistant.
5. Color: Option to include black, white, and green

F. TERMINAL COVER

1. Each speaker shall include a terminal block electrical cover to provide additional weather protection of the wires and terminal connections. The cover shall fit securely over the terminal block area on the back of the speaker.
2. The terminal cover shall be Bogen model ASTB4 or Engineer approved equivalent.

G. BRACKET

1. Each speaker shall include a mounting bracket with multiple mounting angles.
2. The bracket shall be heavy-gauge steel, treated and painted for all environment installations.

3. The bracket shall be painted to match speaker color.
4. See Contract Drawings for additional bracket information.

2.02 TYPE 2 (Type 2A) SPEAKER

A. GENERAL:

1. Type 2 speakers shall be Bogen model OCS1 or Engineer approved equivalent.
2. Type 2A speakers shall be Atlas C10AT72 or Engineer approved equivalent.

B. ENVIRONMENTAL:

1. Rated for operation in indoor environments with harsh conditions, including but not limited to, extreme heat and cold, and constant humidity.
2. UL Listed
3. UL-2043 compliant

C. ACOUSTICAL:

1. Sensitivity: 89.5 dBspl (1Watt@1 meter)
2. Dispersion Angle: 140 degrees
3. Frequency Response: 45 Hz – 19 kHz (half-space response)
4. Type 2 Coaxial design:
    a. 6-1/2 inch low frequency transducer, metal alloy cone with deep anodized surface treatment for rigidity and corrosion resistance (paper or plastic cones will not be allowed)
    b. Voice coil centered in a high gauss, low viscosity magnetic fluid to prevent corrosion in the magnet gap and allow for heat transfer under high power input
    c. Compounded rubber cone gasket to withstand all environmental conditions
    d. ¾ inch high frequency transducer, black polycarbonate diaphragm
    e. low viscosity magnetic fluid to dampen the voice coil and allow for heat transfer under high power input

D. ELECTRICAL:

1. 70-volt rated operation
2. Integrated power transformer with 1W, 2W, 4W, 8W, 16W, and 32W power taps
3. Front mounted power tap selector via rotary switch, under a removable grille
4. Four screw snap-lock input connector with loop-through connections

E. PHYSICAL:

1. Recessed ceiling mount for installation above ceilings.
2. Plated steel can enclosure
3. ABS constructed front baffle, with 94VO fire rating Acrylonitrile butadiene styrene
4. Integral ceiling mount clamps that rotate outwards to provide a secure installation to the ceiling surface.

5. Attachment point for steel tether support cable
6. Dimensions: 12-3/8 inches Diameter (round) x 12 inches Deep, maximum
7. Weight: 10 lbs, nominal
8. Perforated speaker grille, heavy-gauge steel, color-matched to baffle
9. Color: off-white baffle with mild texture finish for paint adhesion

F. BRACKET

1. Each speaker shall include a 10 foot maximum steel tether cable to provide secondary suspension of the speaker as a safety mechanism if the primary ceiling mount fails.
2. The safety tether cable shall be Bogen CK10 or Engineer approved equivalent.
3. Each speaker shall include a ceiling tile support ring bracket to provide mounting support of the speaker in the suspended ceiling grid system.
4. The bracket shall be of rigid steel or aluminum sized to mount the Type 2 speaker specified herein.
5. The ceiling tile support ring bracket shall be Bogen TBCR or Engineer approved equivalent.
6. See Contract Drawings for additional bracket information.

2.03 TYPE 3 SPEAKER

A. GENERAL:

1. Type 1 speakers shall be Bogen model A6T or Engineer approved equivalent.

B. ENVIRONMENTAL:

1. Weather-tight, fully sealed enclosure
2. Rated for operation in any weather, including but not limited to, extreme heat and cold, constant humidity, ice, snow, rain, sun/ultraviolet light, wind and salt spray.
3. Compliant with Mil-Std-810E
4. High density polypropylene enclosure with UV inhibitors

C. ACOUSTICAL:

1. Sensitivity: 89 dBspl (1Watt@1 meter)
2. Dispersion Angle: 110 degrees horizontal, 45 degrees vertical up, 35 degrees vertical down
3. Frequency Response: 50 Hz – 20 kHz (half-space response)
4. Coaxial design:
    a. 6 inch low frequency transducer, metal alloy cone with deep anodized surface treatment for rigidity and corrosion resistance (paper or plastic cones will not be allowed)
    b. Voice coil centered in a high gauss, low viscosity magnetic fluid to prevent corrosion in the magnet gap and allow for heat transfer under high power input

c. Compounded rubber cone gasket to withstand all environmental conditions

d. 1-1/8 inch high frequency transducer, environmental polycarbonate diaphragm

e. low viscosity magnetic fluid to dampen the voice coil and allow for heat transfer under high power input

D. ELECTRICAL:

1. 70-volt rated operation

2. Integrated power transformer with 8W, 16W, and 32W power taps

3. Gold-plated, rust-proof barrier terminal screws

E. PHYSICAL:

1. Surface mount, fully sealed enclosure for installation via bracket on poles, walls, or other exterior surfaces, as well as installation within light trays or above ceilings designed to produce a recessed speaker mount installation.

2. Dimensions: 13-7/8” H x 7-1/8” W x 7-3/4” D, maximum

3. Weight: 12 lbs, nominal

4. Side mount threaded bolt taps, 5/16-18 thread, for mounting to the speaker bracket. Mounting bolts shall be tamper-resistant.

5. Color: Option to include black, white, and green

F. TERMINAL COVER

1. Each speaker shall include a terminal block electrical cover to provide additional weather protection of the wires and terminal connections. The cover shall fit securely over the terminal block area on the back of the speaker.

2. The terminal cover shall be Bogen model ASTB4 or Engineer approved equivalent.

G. BRACKET

1. Each speaker shall include a mounting bracket with multiple mounting angles.

2. The bracket shall be heavy-gauge steel, treated and painted for all environment installations.

3. The bracket shall be painted to match speaker color.

4. See Contract Drawings for additional bracket information

2.04 END OF LINE FILTER MODULE

A. Each speaker circuit shall include an End of Line filter module to allow automatic 20 kHz system testing from the PA system for testing continuity of speaker wiring to the end of each speaker circuit.

B. The EOL filter module shall meet the following requirements:

1. NFPA 72 compliant

2. Senses current for speaker line integrity performed by the PA System microprocessor controlled amplifier chassis.

3. Test tone limits:

a. Continuous tone: less than or equal to 5V at 20 kHz

b. Time limited tone: greater than 5V at 20 kHz

c. Four minutes max: 10 V at 20 kHz

d. 100 V maximum test tone voltage

4. Slip on, insulated, crimp-type, female connectors, 6 inch leads

5. 1.96 inch L x 0.956 inch W x 1 inch D

6. Temperature:

a. -40 degrees F to +212 degrees F

2.05 SPEAKER CABLE

A. Provide speaker cables as follows:

1. Speaker Wire: 1 TP, 16 AWG, shielded; PVC insulation, aluminum polyester shield, chrome sunlight resistant PVC jacket, temperature rating: 105 degrees C, and voltage rating: 300 volts.

PART 3 - EXECUTION

3.01 TYPE 1 and TYPE 3 SPEAKERS

A. All Type 1 and Type 3 speaker installations shall be coordinated with the Architectural Reflected Ceiling Plans in the Contract Drawings.

B. Install Type 1 and Type 3 speakers in accordance with the speaker manufacturer recommended installation procedures.

C. Type 1 and Type 3 speakers along the north split platform and the south split platform shall be installed recessed between the station canopy support steel plates.

D. Type 1 and Type 3 speakers along the north split platform and the south split platform shall be angled such that the center axis of each speaker is pointed at the mid-point of the platform between the track edge and back edge of the platform.

E. Type 1 and Type 3 speakers along the center platform tube structure shall be installed recessed within the speaker cavity integrated into the continuous light tray.

F. Type 1 and Type 3 speakers along the center tube structure shall be angled such that the center axis of each speaker is pointed directly down at a right angle to the platform.

G. Type 1 and Type 3 speakers along the ground level walkway shall be installed recessed within the speaker cavity integrated into the continuous light tray.

H. Type 1 and Type 3 speakers along the ground level walkway shall be angled such that the center axis of each speaker is pointed at the mid-point of the walkway, to the extent the light tray structure allows.

I. Type 1 and Type 3 speaker connections shall be protected by a rubber cover that allows speaker wires to enter at tip and continue through to terminate on the speaker terminals.

1. The tapered tip of the terminal cover shall be cut to allow a snug fit over the speaker wires.
2. The tapered tip shall be treated with a weather-proof silicone-based caulk after installation to prevent the ingress of moisture through the terminal cover tip.
3. The terminal cover base shall be snugly affixed to the back of the speaker over the terminal connections.

3.02 TYPE 2 and Type 2A SPEAKER

A. All Type 2 and 2A speaker installations shall be coordinated with the Architectural Reflected Ceiling Plans in the Contract Drawings.

B. Install Type 2 and 2A speakers in accordance with the speaker manufacturer recommended installation procedures.

C. Type 2 and 2A speakers in the ground level station areas shall be installed in coordination with the station ceiling grid system.

D. Each Type 2 and 2A speaker shall be installed with a steel safety tether cable to the back of each speaker. The other end of the safety tether cable shall be looped around or attached to a structural support above the ceiling grid, and independent of the ceiling grid structure.

E. Each Type 2 and 2A speaker shall be installed with a ceiling tile support ring bracket to provide support above and independent of the ceiling grid panels.

F. Type 2 and 2A speakers in the station areas shall be angled such that the center axis of each speaker is pointed directly down at a right angle to the floor.

3.03 END OF LINE FILTER MODULE

A. The EOL module shall be installed at the last speaker of each speaker chain circuit.

3.04 SPEAKER CABLE

A. Refer to PA System Placement Plans in the Contract Drawings for speaker circuit correlation.

B. Speakers in the Main Station, Center Station, and South Station shall be daisy-chain connected, in their respective speaker zones, with a single-pair, single cable.

C. Speakers along the platform and the ground level walkway shall be daisy-chain connected, in their respective speaker zones, with two single-pair cables. There shall be dual speaker circuits for each zone, with one circuit alternating every other speaker to the end of the speaker chain, while the second circuit alternates the remaining speakers to the end of the speaker chain.

D. Shield continuity for shielded cable shall be maintained throughout each run and the shield grounding shall be accomplished only at the communication room end of each shielded cable run.

E. All speaker circuits shall be terminated on the wallfield in the Communications Room in the

Main Station on a disconnect-capable terminal block as the demarcation point between the field speakers and the amplifier chassis. Each terminal block shall meet the following requirements:

1. 12 pole terminations (accommodates 6 pairs of conductors)
2. Heavy nickel-plated, brass contacts
3. Sliding mechanical link to open a circuit pair without disconnecting wire connections
4. High isolation barriers between contacts
5. UL listed
6. Rated at 600 volts, 30 amperes
7. Marker strips to identify each conductor/pair
8. Clear cover
9. The speaker circuit demarcation block shall be Megger brand, States Products series Type NT, model CSM-25012, or Engineer approved equivalent.

3.05 CONDUIT

A. All conduit shall comply with Specification 26 05 00 – Raceways and Boxes.

B. All PA conduit and raceways shall be hidden from public view to the extent possible. Any installations that cannot be hidden from view shall be brought to the attention of the Authority for resolution prior to proceeding.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of PUBLIC ADDRESS SPEAKERS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of PUBLIC ADDRESS SPEAKERS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 16 19

INTRUSION DETECTION REMOTE DEVICES AND SENSORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This specification consists of furnishing and installing INTRUSION DETECTION REMOTE DEVICES AND SENSORS at the locations as shown on the Contract Drawings.

B. The Intrusion Detectors shall be provided in the station houses to monitor for intrusion into the floor space of the stations when stations are closed overnight.

