JOINT BASE LEWIS/MCCHORD, WA
CONSTRUCT DUAL FOOD
(Arby’s and Popeye’s)
AAFES Project No. 4915-09-000006

100% SOLICITATION SET SUBMITTAL
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VOLUME II - DIVISIONS 21 THROUGH 33

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PROJECT MANAGER

CONTRACTING OFFICER

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FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY
A. Work Included: Provide all material, labor, equipment, design and services necessary to perform the installation of the fire sprinkler system as shown on the drawings and as described herein.
B. Summary of Work: This installation will consist of hydraulically calculated wet pipe sprinkler systems protecting the entire building.
C. Design densities shall be in accordance with NFPA 13 and the following:
1. Mechanical rooms, storage rooms, and similar areas shall be designed for an ordinary hazard group 1 density.
2. All other areas shall be designed in accordance with NFPA 13.
D. The water supply for this installation is supplied from a 2000 gpm, 80 psi fire pump at the high school taking suction from on-site storage tanks. A margin of 10% between all demand points and the water supply is required.

1.2 QUALITY ASSURANCE
A. Codes and Standards: This installation shall conform to each of the following:
B. All work shall comply fully with all applicable codes and standards. Nothing in the contract documents shall be construed to permit non-compliance with any code or standard.
C. Warranty: The contractor shall guarantee all materials, equipment and workmanship in this installation for a period of one year from the date of completion. Any system failure during that time shall be repaired at the contractor's expense. Contractor shall respond on site to system problems within 24 hours.
D. Qualifications of Contractor: All work shall be performed by a Contractor with a valid State Contractor's license for the installation of fire sprinkler systems.
E. The field installation shall be supervised at all times by a journeyman sprinkler fitter or person with equivalent experience.
F. Approval by the Authority Having Jurisdiction: For purposes of code compliance the Authority Having Jurisdiction (AHJ) for this installation will be the Washington State Fire Marshal, Spokane County Division of Building, and Fire District 11. Where there are conflicts between the AHJ and the referenced codes and standards, the more stringent shall apply.

1.3 SUBMITTALS
A. Material Submittals: At least 10 working days prior to submitting shop drawings, furnish to the A/E a complete list of equipment and products, and a manufacturer's catalog sheet for each item to be included in the project. The Contractor may submit as many copies as it practically needs. Three copies will be retained, the remainder will be returned to the contractor. Each copy shall be bound separately in a soft cover three-hole folder, and shall include an index of all items in the submittal.
B. All material submittals shall include all items listed in the product section of this specification and all additional items necessary to provide a complete installation. Where more than one item appears on a manufacturer's catalog sheet, the item or items to be used shall be indicated.
C. Shop Drawings: At least 15 working days prior to any installation or fabrication of the system components, the Contractor shall submit two sets of shop drawings and hydraulic calculations to the A/E for review by the A/E. The A/E will review the submittals and make any pertinent comments, returning one set to the contractor. The contractor will then make any necessary corrections and submit six sets for approval. Two sets of each will be retained by the A/E. Submit additional sets as desired for return to the contractor.

D. Shop drawings shall conform to, and include all items as set forth in NFPA 13.
1. After approval is received from the A/E, submit shop drawings to the AHJ for approval. Submit evidence of final drawing approval by the AHJ to the A/E prior to the start of fabrication or installation.

1.4 DRAWINGS OF RECORD

A. Updating Drawings: Provide and keep up to date, a complete record set of approved shop drawings, corrected daily to show every change from the approved shop drawings. Keep this set of prints on the job site and use only as a record set.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and Equipment: All materials and equipment in the system shall be new and current products of a manufacturer regularly engaged in the production of such materials and equipment. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

B. Approval Guides: Unless otherwise indicated, all products shall be listed in the latest publication of the Underwriters Laboratory Fire Protection Directory or the Factory Mutual Approval Guide.

C. Schedule of Pipe: All pipe shall be ferrous, and shall meet the requirements of NFPA 13, section 2-3. All threaded pipe shall be schedule 40.

D. Threaded Fittings: Threaded fittings shall be cast iron class 125, rated for 175 psi. cold water working pressure and shall conform to ANSI B16.4, ASTM 126 and ANSI B2.1 NPT.

E. Grooved Fittings: 90's, 45's, Tees, and reducers shall be malleable iron or ductile. The fittings shall be by Gustin Bacon, Gruvlok, Victaulic, or approved equal.