C. The Intrusion Detectors shall be connected and integrated with the station SCADA system for collecting intrusion status alarms for alerting CTA Control Center and as logical inputs to automated security detection and response systems such as the Video Management System.

D. The Contractor shall provide the Intrusion Detection system in the Station including all necessary hardware and software to make the system operational and be compatible with the CTA's existing SCADA Master System at the Control Center. The Contractor shall be responsible for all circuit assignments, programming, and wiring with the system and the CTA's existing SCADA Master network to make the SCADA remote terminal unit and intrusion detection devices operational.

1.03 RELATED WORK

A. INTRUSION DETECTION REMOTE DEVICES AND SENSORS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. PIR – Passive Infra-Red
2. UL – Underwriters Laboratories

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 INTRUSION DETECTOR SENSOR

A. GENERAL:

1. The Intrusion Detector Sensor shall be a multiple technology sensor utilizing:
    a. PIR sensor
    b. Microwave range adaptive radar sensor
    c. Tri-focus optical sensor
2. Intrusion Detector Sensor shall be Bosch DS-9370 or Authority approved equivalent.

B. PHYSICAL:

1. Power: 9VDC to 15 VDC
2. Current (maximum): < 26mA
3. Current (standby): 18mA @ 12VDC
4. Outputs (tamper): normally-closed (NC) contacts rated at 25VDC, 125mA maximum
5. Outputs (trouble): solid state relay normally-closed (NC) contacts
6. Outputs (alarm): solid state relay, normally-closed (NC) contacts, power supervised; 3W, 125mA, 25VDC, <10 Ohms
7. Dimensions: 5 inches x 2.75 inches x 2.25 inches
8. Construction: high-impact ABS plastic, white
9. Alarm Indicators:

a. Blue LED

b. Yellow LED

c. Red LED

10. Detection Zones: 86
11. Temperature: -30 degrees c to +55 degrees C
12. Relative Humidity: 0 to 95% non-condensing
13. Built-in Bubble Level
14. Anti-mask technology

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Intrusion Detector Sensor shall be mounted following the manufacturer's recommendations and industry best practices.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of INTRUSION DETECTION REMOTE DEVICES AND SENSORS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of INTRUSION DETECTION REMOTE DEVICES AND SENSORS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 23 13

VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT

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 specification consists of furnishing and installing VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT at the locations as shown on the Contract Drawings:

B. The Video Client shall be 100% compatible and interchangeable with the Authority's existing Teleste S-VMX Video Management System.

C. The Video Client shall be 19" rack mountable and be installed in the new Communications Room equipment cabinets.

D. The Video Client shall be capable of operating a Touchscreen monitor (Security Video Terminal specified elsewhere).

E. The Video Client shall include all required software video licenses to integrate into the CTA's existing Teleste Video Management System, including per camera stream licenses and video client viewing licenses.

F. A Video Client shall be provided to serve each CA Kiosk and respective SVT.

G. The Video Client shall be Teleste S-VMX #XI2901-6.0, or Authority approved equivalent.

1.03 RELATED WORK

A. VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. CCTV – Closed Circuit Television
2. NVR – Network Video Recorder
3. SVT – Security Video Terminal

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT

A. GENERAL:

1. The Video Client shall be Teleste S-VMX # XI2901-6.0 or Engineer approved equivalent.

B. PHYSICAL:

1. Transport: TCP/IP, HTTP/HTTPS
2. Video Decoding Format: JPEG, MJPEG, MPEG-1, MPEG-2, MPEG-4 SP, H.264
3. Video Transport Format: RTP/UDP/IP multicast and unicast
4. Audio Decoding Format: ITU G711, G722
5. Operating System: Microsoft Windows XP/7
6. Application Software: Teleste S-VMX
7. CPU: Xeon E5-2600
8. RAM: 16GB
9. HDD: 1TB
10. Graphic Adapter: VGA
11. Network: 2 x 10/100/1000Base-T
12. Optical Drive: 16x DVD +/-RW

C. ELECTRICAL:

1. Input Power: 120VAC
2. Power Supply: 300W

D. MECHANICAL:

1. Chassis: 4U
2. Dimensions: 7” H x 19” W x 28” D
3. Weight: 71.5 lbs maximum
4. Operating Temperature: +10 degrees C to +35 degrees C
5. Storage Temperature: -40 degrees C to +65 degrees C
6. Humidity: 10-80% non-condensing

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Video Client shall be installed in the CCTV equipment cabinet in the Communications Room as shown on the Contract Drawings.

B. The Video Client shall be installed in accordance with the manufacturer’s established installation procedures.

C. The Video Client shall be powered from a designated circuit from the CCTV UPS.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of VIDEO SURVEILLANCE CONTROL AND MANAGEMENT CLIENT must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 23 16

SECURITY VIDEO TERMINAL

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 specification consists of furnishing and installing SECURITY VIDEO TERMINAL at the locations as shown on the Contract Drawings.

B. The Security Video Terminal shall be a 19” Touchscreen VGA monitor, installed in each CA Kiosk.

C. The SVT shall be mounted in the CA Kiosk on a swing arm wall mount that allows the monitor to swing away from the wall/window and flip flat against the kiosk window such that the CA can view the monitor through the window from the exterior of the kiosk.

D. The SVT shall include a VGA and USB Touchscreen extender to drive VGA video and touch screen USB control of the Video Client PC in the Communications Room to the SVT in the CA kiosk.

E. The SVT shall be Tru-Vu #SRMOBTPWPM-19CH, or Engineer approved equivalent. The swing arm wall mount shall be Innovative Office Products #9110-8.5-4, or Engineer approved equivalent. The SVT VGA/USB Media Converter shall be Apantec #TSE-1-Eu / TSE-1-Ru or Authority approved equivalent.

1.03 RELATED WORK

A. SECURITY VIDEO TERMINAL specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. CCTV – Closed Circuit Television
2. SVT – Security Video Terminal

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 SECURITY VIDEO TERMINAL

A. GENERAL:

1. Security Video Terminal shall be Tru-Vu #SRMOBTPWPM-19CH or Engineer approved equivalent.

B. PHYSICAL:

1. Display area: 19” diagonal display area, 376.17 mm x 300.98 mm
2. Display: Sunlight readable, LCD, LED backlit display
3. Touchscreen
4. Anti-reflective glass
5. Brightness: 1000 nits
6. Resolution: SXGA 1280 x 1024 video
7. Contrast Ratio: 1000:1
8. Pixel Pitch: 0.294 (H) x 0.294 (V) mm
9. Viewing Angle: 80 degrees (H) x 85 degrees (V)
10. Display Colors: 16.7M
11. Response Time: 5ms
12. Control: 5 key control (on/off, menu, select +/-, auto)
13. Setup: on-screen menu
14. Mount: panel mount

C. ELECTRICAL:

1. Power Input: 12VDC, 90-240 VAC with power brick option
2. Power Consumption: 48W

D. MECHANICAL:

1. Indoor rated operation
2. Dimensions: 451mm x 343mm x 58mm
3. Weight: 5.35 kg

2.02 SVT WALL MOUNT BRACKET

A. GENERAL:

1. SVT Wall Bracket shall be Innovative Office Products #9110-8.5-4 or Engineer approved equivalent.

B. PHYSICAL:

1. VESA 75mm and 100mm standard
2. Swivel Range: 30 degrees up/down, 30 degrees left/right
3. Two piece arm extensions: 8.5 inch / 4 inch
4. 35lb maximum support

2.03 VGA / USB TOUCHSCREEN EXTENDER

A. GENERAL:

1. The SVT VGA/USB Touchscreen Extender shall extend VGA video and USB control over a single Cat-5e/Cat-6 cable.
2. SVT VGA/USB Touchscreen Extender shall be Apantec #TSE-1-Eu / TSE-1-Ru or Engineer approved equivalent.

B. PHYSICAL:

1. Resolution: up to 2048 x 1536
2. Distance: up to 1,000 feet
3. Setup: Plug and Play, software shall not be required to setup and operate
4. VGA / USB Extender Pair:
    a. Extender Unit:
        1) Input: (2) USB, Audio
        2) Output: VGA, Audio, RJ45
        3) Cable: 3 ft VGA / Audio / USB combination cable
        4) Mount: magnetic
        5) Power: USB 5V, External 5VDC, 1000mA
    b. Receiver Unit:
        1) Input: RJ45

2) Output: VGA, USB, Audio

3) Adjustments: equalizer, gain

4) Mount: magnetic

5) Power: 5VDC, 1000mA

PART 3 - EXECUTION

3.01 INSTALLATION

A. The SVT shall be mounted in the CA Kiosk on a swing arm wall mount that allows the monitor to swing away from the wall/window and flip flat against the kiosk window such that the CA can view the monitor through the window from the exterior of the kiosk.

B. The VGA/USB Touchscreen extender unit shall be installed in the Communication Room CCTV rack connected to the USB control and VGA video port of the Video Client PC. The receiver unit shall be installed behind the video monitor in the kiosk connected to the USB input and the VGA video port of the SVT.

C. The Contractor shall provide all required power, USB, and VGA cables to make the SVT fully operational with the Video Client.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of SECURITY VIDEO TERMINAL will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of SECURITY VIDEO TERMINAL must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 23 19

NETWORK VIDEO RECORDER

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 specification consists of furnishing and installing NETWORK VIDEO RECORDER at the locations as shown on the Contract Drawings:

B. The Network Video Recorder shall be a high availability, high capacity NVR that is 100% compatible and interchangeable with the CTA's existing Teleste VMX Video Management System.

C. The NVR shall be 19" rack mountable and be installed in the new Communications Room equipment cabinets.

D. Each NVR shall have the capacity to record 30 camera streams, minimum, at 1920x1080 resolution, 4 Mbps, 30 frames/second, for a minimum period of 14 consecutive days.

E. The NVR shall be Teleste VMX #XN1201-6.0, or Engineer approved equivalent.

1.03 RELATED WORK

A. NETWORK VIDEO RECORDER specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. CCTV – Closed Circuit Television
2. NVR – Network Video Recorder
3. SVT – Security Video Terminal

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 NETWORK VIDEO RECORDER

A. GENERAL:

1. The Network Video Recorder shall be Teleste VMX #XN1201-6.0 or Engineer approved equivalent.

B. PHYSICAL:

1. Transport: TCP/IP, HTTP/HTTPS
2. Video Encoding Format: JPEG, MJPEG, MPEG-1, MPEG-2, MPEG-4 SP, H.264
3. Video Transport Format: RTP/UDP/IP multicast and unicast
4. Audio Coding Format: ITU G711, G722
5. Operating System: Microsoft Windows Server 2008 R2
6. Application Software: Teleste VMX High Availability
7. CPU: Xeon E3-1200
8. RAM: 16GB
9. HDD: 12 x 3.5”, 2 x 500GB RAID1, hot-swappable
10. Graphic Adapter: VGA
11. Network: 2 x 10/100/1000Base-T
12. Optical Drive: 16x DVD +/-RW
13. RAID Support: RAID1, RAID5, RAID6
14. Storage: 24 TB, (12x2TB drives)

C. ELECTRICAL:

1. Input Power: 120VAC

2. Power Supply: Dual power supplies 750W each

D. MECHANICAL:

1. Chassis: 2U
2. Dimensions: 3.5” H x 19” W x 28” D
3. Weight: 71.5 lbs maximum
4. Operating Temperature: +10 degrees C to +35 degrees C
5. Storage Temperature: -40 degrees C to +65 degrees C
6. Humidity: 10-80% non-condensing

PART 3 - EXECUTION

3.01 INSTALLATION

A. The NVR shall be installed in the CCTV equipment cabinet in the Communications Room as shown on the Contract Drawings.

B. The NVR shall be installed in accordance with the manufacturer’s established installation procedures.

C. The NVR shall be powered from a designated circuit from the CCTV UPS.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of NETWORK VIDEO RECORDER will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of NETWORK VIDEO RECORDER must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 23 31

CLOSED CIRCUIT TELEVISION FIXED CAMERAS

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 specification consists of furnishing and installing CLOSED CIRCUIT TELEVISION CAMERAS at the locations as shown on the Contract Drawings.

B. This section specifies the requirements for the procurement, installation, and testing of in-ceiling mountable, pendant mount, and surface mount CCTV fixed dome high definition (HD) digital color cameras.

C. The dual image fixed dome HD camera shall be capable of accepting Power over Ethernet (IEEE 802.3af) or 24 VAC.

D. The dual image fixed dome HD camera shall follow open IP standards and shall have H.264 and MJPEG Compression Capability.

E. The digital HD cameras provided under this contract shall be Axis, or Engineer approved equivalents.

1.03 RELATED WORK

A. CLOSED CIRCUIT TELEVISION CAMERAS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 26 50 30 - Cable and Light Tray Enclosure
2. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. CCTV – Closed Circuit Television

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. H.264 and MJPEG Compression Capability & Open IP Standards

2.02 DUAL-IMAGE FIXED DOME CAMERA - TYPE 1

A. The Type-1 indoor/outdoor integrated CCTV high definition (HD) digital camera and enclosure shall consist of two tamper/impact resistant, in-ceiling mountable dome enclosures with integrated fixed cameras and lenses. The integrated high definition (HD) digital cameras and lenses shall consist of one module that is packaged separately for shipment and which shall allow the installation of the enclosure to precede installation of the camera and lens.

B. Dome Enclosure

1. The enclosure back box, when installed, shall not require more than 2.45 inches of space inside a wall or ceiling.
2. The overall height of the enclosure shall not exceed 3.4 inches high, 5.2 inches wide and 8.1 inches long.
3. The enclosure shall be provided with a tamper switch.
4. The domes shall consist of a polycarbonate high security bubble with IK10 impact-resistant rating.
5. The enclosure shall be NEMA 4X, IP67 and IP66 rated, when installed.
6. The enclosure shall be suitable for use in environmental air handling spaces.

7. The enclosure, when loaded with camera and integrated low temperature resistor array shall be capable of operation between –22°F to 122°F and humidity from 10 to 100% RH.

8. The enclosure, when installed, shall have no exposed cables.

C. Camera and Lens

1. The digital camera and lens assembly shall be capable of accepting a wide range of megapixel varifocal 3 to 6mm lenses.

2. Each camera shall be available in high definition color capable of maximum resolution of 1080p.

3. Each camera shall have shutter range at 1-1/32,000 sec.

4. The digital camera shall be capable of supporting multiple video streams.

D. Each camera shall be capable of transmitting over one CAT6 cable.

E. The camera shall be provided with a manufacturer's warranty covering repair or replacement of defective parts for a period of five years from the date of shipment.

F. The dual image Type digital camera shall be the Axis P3715 or Engineer approved equivalent.

2.03 IN-CEILING 360 DEGREE CAMERA

A. The 360 Degree indoor/outdoor integrated CCTV high definition (HD) digital camera and enclosure shall be designed for demanding industrial environments, 6 MP electropolished marine grade 316 stainless steel, IP66 rated video camera, employing one 2592H x 1944V image sensor, capable of providing 360 degree surveillance with no moving parts and three independent video streams.

B. General

1. The 360 degree camera shall employ a single image sensor capable of providing 2592H x 1944V resolution.
2. The 360 degree camera shall provide dewarping software to convert the spherical video image into a continuous flat view
3. H.264 and MJPEG compression
4. 30fps for 1MP and ¼MP resolution, 15fps for 2MP resolution, 10fps for 4MP full resolution
5. The 360 degree camera shall be unicast supported for up to 20 simultaneous users depending on the resolution settings
6. The 360 degree camera shall be multicast supported for the H.264 main camera stream
7. 0.2 lux minimum illumination, providing clarity in low light
8. 10x zoom with Oncam 3D client-side dewarping software
9. 10 configurable privacy regions
10. 8 polygonal Video Motion Detection regions
11. local alarm digital input and output
12. audio microphone input
13. built-in SD Card slot. Supports cards up to 128 GB capacity. Speed class 10 or higher required.
14. video file transfer by FTP
15. image snapshot transferred by email

16. operate on an embedded Linux platform
17. include a built-in web server
18. PoE (IEEE standard 802.af) or 12VDC powered
19. IP69K and IK10 rated

C. Enclosure

1. Housing Materia shall be electropolished marine grade 316 stainless steel with polymer dome cover
2. Dimensions shall be:
   a. Surface 7.2" L x 6.3" W x 4.8" H
   b. Pendant 7.7" L x 7.7" W x 5.7" H
3. Operating Temperature shall be -40° C to 55° C (-40° F to 131° F)
4. Environmental Rating shall be IP66
5. Impact Rating shall be IK10

D. Imager

1. Sensor: 5 MP, Array Format 2592H x 1944V = 5,038,848 pixels and 1/2.5-Inch CMOS Sensor
2. Minimum illumination: 0.2 lux (50 IRE, F/2.0)
3. Scanning: Progressive

E. Image Control Settings

1. Automatic white balance (AWB): 2,500K to 8,000K (approximately)
2. Privacy zone definition: 10 configurable zones
3. Wide Dynamic Range (WDR): Electronic WDR 60 dB
4. Brightness
5. Sharpness
6. Contrast
7. Saturation
8. Exposure compensation
9. Compression – image quality Multi-levels of compression and frame rate adjustment

F. Lens: 185° fixed, F/2.0

1. Angle of view: 180° horizontal, 168° vertical (hemispherical)

G. Video Streams

1. The 360 degree camera shall support the transmission of three configurable video streams, whose properties are detailed in Attachment A.
2. Available compression types:
   c. H.264, available in 2 streams
   d. MJPEG, available in 1 stream
   e. Available resolutions:
      1.) H.264 compression
         a.) 2144 x 1944 (4 MP)

b.) 1488 x 1360 (2 MP)

c.) 1056 x 960 (1 MP)

d.) 528 x 480 (1/4 MP)

2.) MJPEG compression

a.) 2144 x 1944 (4 MP)

b.) 1488 x 1360 (2 MP)

c.) 1056 x 960 (1 MP)

d.) 528 x 480 (1/4 MP)

3. Bit rate

a. Range: 0.8 Mbps – 5 Mbps (Constant Bit Rate)

b. H.264 options:

1.) Constant Bit Rate

2.) Variable Bit Rate

3.) Capped Variable Bit Rate

4.) GOP length

5.) maximum frames per second

c. MJPEG options:

1.) maximum frames per second

2.) quality

4. Frame rate: 0 – 30 fps

5. Presentation: Three video streams in the form of fisheye views (one of which shall be MJPEG).

H. Video Viewing

1. Video and snapshots shall be capable of being accessed through the following means:

a. JPEG images accessible through a web browser

b. Video streaming through an available media player

c. ONVIF driver

d. PSIA driver

I. Storage and Recording

1. The 360 degree camera shall have the facility for onboard SD card storage.

J. Video Motion

1. Video motion analytics shall be pre-loaded in the 360 degree camera.

2. The 360 degree camera shall have the ability to detect motion within up to 8 user defined polygonal areas of the video image.

K. Pan Tilt Zoom (PTZ) Functionality - The 360 degree camera shall support 10x digital zoom.

L. Network

1. Connectivity shall be 100BASE-TX Ethernet with RJ-45 connector
2. Protocols supported shall include the following:
    a. Transmission Control Protocol (TCP), Internet Protocol (IP) v4, User Datagram Protocol (UDP)
    b. Configuration: Dynamic Host Configuration Protocol (DHCP)
    c. Web services: Hypertext Transfer Protocol (HTTP)
    d. Network services: Domain Name System (DNS), Network Time Protocol (NTP), Internet Control Message Protocol (ICMP), Universal Plug and Play (UPnP)
    e. Media: Real-Time Transport Protocol (RTP), Real-Time Streaming Protocol (RTSP)
    f. Multicast: Internet Group Management Protocol (IGMP)
    g. Notifications: File Transfer Protocol (FTP), Simple Mail Transfer Protocol (SMTP)
3. Unicast - The 360 degree camera shall support 20 simultaneous users of independent streams.
4. Multicast – The 360 degree camera shall support multicast for an H.264 main camera stream
5. Security
    a. The 360 degree camera shall have a user configurable password feature

M. Electrical

1. Power source shall be PoE (IEEE standard 802.3af) – 48 VDC nominal and 12VDC.
2. Power Consumption (maximum) at 12 VDC to be 3.19 W and at POE to be 4.05 W
3. Connectors provided shall be
    a. Ethernet RJ-45 connector
    b. External power (12 VDC): 2.1 mm input jack
    c. External input/output shall be 6-pin 1.5 mm Phoenix style connector.

N. Wall/pole brackets, pendent style brackets, and surface mounting shall be provided as shown on the Drawings.

O. The 360 degree digital camera shall be the TKH Group Security Solutions FD360IR-E-6 Series or Engineer approved equivalent.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall be responsible for inspecting all equipment ordered when it arrives on site. Any damaged equipment shall be returned and replaced at the Contractor's expense.

B. The Contractor shall ensure that all returned equipment is replaced within thirty (30) days. No schedule modifications shall be allowed due to returned equipment unless authorized in writing by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CLOSED CIRCUIT TELEVISION FIXED CAMERAS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CLOSED CIRCUIT TELEVISION FIXED CAMERAS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 23 32

CLOSED CIRCUIT TELEVISION PTZ CAMERAS

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 specification consists of furnishing and installing CLOSED CIRCUIT TELEVISION PTZ CAMERAS at the locations as shown on the Contract Drawings.

B. This section specifies the requirements for the procurement, installation, and testing of in-ceiling mountable, pendant mount, and surface mount CCTV PTZ dome high definition (HD) digital color cameras.

C. The PTZ dome HD camera shall be capable of accepting Power over Ethernet (IEEE 802.3af, typical 9W, max 22W.

D. The PTZ dome HD camera shall follow open IP standards and shall have H.264 and MPEG Compression Capability.

E. The CCTV HD PTZ camera system provided under this contract shall be Axis Model Q6010-E; the quad view camera with Axis Model Q6075 PTZ camera that mounts in the center of the Q6010, or Engineer approved equivalent.

1.03 RELATED WORK

A. CLOSED CIRCUIT TELEVISION PTZ CAMERAS specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 26 50 30 - Cable and Light Tray Enclosure
2. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. CCTV – Closed Circuit Television
2. PTZ – Pan / Tilt / Zoom

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. H.264 and JPEG Compression Capability & Open IP Standards

2.02 HD PTZ DOME NETWORK CAMERA

A. The indoor/outdoor HD series network dome system shall be consisting of a 360 degree camera with one-click pan-tilt-zoom control, four 5MP sensors (total of 20 MP resolution), exchangeable and tiltable lenses within common enclosure.

B. Four fixed lenses shall be each at 5 MP progressive scan RGB CMOS 1/2.5".

C. Each lens shall be autofocus lenses, fixed iris, F2.0, Focal length: 2.8 mm, horizontal field of view: 360 degrees, vertical field of view: 84 degree, automatically removable infrared-cut filter and shutter speed at 1/32,500 to 1/20 seconds.

D. PTZ lens shall be ½.8" progressive scan CMOS, 4.25–170 mm, F1.6–4.95, horizontal field of view: 65.1°–2.00° (1080p), vertical field of view: 39.1°–1.18° (1080p), autofocus, auto-iris, and shutter speed at 1/11,000 to 1/3 seconds.