F. Adapter Flanges: Adapter flanges (fittings) shall be cast iron/class 125 conforming to ANSI B 16.1, with a rust inhibiting coating. The adapter flanges shall be by Gustin Bacon, Gruvlok, Victaulic, or approved equal.

G. Grooved Couplings: Grooved couplings and reducers shall be malleable or ductile iron conforming to ASTM A 47.

H. Plain End Couplings: Plain-end couplings are permitted when installed in complete conformance with their listings.

I. Hangers: Provide hangers to support all piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet the requirements of NFPA 13.

J. Pipe Rings: Pipe rings to be zinc coated Grinnell figure 69 or equal.

K. Earthquake bracing shall be with a pipe clamp and pipe with a swivel type anchor or similar to those illustrated in NFPA 13. Other types of bracing may be used when UL-listed or FM approved.

L. Butterfly Valves: Butterfly valves shall be Gruvlok Model 7700 FP with integral tamper switch, or approved equal. Externally mounted tamper switches are also permissible.
M. Drain Valves: Drain valves shall be screw in bonnet bronze globe valves, rated to 175 psi non shock cold water working pressure by Nibco, United or approved equal. Low point drain valves shall have, in addition, a ¾ inch brass nipple with ¾ inch male hose threads and cap.

N. Check valves shall be grooved, iron body, bronze seat, stainless steel clapper with a replaceable rubber seal and 175 psi non shock cold water working pressure. Viking model D, Central model 90 or approved equal.

O. Provide quick response sprinklers throughout.

P. Sprinklers in ceilings shall be glass bulb, white finish, with white recessed escutcheon.

Q. Sidewall sprinklers in finished areas shall be white finish in white recessed escutcheon.

R. Spare Sprinklers: Provide spare sprinklers and escutcheons for each type and style of sprinkler used in accordance with NFPA 13 and proportioned based upon the number of each type and style of sprinkler used on the project.

S. Provide a spare sprinkler cabinet to accommodate the required number of spare sprinklers and escutch- eons. Include a wrench for each type of sprinkler in the cabinet.

T. Provide chrome- or nickel-plated, UL Listed sprinkler headguards for sprinkler heads subject to mechanical damage or for any sprinkler lower than 7 feet above the floor. All sprinklers in the gyms shall be provided with plated head guards.

U. Provide a 3½ inch diameter, bourdon type pressure gauge, 0 200 lbs, ¼ inch soft metal seat globe valve with arrangements for draining pipe between gage and valve.

V. Provide plastic split ring type escutcheons. Escutcheons are only required where wall penetrations are exposed.

W. Equipment in this section shall be provided, installed, and adjusted by the sprinkler Contractor. Conduit, wiring, and terminations, shall be by others.

X. Waterflow Switch: Potter VSR F or approved equal.

Y. Supervisory Switches: SPST, normally closed contacts, designed to signal valve in other than full open position

Z. Provide all control, drain and test valves with signs identifying the type of valve and the area affected by the valve. Signs shall be three layer etched plastic with red letters on a white background to identify valves above ceilings or behind access doors. Lithographed metal plates may be used in unfinished spaces or above ceilings. Provide hydraulic design information plates as required by NFPA 13.

AA. Firestopping material is to be UL classified Bio Fireshield BFS100, 200 caulk or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Requirements Prior to Installation: Do not order, fabricate, or install any material prior to receipt of all approvals as stipulated in Part 1 of this Section.

B. The most current architectural backgrounds shall be used to produce shop drawings. Obtain these from the architect prior to starting design.

C. Standards and Requirements: All installation work shall be performed in accordance with the reference standards without exception, and as required by the AHJ. All piping shall be installed straight, true and plumb.
D. Changes to the Work: Install all piping as shown on the approved shop drawings. Minor deviations shall be carefully noted on the record drawings as outlined in Part 1 of this Section. Before making significant deviations from the approved drawings, written approval must be obtained from the Owner and the AHJ.

E. Coordination of Work: Carefully coordinate work with other trades so that unnecessary offsets and revisions to the approved drawings are avoided. Failure to coordinate does not relieve Contractor from meeting the performance standards herein. The contractor is responsible for completely coordinating with all other trades and building conditions, providing all offsets as necessary for a completely coordinated installation. No extras will be allowed for resolving conflicts with other trades.

F. Sprinklers shall be spaced in accordance with NFPA 13 and as noted in Part 2 of this specification.

G. In addition to the sprinklers indicated on the drawings, provide all design, materials, and labor for installation of 6 additional sprinklers as directed by the AHJ or the engineer.