E. PTS movement shall be Pan at 360° endless, 0.05°–450°/s; Tilt at 220°, 0.05°–450°/s; Zoom at 40x optical, 12x digital, total 480x zoom, E-flip, 256 preset positions, tour recording (max 10, max duration 16 minutes each), guard tour (max 100), control queue, on-screen directional indicator, orientation aid PTZ, set new pan, 0°, adjustable zoom speed, focus recall.

F. VIDEO

1. Video Encoding: H.264 high, main, or base profile and MPEG
2. Video Stream: multiple, individually configurable streams
3. Controllable frame rates and bandwidth up to 20 frames per second in all resolutions
4. Image setting: resolution, compression, saturation, brightness, sharpness, contrast, white balance, exposure level, exposure mode, shutter and gain fine tuning of behavior at normal and low light, polygon privacy masks (maximum 8 per channel), WDR, dynamic text and image overlay

G. ELECTRICAL

1. Port requirement: RJ-45 connector for 100Base-Tx; Auto MDI/MDI-X; Auto negotiate/manual settings
2. Cable type: Cat5 or better for 100baseTx
3. PoE: Without PTZ shall be 9W typical, 22W maximum.
4. PTZ: 65W maximum, 24VDC min 3.2A (75 W)

H. Enclosure

1. The enclosure shall meet or exceed NEMA Type 4X, IP66 Standards.
2. The enclosure dome shall be polycarbonate with IK10 impact rating.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall be responsible for inspecting all equipment ordered when it arrives on site. Any damaged equipment shall be returned and replaced at the Contractor's expense.

B. The Contractor shall ensure that all returned equipment is replaced within thirty (30) days. No schedule modifications shall be allowed due to returned equipment unless authorized in writing by the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CLOSED CIRCUIT TELEVISION PTZ CAMERAS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CLOSED CIRCUIT TELEVISION PTZ CAMERAS must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM

GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. These specifications provide for the furnishing, installation, and connection of the fire alarm equipment required to form a complete coordinated system ready for operation. The Fire Alarm System shall include, but not be limited to, alarm initiating devices, control panel, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

B. The work described in this Section consists of all labor, materials, equipment and services necessary and required to complete and test the Fire Alarm System of a City of Chicago Elevator Recall. Any material not specifically mentioned in this Specification or not shown on the Drawings but required for proper performance and operation shall be furnished and installed.

C. Basic Performance:

1. Addressable Signal Line (SLC) circuits shall be wired Class A (NFPA Style 6), supervised for opens and grounds.

D. Basic System Functional Operation: When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. Indicate the device in alarm at the main control panel, by activating an audible and visual alarm at the main control panel.
2. Provide two dry contacts signals, for both Alarm and trouble indications. Contacts for each of the two alarm conditions shall be for connection to a local annunciator, and for connection to the Communications System for transmitting to the Central Control Office. Provide necessary 48VDC rated auxiliary contacts for remote signal via SCADA system to remote CTA central office.

1.03 RELATED WORK

A. Related work specified elsewhere:

1. Section 26 05 00 “Raceways and Boxes”
2. Section 26 10 00 “Basic Electrical Materials and Methods”
3. Section 26 12 30 “Wires, Cables, Splices, Terminations”
4. Section 26 14 10 “Wiring Devices”
5. Section 26 17 00 “Local Control”

6. Section 26 17 50 “Local Control Panels”
7. Section 26 19 00 “Grounding”
8. Section 26 19 50 “Identification”

1.04 REFERENCES

A. The publications listed below form a part of this specification.

B. National Fire Protection Association (NFPA) - USA:

1. No. 70-90 National Electrical Code (NEC).
2. No. 71-89 Central Station Signaling Systems.
3. No. 72-2007 Protective Signaling Systems, National Fire-Alarm Code

C. Underwriters Laboratories Inc. (UL) - USA:

1. No. 268 Smoke Detectors for Fire Protective Signaling Systems, July 20,1987.
2. No. 864 Control Units for Fire Protective Signaling Systems, May 26, 1987.
3. No. 268 A Smoke Detectors for Duct Applications.
4. No. 521 Heat Detectors for Fire Protective Signaling Systems. No. 464 Audible Signaling Appliances.
5. No. 1971 Visual Signaling Appliances.
6. No. 38 Manually Actuated Signaling Boxes.
7. No. 346 Waterflow Indicators for Fire Protective Signaling Systems.

D. City of Chicago Building Code:

1. No. Article 620
2. No. Article 760

1.05 QUALITY ASSURANCE

A. The fire alarm system shall comply with requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

1.06 SUBMITTALS

A. Shop Drawings: Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, and complete wiring point-to-point diagrams.

B. Manuals: Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets (with model numbers to be used indicated).

PRODUCTS

2.01 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and component manufacturers which may be incorporated in the Work include but not limited to Notifier current model, NFS300.

B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations.

C. All Equipment shall be attached to and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

D. Equipment mounted in locations on grade, or electrically continuous with slabs on or below grade, shall be installed so as to maintain the electrical system isolation from earth ground.

E. Fire Alarm Control Panel (FACP) to be provided in the Main Electrical Room. Fire Alarm Annunciator (FAA) panel to be provided near the Customer Assistant Kiosk as shown on the Drawings.

2.02 CONDUIT AND WIRE

A. Conduit:

1. Conduit shall be in accordance with Section 26 05 00 Raceways and Boxes of this Specification.
2. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.
3. Cable shall be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
4. Conduit shall be 3/4 inch minimum.

B. Wire:

1. All fire alarm system wiring shall be new and installed in conduit.
2. Number and size of conductors shall be as recommended by the fire alarm system manufacturer.
3. All field wiring to the indicating devices, shall be completely supervised.

C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

D. The Fire Alarm Control Panel (FACP) shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the Emergency Power Panel as "FIRE ALARM". Fire Alarm Control Panel Primary Power wiring shall be 12 AWG.

E. The Fire Alarm Annunciator Panel (FAAP) to be connected to the FACP with manufacturer recommended or provided cable as required to provide annunciation of each zone and Code required indication.

2.03 FIRE ALARM CONTROL PANEL

A. The addressable FACP shall communicate with and control the following types of equipment used to make up the system: smoke detectors, heat detectors, manual pull stations, and other system-controlled devices.

1. Function: The FACP shall perform the following functions:

a. Supervise and monitor all initiating device circuits and alarm indicating circuits for trouble and alarm conditions.
b. Detect the operation of any initiating device circuit and visually and audibly annunciate the alarm condition at the panel display, and operate all auxiliary relays required for remote indication of the alarm.
c. Visually and audibly annunciate any trouble, supervisory or alarm condition at the panel display, and operate all auxiliary relays required for remote indication of the alarm.

2. The FACP shall perform the following options: Alarm Verification, Waterflow, Supervisory, Silence Inhibit, Disable Circuits, and Walk Test.

B. The Control Panel shall include Indicating Circuits, Alarm Contacts, Trouble Contacts, Supervisory Contacts, the required number of Initiating Device Circuits, and two dry output alarm contacts. Output Contacts shall be rated 48VDC.

C. System Display: The System Display shall indicate the status of the following system parameters:

AC POWER	Green LED
SYSTEM ALARM	Red LED
RELEASE	Red LED
SUPERVISORY	Yellow LED
SYSTEM TROUBLE	Yellow LED
CIRCUIT TROUBLE	Yellow LED
ALARM SILENCED	Yellow LED
POWER TROUBLE	Yellow LED

D. System Functions:

1. System Status LEDs: The alarm, supervisory, or trouble LEDs shall flash until events have been acknowledged. Any subsequent new alarm, supervisory, or trouble will flash new conditions only.
2. Zone Disable: Disable/Enable shall be accomplished using a special sequence of operation of the 4 control switches. If a zone has been disabled, an alarm shall activate the red zone LED, but not the piezo or any output circuit.
3. Last Event Recall: Last Event Recall shall allow the user to display the previous panel status. Last Event Recall may be used to diagnose intermittent trouble conditions.

E. The Control Panel shall also include the following Features:

1. Battery/Earth fault supervision.

2. Alarm verification shall be an optional selection and shall only verify smoke detectors and not other devices on the same circuit.
3. Walk Test shall be provided which allows a single installer to test the system without returning to the panel to reset the system.
4. Watchdog timer to supervise the microprocessor shall be provided.
5. Slide-in zone identification labels shall be provided.
6. Bell circuit disconnect switch shall be provided.

F. Power Supply:

1. The Power Supply for the Fire Alarm Control Panel shall be integral to the Fire Alarm Control Panel itself and shall provide all control panel and peripheral device power needs.
2. Input power shall be 120 VAC, 60 HZ. The power supply shall provide an integral battery charger for use with batteries up to 12 AH.
3. It shall provide 2.25 amperes of regulated 24 VDC power for
4. Audio-Visual alarm indicating devices, four-wire Smoke Detector Power at 24 VDC. up to 200 ma, and Non-Resettable Power at 24 VDC up to 200 ma.
5. The Power Supply shall be designed to meet UL and NFPA requirements for power-limited operation on all initiating and indicating circuits.
6. Positive-temperature-coefficient thermistors, circuit breakers, fuses, or other over-current protection shall be provided on all power outputs.

G. Mechanical Design: The control panel shall be housed in a factory approved cabinet designed for mounting directly to a wall or vertical surface. The panel shall be designed to meet the requirements of Section 261750 Local Control Panels of this Specifications, except the color shall be RED.

H. System Circuit Supervision:

1. The FACP shall supervise all circuits to annunciators and peripheral equipment and annunciate loss of communications with these devices.
2. Each initiating device circuit shall have individual alarm and trouble indication.

2.04 BATTERIES

A. Shall be 12 volt, sealed Gell-Cell type (minimum 2 required).

B. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.

C. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

2.05 SYSTEM COMPONENTS

A. Ionization Type Area Smoke Detectors

1. Ionization type smoke detectors shall be two wire, 24 VDC type using a dual unipolar chamber.
2. Each detector shall contain a remote LED output and a built-in test switch.
3. Detector shall be provided on a twist-lock base.

4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360°, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not alarm when exposed to air velocities of up to 1200 feet per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
7. All field wire connections shall be made to the base through the use of a clamping plate and screw.

B. Automatic Heat Detectors:

1. Automatic Heat Detectors shall be combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit for areas where ambient temperatures do not exceed 100 degrees, and 200 degrees for areas where the temperature does not exceed 150 degrees.
2. Automatic Heat Detectors shall be low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F. per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic Heat Detectors shall have a smooth ceiling rating of 2500 square feet.

C. Automatic Heat Detectors (Weatherproof fixed Temperature):

1. Automatic Heat Detectors designated with WP shall be weatherproof type and shall be fixed temperature rated at 135 degrees Fahrenheit for areas where ambient temperatures do not exceed 100 degrees, and 200 degrees for areas where the temperature does not exceed 150 degrees.
2. Automatic Heat Detectors shall be low profile, ceiling mount type with positive indication of activation.
3. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
4. Automatic Heat Detectors shall have a smooth ceiling rating of 2500 square feet.

D. Addressable Relay Modules:

1. Addressable Relay Modules shall be made available for Elevator Recall control with the following functions; Primary Elevator Recall, Secondary Elevator Recall, and Fireman Helmet Signaling. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary relays may be energized at the same time on the same pair of wires.
2. Final connections to be coordinated with the elevator contractor.

2.06 MANUFACTURES:

A. Fire alarm system Manufacturers which may be incorporated in the Work include but not limited to Notifier, Simplex, or Siemens.

EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, and local codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. At the final inspection a factory trained representative of the manufacturer of the major equipment shall perform the tests in Article 3.02 TEST.

3.02 TEST

A. Provide the service of a competent, factory-trained Commissioner or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
3. Verify activation of all flow switches.
4. Open initiating device circuits and verify that the trouble signal actuates.
5. Open and short indicating appliance circuits and verify that trouble signal actuates.
6. Ground circuits and verify response of trouble signals.
7. Check presence and audibility of tone at all alarm notification devices.
8. Check installation, supervision, and operation.
9. Verify that each initiating device alarm is properly received and processed by the FACP (Walk Test).
10. Conduct tests from the FACP to verify trouble indications for common mode failures, such as alternating current power failure.

3.03 FINAL INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.04 INSTRUCTION

A. Provide eight hours of instruction to the Commissioner's personnel. "Hands-on" demonstrations of the operation of all system components and the entire system shall be provided.

MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of FIRE DETECTION AND ALARM will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of FIRE DETECTION AND ALARM must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION

SECTION 28 46 11

SCADA REMOTE TERMINAL UNIT

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 specification consists of furnishing and installing SCADA REMOTE TERMINAL UNITS at the locations as shown on the Contract Drawings:

B. The remote terminal unit(s) (RTU) described in this section of the specification shall be fully compatible with the CTA's existing Supervisory Control And Data Acquisition (SCADA) system. The Contractor shall integrate the specified remote terminal units (RTUs) provided under this contract with the Control Center SCADA equipment that has been provided by others. The remote terminal units shall collect device status data and provide control for controllable devices. The flow of information to and from the remote devices shall be initiated by and originated from the CTA Master Server at the CTA Control Center.

C. The Contractor shall include all required programming and updating of the SCADA database at remote locations. In addition, all communications equipment and components necessary for a complete and operational system shall be included at the remote and central sites, if required.

D. System Requirements: The SCADA RTU inputs shall be Rapid Transit (RT) Station alarm inputs, Train Location indicator circuits and Rail Track Heaters if required. The Contractor shall provide one ethernet channel under this contract for the SCADA Alarm System identified as SCADA Main routed from the Ethernet Switch at the station node to the CTA’s Control Center SCADA Master Server via the OC-48 network or latest CTA standard technology.

E. Remote Terminal Units: Remote Terminal Units (RTUs) shall be furnished and installed in the RT Station communication rooms within the designated SCADA equipment cabinet and shall include the auxiliary equipment necessary for monitoring and/or controlling the functions associated with the location.

F. Control Center Master Station: The SCADA System shall be over an IP-based communications network. The Contractor shall provide an IP interface card in addition to the specified communications modules herein for each RTU.

1.03 RELATED WORK

A. SCADA REMOTE TERMINAL UNIT specified to be furnished and installed herein have related work in various other sections, including, but not limited to:

1. Section 27 00 10 – Communications General Provisions

1.04 REFERENCES

A. Technical Abbreviations and Definitions.

1. AC – Alternating Current
2. ANSI – American National Standards Institute
3. AWG – American Wire Gage
4. BCH – Binary Coded Hexadecimal
5. CMOS – Complimentary Metal-Oxide Semiconductor
6. DC – Direct Current
7. EIA – Electronics Industry Association
8. FSK – Frequency Shift Key
9. IEEE – Institute of Electrical and Electronic Engineers
10. LED – Light Emitting Diode
11. mA – Milliamperes (10^{-6} amperes)
12. MTBF – Mean Time Between Failures
13. NEC – National Electric Code
14. RTU – Remote Terminal Unit
15. SCADA – Supervisory Control And Data Acquisition
16. TIA – Telecommunications Industry Association
17. UPS – Uninterruptible Power Supply
18. VAC – Volts, Alternating Current
19. VDC – Volts, Direct Current

B. Publications.

1. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

C. Reference Standards.

1. National Electrical Code (NEC), Article 800
2. IEEE Surge Withstand Capability Test C37-90-1

1.05 QUALITY ASSURANCE

A. The quality assurance for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.05.

B. General: The contractor shall utilize a Quality Assurance program designed for early detection of any deficiencies and effective corrective action. The complete process shall result in documented test reports which will confirm that all components and functions are thoroughly tested in a methodical and organized manner in accordance with a written test procedure. The bidder shall comply with the overall quality assurance methodology depicted in the Specification.

1.06 SUBMITTALS

A. The submittals for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.06.

B. Shop Drawings: The Contractor shall prepare and submit to the CTA for review before fabrication and assembly of equipment, electronic files and four prints of each of the following. The Contractor shall submit complete original sets (photocopies of printed material are not acceptable) of the following to the CTA for approval prior to ordering any of the equipment specified in this Section:

1. All submittals as required by the Special Conditions of this Specification.
2. Single line block and system diagrams detailing the entire fiber optic outside plant system.
    a. A block diagram shall be submitted showing the existing CTA fiber optic backbone with the new fiber optic node to be integrated into the backbone. The block diagram shall include interconnection between major independent elements, such as fiber optic cable, and fiber distribution panels or frames.
    b. Optical path loss budget analysis detailing passive loss on each optical link to be provided under this Contract.
3. Proposed Manufacturer's detailed product data "cut-sheets" and specifications for each piece of equipment to be furnished.
4. Installation details of fiber optic cable, and termination/splicing equipment.
5. Wiring diagrams of distribution frames, equipment racks, and the fiber optic cable.
6. Detailed testing procedures and certified copies of all test results and reports, including actual path loss measurement data.
7. All shop drawings as detailed herein.
8. Copies of the Contractors splice log.

C. Record Drawings: Furnish record drawings annotated with the changes made during installation of the Work so as to be a complete set of "as-installed" drawings and wiring diagrams.

D. Test Reports: The Contractor shall submit for record and distribution after installation of equipment, 10 copies of the certified test report.

1.07 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.07.

B. General: Deliver and store materials in manufacturer's original packaging labeled to show name, brand, type, and grade. Store materials in protected dry location off ground in accordance with manufacturer's instructions. Do not open packaging nor remove labels until time for installation.

C. Handling: The equipment shall be shipped on a pallet suitable for forklift handling. The equipment shall be covered with clear plastic or other impenetrable sheeting to prevent dust, dirt and moisture from entering the equipment during shipment and storage.

1.08 WARRANTY

A. The warranty for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.08.

B. Special Warranty: Submit for Owner's documentation. Furnish written warranty, signed by Contractor and Installer, agreeing to repair or replace Work which has failed as a result of defects in materials or workmanship. Upon notification of such defects, within the warranty period, make necessary repairs or replacement at the convenience of the Owner.

C. Following successful completion of a 30-day Performance Test and Construction Acceptance, the Warranty Period shall commence. The purpose of this period is to ensure that all components of the Fiber Optic Outside Plant portion of the Communications System function in accordance with the Specifications over an extended length of time, and to provide continuing assistance to the CTA in all phases of system operation as required. This consists of a 720-day Warranty Period. For a 720 day period, beginning at construction acceptance of the system, the Contractor shall be responsible for the proper performance of all equipment.

D. The Contractor shall also be responsible for obtaining technical assistance from the equipment manufacturers and/or suppliers in cases where programming, operational or adjustment difficulties are encountered; the Contractor shall be responsible for providing training to the CTA on any communications equipment if new or unusual problems/repairs are discovered during the Warranty Period. The Contractor shall be responsible for correcting any problems attributable to poor workmanship and/or equipment.

1.09 TRAINING

A. The training for this section shall be in accordance with Specification Item 27 00 10 - Communications General Provisions, Section 1.09.

B. General: The Contractor shall provide comprehensive training for twelve (12) CTA technicians, on the use of the system, including general maintenance, and failover/startup recovery. Training shall be at the CTA's facilities or at the Contractor's facilities, at the option of the CTA. Training shall be based on an 8-hour workday (6.5 hours classroom time) and shall be conducted during the normal workday Monday through Friday. If training at the CTA's facilities is elected, the bid price shall reflect all training costs: the cost of instruction, student's manuals, instructor's travel and living expenses. Training shall be conducted by employees of the vendor who are experienced trainers and engaged full time in technical training on the products provided. Course syllabuses shall be included with the Contractor's proposal.

C. Hardware Training Course

1. Remote Station training shall consist of board-swap level repair of the remote stations.
2. Hardware training shall consist of a minimum of one (1) full day of instruction.
3. Training for component level repair of remote stations shall be available on request.

D. Training Equipment, Literature and Drawings: Recommended test equipment, literature and drawings for the classes shall be furnished by the Contractor. At the conclusion of classes, all items furnished, which are not currently owned by the CTA, shall become the property of the CTA.

E. Training Class: All training class time (indoor and outdoor) shall be videotaped by the Contractor on standard VHS video tape(s) for use in a standard VCR. The video tape(s) shall become the property of the CTA.

PART 2 - PRODUCTS

2.01 REMOTE TERMINAL UNITS (RTUs)

A. Functional Requirements:

1. The RTUs shall be microprocessor controlled such that changes in their operation may be made by merely changing memory elements. System input/output boards shall be cable connected to logic boards and arranged such that future expansion of the RTU may be made with minimum effort and not require specialized tools or knowledge.
2. All remote terminal units shall communicate with the Master Station over the leased lines specified under this contract.
3. Standard telephone cable shall be used to connect the RTU to the telephone terminal cabinet.
4. The inputs to the RTU shall be status points and analog measurement points. RTU outputs shall be control points.
5. Equipment shall be furnished as required to permit remote monitoring and control functions.
6. All Contractor furnished equipment shall function and communicate with existing CTA SCADA equipment, located at the Control Center.

B. Operational Requirements:

1. The RTUs shall be capable of accommodating variations (without degradation in communications) in line impedance, delay distortion, etc., which may be expected on these types of circuits.
2. The remote station RTU enclosures shall contain, but not be limited to, solid state circuit boards, interposing relay panels, semiconductor rectifier power supplies (copper oxide type not acceptable), ground detectors, communication equipment, terminal blocks, fuse blocks and switches as required. Fusing also shall be furnished to protect the lines and equipment in the event of accidental contact with 120VAC or 600V DC.
3. The RTU shall support programmable calculation and control algorithms. These shall be written on a portable laptop computer using a script editor. These shall be compiled and loaded into non-volatile memory in the RTU. The RTU shall have the capability to upload the script to the Master Station. In the event of a failure of the RTU or corruption of the script file, the Master Station shall download the file into the RTU. This file format and communication protocol shall be compatible with the existing CTA Traction Power SCADA System.
4. As a minimum, the calculation and control routines shall support the following mathematical and logical functions: add, subtract, multiply, divide, assign, log, exponential, sine, cosine, tan, arcsine, arccosine, arctan, equal to, not equal to, greater than or equal to, less than, less than or equal to, square root, absolute value, reciprocal, AND, OR, NOT, and XOR.
5. The available database for the above shall include: local status values, local

analog values, local accumulator values, setpoint values from Master Station, Control requested from the Master Station, date and time variables, and communications failure.

6. Functions shall include: set status value, set analog value, set accumulator value, set setpoint control value, execute local controls, and start local timer.

7. The RTU shall have a built-in circuit to detect and isolate a grounded SCADA communication line from the RTU so a "grounded" at only one point on the data transmission line wire shall not cause a LINE SUPERVISION alarm or impair operation of the system. (LINE SUPERVISION is defined as loss of communication between the Master Station and the RTU).

8. The RTU shall have an adjustable ground detection system capable of sensing a resistance to ground with an adjustable range between 5,000 Ohms and 50,000 Ohms on the RTU station DC power (both positive and negative). Two (2) outputs of ground detector circuits shall be dry contacts with configuration "energized in Normal Condition". The negative supply potential of the ground detectors shall be connected to ground or CTA Structure as appropriate. The ground detector system shall be energized from an independent DC power supply, rectified and filtered from an isolated 120 VAC -60 Hz source.

9. RTU status, analog and control module panel addresses shall have plug-in jumpers to configure/reconfigure the module panel address.

C. Input & Output Points:

1. Status Points

a. The RTU shall be capable of accepting SCADA inputs from 128 sources.

b. Input points for status monitoring shall be connected to isolated dry contacts by the Contractor. These shall be monitored by the remote station with the following provisions:

1) All status points associated with an RTU shall be interrogated by the RTU at least once every ten (10) milliseconds.