H. Provide plated head guards for all sprinklers in the gymnasiums.

I. Required Clearance Around Pipe: Piping passing through fire rated assemblies, including fire rated GWB assemblies shall be provided with clearance around the entire circumference of the pipe. Penetrations shall be made in a neat manner using properly sized hole saw or masonry/concrete coring as necessary.

J. Fire Rated Assemblies: The annular spaces around sprinkler pipes which penetrate fire rated assemblies shall be filled with UL classified firestopping material in accordance with the manufacturer’s recommendations. Penetrations of all fire-rated assemblies shall be protected. The shop drawings or material submittals shall clearly depict the firestopping assembly proposed by the contractor.

K. Escutcheons: Split wall plates or escutcheons shall be installed where exposed piping or hangers pass through a finished floor, wall or ceiling and shall fit snugly, securely and cover the opening.

L. Install all control valves and test valves in locations indicated on the plans. Auxiliary drain valves shall be installed in easily accessible locations.

M. Main Drains: Provide main drains for all systems as shown on the drawings. Main drains shall discharge to a safe location outside of the building.

N. Auxiliary Drains: Provide auxiliary drains at all low points of the system, where the trapped section of pipe exceeds five gallons. The drain shall consist of, as a minimum: a valve, a ¾ inch brass nipple with ¾ inch male hose threads, and cap.

O. Provide remote inspectors test drains as required by the AHJ.

P. Sprinklers in 2 x 2 ceiling tiles shall be located in the center of tile, plus or minus 1 inch. Sprinklers in 2 x 4 ceiling tiles shall be located at the quarter points

Q. Where surface mounted lights present an obstruction to sprinkler spray pattern, 401 canopies shall be used.

1.2 FIELD QUALITY CONTROL

A. Hydrostatic tests shall be performed in the presence of the AHJ. Any leaks or drips shall be promptly repaired. Evidence of the completed tests shall be conveyed to the A/E by submitting a completed contractor's Material and Test Certificate.

B. Punch List: Deficiencies found in the installation will be recorded on a punch list and delivered to Contractor. All items on the punch list shall be promptly corrected. Notify the A/E in writing once all punch list items have been corrected.

END OF SECTION 21 00 00
SECTION 22 00 00
PLUMBING-GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS
A. Refer to BIDDING REQUIREMENTS, CONDITIONS OF THE CONTRACT, SUPPLEMENTARY CONDITIONS and DIVISION 01 of these specifications, which govern work under DIVISION 23. Refer to other sections of these specifications for additional related requirements.

1.2 SCOPE OF REQUIREMENTS
A. The work covered by Division 22 of the specifications shall include but not be limited to:
   1. Furnishing all materials and supplying all labor, equipment and services to install the complete mechanical system as shown on the accompanied drawings and specified herein.

1.3 DESCRIPTION OF WORK
A. The contract documents including specifications and construction drawings are intended to provide all material and labor to install complete plumbing, heating ventilating and air conditioning systems for the building.
B. Every effort has been made on the design to meet or exceed the minimum requirements of the Codes; therefore, unless Contractor before signing his Contract, shall have notified the Architect, in writing, of any items in conflict with said Codes, he shall thereafter make any minor adjustments necessary to meet said Codes at no cost to the Owner.
C. The Contractor shall refer to the architectural interior detail, floor plans, elevations, and the structural and other Contract Drawings and he shall coordinate his work with that of the other trades to avoid interference. The plans are diagrammatic and show generally the locations of the equipment and are not to be scaled; all dimensions shall be checked at the building.
D. The Contractor shall comply with the project close-out requirements as detailed in General Requirements of Division 01.

1.4 DESCRIPTION OF BID DOCUMENTS
A. Specifications:
   1. Specifications, in general, describe quality and character of materials and equipment.
   2. Specifications are of simplified form and include incomplete sentences.
B. Drawings:
   1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation.
   2. Scaled and figured dimensions are approximate and are for estimating purposes only.
   3. Before proceeding with work check and verify all dimensions.
   4. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
   5. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
   6. If any part of Specifications or Drawings appears unclear or contradictory, apply to Architect or Engineer for his interpretation and decision as early as possible.

1.5 CODES PERMITS AND FEES
A. Mechanical work shall be in accordance with the following:

2. The Contractor at his expense shall obtain permits and inspections required for the mechanical work on this project. Deliver all inspection certificates to the Owner’s Representative prior to final acceptance of the work.