2) The RTU shall be equipped such that if a device change of state occurs but disappears before that remote is polled by the Master Station, the change is not lost. Storage for up to seven (7) changes of state per status point must be available.

3) All RTU inputs shall be protected against voltage surges and shall meet the IEEE surge withstand test.

4) A separated industrial barrier type interposing terminal blocks shall be provided for all interface connections between other, contractor furnished equipment and the SCADA RTU inputs. These terminal blocks shall accommodate up to No. 10 AWG wire, and shall be General Electric type EB-5 or approved equal.

5) Local LED indicators shall be provided to display the state of all status points.

6) Circulating current to dry contacts shall be supplied by the RTU at a 48 VDC level. Non-shielded wires shall be used and the input point shall not be affected by electromagnetic and electrostatic interferences. The input points shall be capable of operating from contact devices up to 1500 feet from the RTU over No. 14 AWG non-shielded wires.

c. The initial configuration shall contain the following inputs:

Discrete Status Points - Station (ITC)				
Point #	Pair #	Function	Source	Description
1	1	AC Normal Power Status	M52-N	Normal Power - Tripped
2	2	AC Normal Power Status	M52-R	Reliable Power - Tripped
3	3	AC Normal Power Status	T52-R	Tie Breaker - Tripped
4	4	AC Reliable Power Status	52-M1	Normal Main CB - Open
5	5	AC Reliable Power Status	52-M2	Reliable Main CB - Open
6	6	AC Reliable Power Status	CT-N	Normal Power - Undervoltage
7	7	ITC Control Power	RCP	Control Power Failure
8	8	AC Normal Power Status	SWBD	N-LP-NE CB OPEN
9	9	AC Normal Power Status	SWBD	N-LP-SE CB OPEN
10	10	AC Normal Power Status	SWBD	N-LP-NW CB OPEN
11	11	AC Normal Power Status	SWBD	N-LP-SW CB OPEN
12	12	AC Normal Power Status	SWBD	N-PP-NE CB OPEN
13	13	AC Normal Power Status	SWBD	N-PP-SE CB OPEN
14	14	AC Normal Power Status	SWBD	N-PP-NW CB OPEN
15	15	AC Normal Power Status	SWBD	N-PP-SW CB OPEN
16	16	AC Normal Power Status	SWBD	EM-1 CB OPEN
17	17	AC Normal Power Status	SWBD	EM-2 CB OPEN
18	18	Heat Trace Failure	CR	Loss of Heat Trace
19	19	South Station CA Kiosk Door - Status	DS	Station CAK - Intrusion
20	20	South Station Electrical Closet Doors - Status	DS	Station Electrical Room - Intrusion
21	21	South Station Comm Room Doors- Status	DS	Station Inverter Room - Intrusion
22	22	South Station Janitor Closet Door - Status	DS	Station Janitor Closet - Intrusion
23	23	South Station Elev #1 Mach Rm Dr - Status	DS	Station Elev #1 Machine Room - Intrusion
24	24	South Station Elev #3 Mach Rm Dr - Status	DS	Station Elev #3 Machine Room - Intrusion
25	25	South Station Toilet Rm Door - Status	DS	Station Toilet Rm - Intrusion
26	26	South Station Emergency Exit Door - Status	DS	Station Emergency Exit - Intrusion
27	27	South Station Emer.Exit Panic Bar - Status	CR	Station Emergency Exit - Panic Bar Alarm
28	28	South Station Accessible Gate - Status	DS	Station ADA Fare Gate - Intrusion
29	29	South Station Acc. Gate Panic Bar - Status	CR	Station ADA Fare Gate - Panic Bar Alarm
30	30	South Station Comm Hub Door- Status	DS	Comm Hub Enclosure #1 - Intrusion
31	31	South Station Comm Hub Door- Status	DS	Comm Hub Enclosure #3 - Intrusion
32	32	South Station Comm Hub Door- Status	DS	Comm Hub Enclosure #5 - Intrusion
33	33	South Station Motion Sensor - Status	MS	Station Unpaid Area - Intrusion
34	34	South Station Motion Sensor - Status	MS	Station Paid Area - Intrusion
35	35	spare	spare	spare
36	36	spare	spare	spare
37	37	spare	spare	spare
38	38	spare	spare	spare

Discrete Status Points - Station (to ITC)				
Point #	Pair #	Function	Source	Description
1	39	South Station HPT Unpaid Area - Status	HPT-S01-1	Customer Assistance Request - Unpaid
2	40	South Station HPT Paid Area - Status	HPT-S02-1	Customer Assistance Request - Paid
3	41	South Station Elev Cab Phone - Status	EL1-TEL-1	Customer Assistance Request - Elevator
4	42	South Station Fly Over Elev Cab Phone - Statu	EL3-TEL-1	Customer Assistance Request - Elevator
5	43	Elevator #1 Equipment Status	CP-ELP-1	Elevator #1 - Malfunction
6	44	Elevator #1 Equipment Status	CP-ELP-1	Elevator #1 - Emerergency Alarm / Stop
7	45	Elevator #1 Equipment Status	OAP-1	Elevator #1 - Oil Alarm
8	46	Elevator #1 Pit Status	Elev #1 Pit	Elevator #1 - Pit Oil Alarm
9	47	Elevator #1 Pit - Float Switch Status	Elev #1 Pit	Elevator #1 - Float High Level Alarm
10	48	Fire Alarm Panel	FACP / FAPS	General Alarm - Fire
11	49	Fire Alarm Panel	FACP / FAPS	Panel Alarm - Trouble
12	50	UPS Status	UPS	UPS - Failure

Discrete Status Points - Station (Local)				
Point #	Pair #	Function	Source	Description
1	101	Local / Remote	CR-M07-1	RTU Local/Remote Operation
2	102	Local AC Power Fail	R-CP-M	AC Input Failure
3	103	SONET (Critical)	SONET Chassis	SONET Communication Failure (Critical)
4	104	SONET (Major)	SONET Chassis	SONET Communication Failure (Major)
5	105	SONET (Minor)	SONET Chassis	SONET Communication Failure (Minor)
6	106	Channel Bank (Critical)	Channel Bank Chassis	Channel Bank Comm Failure (Critical)
7	107	Channel Bank (Major)	Channel Bank Chassis	Channel Bank Comm Failure (Major)
8	108	Channel Bank (Minor)	Channel Bank Chassis	Channel Bank Comm Failure (Minor)
9	109	Channel Bank (Misc.)	Channel Bank Chassis	Channel Bank Comm Failure (Misc)
10	110	Rectifier (Input)	48VDC Rectifier Chassis	Rectifier Failure (Input)
11	111	Rectifier (Output)	48VDC Rectifier Chassis	Rectifier Failure (Output A)
12	112	Rectifier (Output)	48VDC Rectifier Chassis	Rectifier Failure (Output B)
13	113	PA 1	PA Logic Output / Ch 1	PA System Failure (Critical)
14	114	PA 2	PA Logic Output / Ch 2	PA System Failure (Major)
15	115	PA 3	PA Logic Output / Ch 3	PA System Failure (Minor)
16	116	PA 4	PA Logic Output / Ch 4	PA System Failure (Speakers)
17	117	NVR #1	NVR Chassis	NVR Failure
18	118	NVR #2	NVR Chassis	NVR Failure
19	119	UPS #1 (Fail)	UPS Chassis	Node UPS Failure
20	120	UPS #2 (Fail)	UPS Chassis	CCTV UPS Failure
21	121	Loop Bound Train Approaching Status	Signal Dept Relay	IB Train Approaching
22	122	Terminal Bound Train Approaching Status	Signal Dept Relay	OB Train Approaching
23	123	Loop Bound Train Arrival Status	Signal Dept Relay	IB Train Arriving
24	124	Terminal Bound Train Arrival Status	Signal Dept Relay	OB Train Arriving
25	125	Copper Outside Cable Plant	Wallfield	Cable Fault
26	126	spare	spare	spare
27	127	spare	spare	spare
28	128	spare	spare	spare

Discrete Status Points - Station (ITC)				
Point #	Pair #	Function	Source	Description
13	51	UPS Status	UPS	UPS - AC Input Failure
14	52	UPS Status	UPS	UPS - Low Battery Voltage
15	53	UPS Status	UPS	UPS - AC Output Failure
16	54	UPS Status	UPS	UPS - Clogged Filter
17	55	UPS Status	UPS	UPS - Low Electrolyte Level
18	56	Elevator #2 Equipment Status	CP-ELP-2	Elevator #2 - Malfunction
19	57	Elevator #2 Equipment Status	CP-ELP-2	Elevator #2 - Emerergency Alarm / Stop
20	58	Elevator #2 Equipment Status	OAP-2	Elevator #2 - Oil Alarm
21	59	Elevator #2 Pit Status	Elev #2 Pit	Elevator #2 - Pit Oil Alarm
22	60	Elevator #2 Pit - Float Switch Status	Elev #2 Pit	Elevator #2 - Float High Level Alarm
23	61	Elevator #3 Equipment Status	CP-ELP-3	Elevator #3 - Malfunction
24	62	Elevator #3 Equipment Status	CP-ELP-3	Elevator #3 - Emerergency Alarm / Stop
25	63	Elevator #3 Equipment Status	OAP-3	Elevator #3 - Oil Alarm
26	64	Elevator #3 Pit Status	Elev #3 Pit	Elevator #3 - Pit Oil Alarm
27	65	Elevator #3 Pit - Float Switch Status	Elev #3 Pit	Elevator #3 - Float High Level Alarm
28	66	Elevator #4 Equipment Status	CP-ELP-4	Elevator #4 - Malfunction
29	67	Elevator #4 Equipment Status	CP-ELP-4	Elevator #4 - Emerergency Alarm / Stop
30	68	Elevator #4 Equipment Status	OAP-4	Elevator #4 - Oil Alarm
31	69	Elevator #4 Pit Status	Elev #4 Pit	Elevator #4 - Pit Oil Alarm
32	70	Elevator #4 Pit - Float Switch Status	Elev #4 Pit	Elevator #4 - Float High Level Alarm
33	71	North Station CA Kiosk Door - Status	DS	Station CAK - Intrusion
34	72	North Station Electrical Rm N Doors - Status	DS	Station Electrical Room - Intrusion
35	73	North Station Electrical Rm E Doors - Status	DS	Station Electrical Room - Intrusion
36	74	North Station Janitor Closet Door - Status	DS	Station Janitor Closet - Intrusion
37	75	North Station Elev #2 Mach Rm Dr - Status	DS	Station Elev #2 Machine Room - Intrusion
38	76	North Station Elev #4 Mach Rm Dr - Status	DS	Station Elev #4 Machine Room - Intrusion
39	77	North Station Emergency Exit Door - Status	DS	Station Emergency Exit - Intrusion
40	78	North Station Emer. Exit Panic Bar - Status	CR	Station Emer.Exit - Panic Bar Alarm
41	79	North Station Emergency Exit Door - Status	DS	Station Emergency Exit - Intrusion
42	80	North Station Toilet Rm Door - Status	DS	Station Etoilet Rm - Intrusion
43	81	North Station Emer. Exit Panic Bar - Status	CR	Station Emer. Exit - Panic Bar Alarm
44	82	North Station Motion Sensor - Status	MS	Station Unpaid Area - Intrusion
45	83	North Station Motion Sensor - Status	MS	Station Paid Area - Intrusion
46	84	North Platform Comm Hub Door- Status	DS	Comm Hub Enclosure #2 - Intrusion
47	85	North Platform Comm Hub Door- Status	DS	Comm Hub Enclosure #4 - Intrusion
48	86	North Platform Comm Hub Door- Status	DS	Comm Hub Enclosure #6 - Intrusion
49	87	North Station HPT Unpaid Area - Status	HPT-M01-1	Customer Assistance Request - Unpaid
50	88	North Station HPT Paid Area - Status	HPT-M02-1	Customer Assistance Request - Paid
51	89	North Station HPT North Platform - Status	HPT-P01-1	Customer Assistance Request - North Plat.
52	90	North Station HPT North Platform - Status	HPT-P01-2	Customer Assistance Request - North Plat.
53	91	North Station Elev Cab Phone - Status	EL2-TEL-1	Customer Assistance Request - Elevator
54	92	North Station Fly Over Elev Cab Phone - Statu	EL4-TEL-1	Customer Assistance Request - Elevator
55	93	spare	spare	spare
56	94	spare	spare	spare
57	95	spare	spare	spare
58	96	spare	spare	spare
59	97	spare	spare	spare
60	98	spare	spare	spare
61	99	spare	spare	spare
62	100	spare	spare	spare

2. Analog Points

   a. Sixteen input points shall be provided for measurement of analog signals. Input signal current amplitude range shall be 0-1 ma DC.

   b. These inputs shall be monitored with the following provisions:

      1) The accuracy of the conversion equipment shall be more than 99.9 percent.

      2) To minimize transverse mode noise problems, the input

multiplexer shall switch both leads of the signal to preserve the balance of the analog signal.

3) To minimize common mode noise problems, the analog inputs shall be electrically or optically isolated from the digital logic of the remote station.

4) Separated industrial barrier type interposing terminal blocks shall be provided for all interface connections between external equipment and SCADA RTU inputs. These terminal blocks shall accommodate up to No. 10 AWG wire, and shall be General Electric type EB-5 or approved equal.

Analog Status Points - Station				
Point #	Pair #	Function	Source	Description
1	1	Comm Room - Temperature	TS-01	Comm Room Temperature
2	2	Comm Room - Humidity	HS-01	Comm Room Humidity
3	1	Elevator #2 Mach Room - Temperature	TS-02	Elev #2 Machine Room Temperature
4	2	Elevator #2 Machine Room - Humidity	HS-02	Elev #2 Machine Room Humidity
5	3	Elec Room - Temperature	TS-01	Elect Room Temperature
6	4	Elec Room - Humidity	HS-01	Elect Room Humidity
7	5	North CAK - Temperature	TS-CAKM-01	North CAK Temperature
8	6	North CAK - Humidity	HS-CAKM-01	North CAK Humidity
9	1	Elevator #1 Mach Room - Temperature	TS-01	Elev #1 Machine Room Temperature
10	2	Elevator #1 Machine Room - Humidity	HS-01	Elev #1 Machine Room Humidity
11	3	Elevator #3 Mach Room - Temperature	TS-01	Elev #3 Machine Room Temperature
12	4	Elevator #3 Machine Room - Humidity	HS-01	Elev #3 Machine Room Humidity
13	5	Elevator #4 Mach Room - Temperature	TS-01	Elev #4 Machine Room Temperature
14	6	Elevator #4 Machine Room - Humidity	HS-01	Elev #4 Machine Room Humidity
15	1	South CAK - Temperature	TS-CAKS-01	South CAK Temperature
16	2	South CAK - Humidity	HS-CAKS-01	South CAK Humidity

3. Control Points

a. Initially, the RTU shall be capable of providing signals to twelve (12) output control points with provisions for expansion to the ultimate configuration which shall handle output to sixteen (16) control points.

b. Output points for control shall be isolated contacts from interposing relays provided by the contractor. The following provisions shall be made in the RTU for all control points:

1) All control operations shall be on a direct basis.

2) Output protection shall meet the requirements of the IEEE surge withstand test.

3) Separated industrial barrier type interposing terminal blocks shall be provided for all interface connections between external equipment and SCADA RTU inputs. These terminal blocks shall accommodate up to No. 10 AWG wire, and shall be General Electric type EB-5 or approved equal.

4) As a minimum, two "form C" contacts from each and every interposing control relay shall be wired to an interposing terminal block.

5) Momentary output contacts shall be closed for an adjustable time interval.

6) Timer shall be adjustable from 0.1 seconds to thirty (30) minutes.

7) The contact rating and type of control relays shall be as specified, required and approved by the CTA.

8) Provide a switched, timed DC output (48VDC-2 Amp) for powering a Station Bus Light Power Relay in Electrical Room.

c. The initial configuration shall include 32 control relays for the following outputs:

Control Points - Station				
Point #	Pair #	Function	Destination	Description
1	1	IB Train Approaching PA Message	PA Logic Controller / Ch 1	IB Train Approaching
2	2	OB Train Approaching PA Message	PA Logic Controller / Ch 2	OB Train Approaching
3	3	IB Train Arrival PA Message	PA Logic Controller / Ch 3	IB Train Arriving
4	4	OB Train Arrival PA Message	PA Logic Controller / Ch 4	OB Train Arriving
5	5	HPT North Platform - CA Request PA Message	PA Logic Controller / Ch 5	Cust Assistance Request - N Kiosk
6	6	HPT South Platform - CA Request PA Message	PA Logic Controller / Ch 6	Cust Assistance Request - S Kiosk
7	7	HPT North Unpaid - CA Request PA Message	PA Logic Controller / Ch 7	Cust Assistance Request - N Turnstiles
8	8	HPT North Paid - CA Request PA Message	PA Logic Controller / Ch 8	Cust Assistance Request - S Turnstiles
9	9	HPT FlyOver N - CA Request PA Message	PA Logic Controller / Ch 9	Cust Assistance Request - N Platform
10	10	HPT Flyover S - CA Request PA Message	PA Logic Controller / Ch 10	Cust Assistance Request - S Platform
11	11	HPT N East Platform - CA Request PA Message	PA Logic Controller / Ch 11	Cust Assistance Request - NE Platform
12	12	HPT S East Platform - CA Request PA Message	PA Logic Controller / Ch 12	Cust Assistance Request - SE Platform
13	13	spare	PA Logic Controller / Ch 13	spare
14	14	spare	PA Logic Controller / Ch 14	spare
15	15	spare	PA Logic Controller / Ch 15	spare
16	16	spare	PA Logic Controller / Ch 16	spare
17	1	spare	spare	spare
18	2	spare	spare	spare
19	1	spare	spare	spare
20	2	spare	spare	spare
21	3	spare	spare	spare
22	4	spare	spare	spare
23		Communication Control Point 1	spare	spare
24		Communication Control Point 2	spare	spare
25		Communication Control Point 3	spare	spare
26		Communication Control Point 4	spare	spare
27		Communication Control Point 5	spare	spare
28		Communication Control Point 6	spare	spare
29		Communication Control Point 7	spare	spare
30		Communication Control Point 8	spare	spare
31		Communication Control Point 9	spare	spare
32		Communication Control Point 10	spare	spare

4. Security and Reliability

a. Security and reliability shall be integrated into the RTU design concept such that proper consideration is given to communications, hardware, software, assembly and construction of the RTU itself.

5. Communication Path Security

a. The RTU's encoding/decoding of information shall guard against false commands being executed and prevent false data from being transmitted to the Master Station.

b. As a minimum the following security features are required:

1) BCH error detection coding or equivalent crosshatch parity error detection encoding.

2) Re-encode and retransmit (to the Master Station) part or all information control messages according to existing master handshake methods.

3) Direct control technique

6. Internal Operation and Construction Security

a. As a minimum, the following features are required:

1) High stability clocks for internal timing. The time base of all RTUs shall be periodically synchronized by the Master Station to ensure Sequence of Event accuracy and a time base for calculate and control programs.

2) Coded trip/close, start/stop, low speed/high speed/stop, forward/reverse/stop, and all other control commands.

3) Selection interlock to prohibit operation of more than one (1) control point selection at a time in an RTU.

4) The following conditions shall not produce false control operations by the Master Station. In addition, these conditions shall not produce false or continuous transmission to the Master Station. These conditions are: Power up of the RTU; Switching from the primary power source to the back-up source; Communication circuit failure; Any component failure in the RTU; A logic card left out of the RTU.

5) The RTU design shall be modular for ease of maintenance and expansion. Failure of one card containing a group of input or output points shall not disable the entire RTU. The RTU reliability shall be high, with a mean time between failures (MTBF) of at least 10,000 hours.

6) The Manufacturer shall provide details of all data security features for the review/approval of the CTA prior to the start of the manufacturing process.

7) Integrated circuits using circuit types other than CMOS logic shall require the approval of the CTA prior to the start of the manufacturing process.

8) High reliability off-the-shelf components shall be used throughout the RTU project.

D. RTU Hardware:

1. Control Panel

a. The panel shall be easily accessible once the door of the RTU is opened. Devices shall be mounted on it as follows:

1) Four (4) LINE TRANSFER switches, each a single pole, double throw with center "OFF" position, labeled L1, L2, L3 and L4. Switches (Ll, L2, L3 and L4) permit either communication line to be used as active and the other as standby or to permit isolation of any or all of the lines. Each communication line shall have a separate input and output isolation device such that a problem on one line shall not affect the other.

2) LINE SUPERVISION TRANSFER switch, a two (2) pole, double throw switch which shall be arranged to disconnect the line wires from the line device and connect a circuit to maintain line supervision shall be provided.

3) ON-OFF POWER switch, a two (2) pole, single throw switch

which shall disconnect the RTU from both primary and emergency power supplies.

2. Interposing Relays

   a. Provide interposing relays installed on the panel inside the RTU cabinet. These devices shall be easily accessible for service and shall be furnished, installed and completely wired by the RTU manufacturer/contractor.

      1) For each control point, two (2) interposing relays shall be provided, unless otherwise specified. One (1) relay shall energize in response to a stop code sent from the Master Station, the other relay shall energize in response to a start code.

      2) The interposing relays shall be industrial type and have two (2) form "C" contacts for the function of the two (2) break contacts with a continuous current-carrying capacity of twelve (12) amperes each, with interrupting capacity of 2.4 amperes noninductive at 115V DC nominal voltage. The interposing relays shall operate at 48 or 24 volts DC, and shall withstand 48V DC, continuously without overheating. The interposing relays shall have dust-tight, easily removable covers and shall be a semi-flush mount type. All interposing relays shall be Potter & Brumfield series KUEP or approved equal.

      3) The interposing relay and device panels shall be wired in such a manner that additional intra-panel wiring required for future expansion shall be plug-in cables, with connectors keyed to prevent improper connection. All interposing relays furnished with the RTU shall be installed complete with all necessary wiring. All interposing relays shall be mounted inside the RTU cabinet.

3. RTU Supervision

   a. The supervision of all devices shall be accomplished via the monitoring of dedicated auxiliary contact(s) on each device.

   b. The auxiliary contact(s) will open or close depending on the status of the device (open, closed, running, etc.). The RTU shall monitor the position of the contacts and report the status of the device to the Master Station. The status of two (2) auxiliary contacts shall indicate a maximum of four (4) possible positions of the device.

   c. The RTU shall be equipped with local indicators that will display the state of each and every contact.

4. Modems

   a. The remote terminal unit shall communicate with the Master Station by means of its own internal modems. Two (2) modems are required for dual communications (simultaneously). One shall be designated as Main and the other as Alternate for dual communication with the Master.

   b. The modems shall employ FSK and (D)PSK modulation at 1200 baud or lower and QAM modulation at 2400 baud or higher and be capable of operating at 9600 baud with a minimum baud rate at 1200 over 2-wire CTA owned, unconditioned, metallic conductors type telephone lines and/or standard Ameritech 2001PL telephone lines. The modems shall

comply with the CCITT, Bell 202 and 212A specifications. The modems shall have adjustments for transmit level, receive balance and sensitivity level. These controls shall be easily accessible and shall not require removal of the modems from their operating position or power shutdown of the system. Current flow and voltages over Ameritech lines shall be within the limits specified by Ameritech. The supervisory control system shall be designed for data transmission communication over the Authority's existing cable communication system. Modems shall be capable of accommodating normal variations in line impedance, delay distortion, etc., with no degradation of communications. The complete set of modem specifications shall be submitted for approval by the Authority's Project Manager before production of the equipment.