3. Contractor shall pay all costs levied by utility companies and/or governing agencies associated with gas connections and include these costs within his bid. This shall include but not be limited to tap fees, service mains, meter, and vault charges.

1.6 DEFINITIONS
A. The terms “The Contractor”, when used in Division 22 shall mean the Contractor for mechanical work.

B. The term “Owners Representative” as used in Division 22 generally refers to the Architect or his designated representative in accordance with the General Conditions.

C. The term “Provide” shall mean furnish and install.

1.7 TEMPORARY HEATING
A. See Section 015000 Temporary Facilities and Controls.

1.8 SAFETY AND PROTECTION
A. Safety Measures: The Engineer has not been retained to provide design and construction services relating to the Contractor’s safety precautions, or means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Provide all required safety measures and consult with the State or Federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether compliance with State or Federal regulations exist.

B. Head protection: Where pipe hangers, equipment support angles, etc., are exposed in access ways for any maintenance, cover all such potentially injurious protrusions less than 7'-0" above the floor with padding; secure and permanently fasten, and finish to match adjacent finishes.

1.9 MECHANICAL COST BREAKDOWN
A. Cost breakdown not required.

1.10 GUARANTEE
A. The Mechanical equipment and installation shall be guaranteed for a period of one (1) year from the date of acceptance unless and individual item or specification is otherwise noted as longer. The Contractor shall make-good at his own expense all defects in his work, and/or equipment furnished by him, which shall develop at any time during the one year guarantee period and shall stand any expense of cutting and patching and repairing made necessary by his corrections of unsatisfactory work or equipment operation.

PART 2 - PRODUCTS

2.1 DUCTWORK AND PIPING COORDINATION
A. Prior to installation of the new Division 22 systems, the Contractor shall coordinate the proposed installation with the Architectural and Structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension and Tile systems), and provide reasonable maintenance access requirements.

B. Provide means of access to all valves, dampers, controllers, operable devices and other apparatus which may require adjustment or servicing.
C. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owners Representative of any discrepancies between that indicated on the Drawings and that existing in the field prior to any installation. Contractor shall be responsible for all costs associated with the removal or relocation of installed systems that have been installed without prior notification of the Owners Representative.

2.2 SHOP DRAWINGS AND SUBMITTALS

A. Submit Shop Drawings and Product Data per the requirements of Section 013300 Submittals Procedures.

B. See individual Division 22 specification sections for additional submittal requirements.

C. Submittals of Product Data shall be bound in a black 3-ring binder with the project name on the cover. Data within this binder shall be arranged as follows:
   1. Provide index tabs for each specification section in the same order and using the same name as appears in the Specifications.
   2. Data shall be black and white, on 8 ½” x 11” or 11” x 17”, single, one-sided sheets suitable for copying. Diagrams and drawings larger than 11” x 17” shall be submitted in reproducible form (translucent bond paper).
   3. Drawings and catalog data must be clean, neat copies. Fax material or other poor quality copies will not be acceptable.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only completed submittal including all applicable specification sections will be reviewed.

E. Indicate manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Indicate sizes, types, model numbers, ratings, capacities and options actually being proposed.

F. Include dimensional data for roughing in and installation, and technical data sufficient to confirm that equipment meets requirements of drawings and specifications.

G. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.

H. Submit five (5) copies of each shop drawing. The Engineer will retain one stamped copy, one will be provided to the Architect, one will be provided to the owner and a two stamped copies will be returned to the Contractor. The Contractor shall be responsible for distribution of required number of reviewed copies to parties other than the Owner’s Representative(s).

2.3 RECORD DRAWINGS

A. Refer to Division 01.

B. Keep on site, an extra set of drawings and specifications recording changes and deviations daily. Return these drawings to the Owner’s Representative at the completion of the Project. These drawings shall not be used for any other purposes.

2.4 OPERATING AND MAINTENANCE MANUALS

A. Refer to Section 017800 Closeout Submittals.

B. See individual Division 23 specification sections for additional Operating and Maintenance Manual requirements.

2.5 OPERATION AND MAINTENANCE TRAINING/STARTUP

A. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual.
B. Individuals present shall include Contractors, subcontractors and equipment factory representatives. These individuals shall assist in instruction and start-up.

C. Instruction period shall occur after final inspection when systems are properly working.

D. Prepare statement and check list to be included in the Operation and Maintenance Manual. This Statement shall read as follows:

“The Contractor, associated factory representatives and subcontractors, have started each system and the total system and have proved their normal operation to the Owner’s representative and have instructed him in the operation and maintenance thereof.”