5. Power Supply and DC/DC Converter

   a. The Contractor shall provide all necessary power supplies/converters required to adapt the standard RTU electronic circuits to the following input voltages:

      1) 120 VAC and 48 VDC with automatic transfer capabilities

   b. The 48 VDC emergency battery supply with 8-hour capacity at full load and associated battery charger with current limiting for each RTU shall be furnished, installed and completely wired by the Contractor.

   c. The Contractor shall be responsible for converting and distributing the DC power within the RTU cabinet as necessary to operate the specified RTU equipment.

   d. The DC/DC converter shall be redundant in all RTU's with automatic switching capabilities such that failure of one converter shall not disrupt RTU operation. The converters shall have the following characteristics:

      1) Outputs shall be fully isolated from the inputs so that no ground can be imposed on the battery.

      2) Both inputs shall be fused and connected with a single On/Off four-pole, single-throw (4PST) switch.

      3) Converter input shall meet the requirements of the IEEE SWC standard tests ANSI C37.90a-1974 and IEEE STD472-1974.

      4) Adequate filtering shall be provided on the output such that no chopper noise from the converter is imposed on the battery.

      5) The chopper circuitry shall produce no audible noise. The circuits shall be designed so as to operate above the audible range, preferably 20 Khz or higher.

      6) Indicating lamps shall be provided which light only if converter output is energized.

   e. Overvoltage and undervoltage protection shall be included on the outputs to prevent the microprocessor hardware from being damaged due to a single component failure in the converter or from becoming unstable and causing false operation of control functions. Short circuit protection shall also be provided on the outputs.

   f. The capacity of all power supplies and converters supplied shall be sufficient to handle expansion of the RTU to its full capacity of points as specified herein.

6. RTU Control

a. Control of devices shall be accomplished by closure of the STOP or START interposing relay associated with each controlled circuit breaker or device. The contacts of the interposing relays shall make and break circuits for the respective control voltage.

7. Terminal Blocks

a. All external wiring interfacing with the RTU cabinet shall terminate on easily accessible interposing terminal blocks within the RTU cabinet. This wiring shall include, but not be limited to; emergency power supply wiring, supervision contacts, interposing relay contacts, telemetering points and line wires. Terminal blocks shall be General Electric type EB-5 or approved equal. Self-extinguishing white vinyl marking strips shall be included on all interposing terminal blocks. All terminals to which battery or other high voltages are to be connected, shall be provided with protective covers. All terminal blocks shall be labeled and have corresponding identification on unit schematic prints.

8. Wiring

a. All wiring shall be stranded and of suitable gauge and insulation to meet the intended use. Extra flexible stranded control wires shall be used for wiring between hinged and stationary portions of panels. All internal wiring to interposing terminal blocks shall be a minimum of No. 14 AWG stranded wire.

b. Input and output wiring shall be kept physically separate where possible. AC, high voltage DC and low voltage DC wiring shall be kept physically separate where possible.

c. All wiring shall be clearly identified with designation at each end using white plastic slip-on markers with black lettering. The marker diameter shall be consistent with the wire diameter to ensure a snug fit, but yet be able to be rotated for identification.

d. All wiring shall be secured into harnesses. All wiring including harnesses shall be routed in such a manner as to not obstruct the installation or removal of RTU components, and shall be secured to the cabinet where appropriate for neatness and to reduce strain on components.

e. All terminations to terminal strips within all RTUs shall be made with crimp-on insulated ring type terminals.

9. Input/Output Isolation and Protection

a. All inputs and outputs including power supply and circuit ports shall be capable of withstanding the IEEE SWC standard test without damage.

10. Components

a. To the greatest extent possible, all components used in the RTU system shall be high quality solid-state silicon type devices suitable for the application and sufficiently rated for long life.

b. Proper mounting shall be employed for all components on printed circuit boards to prevent damage from shipping and vibration encountered in the CTA rail "right-of-way" environments.

c. Circuit boards and their components shall be suitably protected from dampness and corrosion common to the exterior environments.

11. Construction/Packaging/Labeling

a. In addition to general quality workmanship the following shall be implemented:

1) All plug-in printed circuit cards shall be keyed to prevent damage to the RTU or devices connected to the RTU through improper connection.

2) Gold plated contacts shall be used on all printed circuit board and other multi-pin connectors.

3) All printed circuit boards shall be made of glass-epoxy material.

4) Each printed circuit board and all subassemblies shall be serial numbered to uniquely identify them for warranty.

5) All nameplates for cabinets, panels, components, relays, fuse blocks, switches and terminal blocks (except terminal block numbering strips) shall be plastic, utilize white printing on a black background, and shall match those on existing CTA SCADA equipment. All nameplates shall meet the approval of the CTA.

6) All terminal blocks, rows and/or columns shall be suitably and clearly labeled by the contractor using standard methods.

7) All plug in devices/cards shall employ a positive locking design to prevent loosening from vibration.

8) All internal components shall be labeled and referenced to the internal schematic diagram.

E. Remote Terminal Unit Enclosure:

1. Cabinets shall be rigid, weatherproof and constructed from fiberglass reinforced polyester resins for use in highly corrosive atmospheres. Design shall conform to NEMA Type 4X construction.

2. The main box portion of the cabinet shall be of one-piece construction, with smooth, rounded corners and a mounting flange around the entire perimeter (attached back plate is unacceptable). All fabrication seams must be sealed and no unused holes are permitted. There shall be no gasketed joints except for the neoprene door gasket. Gasket material shall be approved by the Authority.

3. Cabinet shall have automatic, corrosion-proof condensation drain plugs installed in the bottom. Plugs shall be of tamper-proof design with stainless steel screening. Cabinet design shall incorporate an integral fiberglass drip shield to protect the door hardware from water, ice/snow buildups and settling dust.

4. The cabinet shall be arranged for bottom cable entry and shall have overlapping double doors. Each door shall be fastened to the main box with a continuous stainless-steel hinge (16 gauge minimum) for the full length of the door. All hinges, latches, etc. shall be fastened to the cabinet using stainless steel rivets with stainless steel backup washers. All rivets shall be sealed with RTV or similar material. All doors shall be capable of opening a minimum of 180 degrees and shall be of tamperproof design and construction.

5. The door surfaces shall incorporate fiberglass bracing to prevent door buckling or warpage. NO RTU ELECTRONIC COMPONENTS OR MODULES SHALL BE MOUNTED ON THE DOORS. The doors shall be equipped with hold opens for the 180 degree position. All cabinet doors shall be furnished with suitable handles and 3-point latching mechanisms. All door locks shall be keyed to match existing SCADA RTU cabinet locks. Doors shall be provided with hasps suitable for a CTA supplied 5/8" padlock. All cabinets shall have a print pocket attached

to the inside of the cabinet door for the storage of prints and point assignment charts.

6. Cabinets shall be provided with a 3/8" fiberglass laminate interior mounting panel of NEMA GPO-2 construction with a UL 94V-O rating for high flame resistance. The panel shall be attached to the inside of the cabinet by stainless steel collar studs embedded in the main cabinet interior. All RTU components shall be installed on this mounting board using bolted connections. All mounting holes must be tapped (nuts behind panels are not permitted).

7. Cabinet shall be designed so that removal of the cabinet from its mounts or the removal of any internal components from the RTU shall not require the removal of any interior mounting panel.

8. Maximum dimensions of the RTU cabinet shall be 48" h X 23" w X 15" d.

9. Enclosure finish shall be Pleogen 2907 Iso-gel coat (18 to 20 mil thickness). Color shall be ASA #61 light gray.

10. All cabinets shall be designed to incorporate necessary bracing to assure the rigidity of the cabinet structure including an optional door(s). The cabinets shall be of sufficient strength that no external supports are required if the cabinets are securely fastened to the wall.

11. Each cabinet shall have mounted on it a large, easily readable identification label corresponding to the location where the RTU will be installed. These shall match labels on existing CTA RTUs or shall be approved by the CTA.

12. A ground lug capable of accommodating up to a No. 8 AWG stranded grounding cable shall be provided in each cabinet.

13. Remote Terminal Units (RTUs) shall be installed in the Station Communication Room within the designated SCADA equipment cabinet (refer to Section 27 11 16 for equipment cabinets).

F. Other:

1. All RTUs shall have a switchable interior AC light and dual duplex AC receptacle mounted inside the RTU cabinet.

2.02 MASTER STATION EXPANSION HARDWARE:

A. Two (2) rack mount, plug-in type modems are to be provided for installation in the Communication Line Termination Cabinet in the Control Center. These modems will be installed and setup by CTA personnel. The modems shall be hot-pluggable. Modems shall be Motorola UDS model V.3225 or approved equal.

PART 3 - EXECUTION

3.01 REMOTE TERMINAL UNITS (RTUs)

A. Installation: Install the Remote Terminal Unit at the location indicated in the Contract Drawings and connect to the assigned terminals of the telephone terminal cabinet. Installation of the RTUs may necessitate the purchase of communications components from the RTU manufacturer to be installed at the control center. In addition, some field programming may be required.

B. Mounting: Mount enclosures as shown on the Contract Drawings, so that all equipment at

the location is of uniform height. A grounding cable shall be attached mechanically to the enclosure such that it can be easily removed if necessary.

C. Verification: Following completion of the installation of all SCADA equipment at a site, the Contractor shall inspect all equipment wiring to verify that all mechanical connections are made and properly secured, all hardware is installed in its proper location, and all wiring is properly terminated. This inspection shall include conductor and shield continuity and isolation verification of all installation wiring. Data sheets containing evidence of such inspection, certified as correct by the Contractor's Quality Control Engineer for the project, shall be delivered to the CTA for approval. The Contractor shall receive approval of such inspection certification before applying power to the SCADA equipment covered by such certification.

D. Grounding: Grounding of all of the equipment shall be provided as required by the Manufacturer's specifications and Electrical Grounding Section of this Specification, and shall be approved by the CTA.

3.02 LOCAL FIELD ACCEPTANCE TESTS

A. Perform local field acceptance test in accordance with the approved test procedures and furnish a report of each test.

B. Test SCADA system's rack equipment under power following approval of the Contractor's installation inspection by the CTA. Installation testing shall demonstrate the full functional capability of the equipment.

3.03 INTEGRATION TESTING

A. Integration testing of the complete SCADA system for the project shall follow completion of all work regarding the SCADA system under the Contract, including system testing at all stations and at the Control Center. Integration testing shall consist of exercising the overall SCADA system from the Control Center and locally to verify all is operational, and shall be done in accordance with the equipment Manufacturer’s recommended System Testing.

3.04 DOCUMENTATION

A. The system shall include thorough documentation of all hardware and software to be supplied. Documentation for all procured Master Station equipment shall consist of the original manufacturer's manuals (one per unit supplied). Documentation delivered for hardware and software manufactured by the RTU vendor shall be subject to approval.

3.05 HARDWARE DOCUMENTATION

A. System Manual:

1. A System Manual shall be provided which includes a complete summary list of deliverable items: remote stations, spares, test equipment, consumables, and all documentation manuals and drawings.

B. Remote Station Manuals:

1. The remote station manual shall include as a minimum the following items:

a. Installation and startup instructions

b. Instructions for expansion of the RTU module

c. Theory of operation

d. Maintenance and trouble-shooting guidelines

e. Functional block diagrams

f. Layout drawings and interconnect drawings

g. Schematics of each RTU module

h. Replacement parts list.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of SCADA REMOTE TERMINAL UNIT will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of SCADA REMOTE TERMINAL UNIT must be included in the contract lump sum price as shown in the Schedule of Prices for Communications Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Communications Work: 270000

END OF SECTION