_________________________       _______________________
Owner’s Representative   Contractor

2.6 EQUIPMENT AND MATERIALS – STANDARDS/CODES

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Each item of equipment shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.

B. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when the Project is turned over to the Owner.

C. All electrically driven or connected equipment shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC.

D. All control panels shall be provided with UL or equivalent Label and/or listing in accordance with the requirements of the NEC an applicable local codes.

2.7 EQUIPMENT/MATERIAL SUBSTITUTIONS

A. Refer to Section 012500 Substitution Procedures for product prior approval and substitution requirements.

B. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.

C. Submit proposals to supply alternative materials or equipment in writing, in accordance with Section 012500 Substitution Procedures.

D. Equipment manufacturers listed in individual sections are approved alternatives for this project and are subject to requirements of drawings and specifications. Revisions required to adapt alternatives shall be the responsibility of the Contractor.

E. Products furnished other than the (basis of design) shall have similar electrical characteristics as the scheduled or specified equipment. Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

2.8 EQUIPMENT PROTECTION AND CLEAN-UP

A. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts and duct systems.

B. Protect equipment with polyethylene covers and crates.

C. Operate, drain and flush bearings and refill with change of lubricant before final acceptance.

D. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.
E. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not re-use existing materials and equipment unless specifically indicated.

PART 3 - EXECUTION

3.1 LOCATIONS

A. Coordination of Division 22 equipment and systems to the available space, with other trades. The access routes through the construction shall be the Contractor's responsibility.

B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes and ducts, as required to maintain proper headroom and pitch of sloping lines and avoid structural, electrical, pipe and duct interference's whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.

C. Determine exact route and location of ducts and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner's Representative prior to fabrication.

D. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of mechanical equipment to fit the available space and promptly notify the Owner's Representative prior to roughing-in if conflicts appear.

E. All wiring, equipment, ductwork, tubing, etc., shall be concealed within building construction unless otherwise noted, or in mechanical rooms.

F. Arrange ducts, and equipment to permit ready access to starters, motors, control components, and to clear openings of doors and access panels.

3.2 CUTTING AND PATCHING

A. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 22 shall be the responsibility of the Division 23 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner's Representative.

C. All cutting and patching made necessary to repair defective equipment, defective workmanship or be neglect of this Contractor to properly anticipate his requirements shall be included in Division 23.

D. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative’s written approval.

E. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under this Division is responsibility of Division 23.

3.3 SCHEDULING

A. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner’s Representative for those changes before proceeding with work.

B. Coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, make proper provision to avoid interference’s. Changes required in work specified in Division 22 caused by neglect to do so shall be made at no cost to Owner.
C. Furnish and install inserts and supports required by Division 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 23.

3.4 PROJECT FINALIZATION & STARTUP

A. Upon completion of the equipment and systems installation and connections, the Contractor shall assemble all major equipment factory representatives (Exhaust fans) and subcontractors together for system start-up and Owner instructional period.

B. These individuals shall assist in start-up and check out of their systems and shall remain at the site until the system operation is acceptable and understood to the Owner's maintenance and/or operation personnel.

C. To provide acceptance of operation and instruction by the Owner's representative, the Contractor shall prepare a written statement of acceptance explaining same for the Owner's signature. The statement should read as follows:
"I, the Contractor, associated factory representative and subcontractor, have started each system and the total system and have proved their normal operation to the Owner's representative and have instructed him in the operation and maintenance thereof."

________________________  __________________________
Owner's Representative    Contractor

D. Copies of this acceptance shall be sent to the Engineer and the Architect, and one copy shall be put in each maintenance manual.

3.5 PUNCH LIST PROCEDURES

A. The Contractor shall notify the Owner's Representative in wiring when the project is ready for punch lists. After punch lists are complete, written notice must be forwarded to the Owner's Representative requesting final checkout.

B. At the time of final observation, the project foreman shall accompany the observation party and shall remove access panels as required, to allow complete observation of the entire mechanical system.

END OF SECTION 22 00 00
SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Sleeves.
   4. Escutcheons.
   5. Plumbing demolition.
   6. Equipment installation requirements common to equipment sections.
   7. Supports and anchorages.
   8. Access doors.

1.2 DEFINITIONS

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

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

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 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.
2.2 JOINING MATERIALS

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

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

2.3 DIELECTRIC FITTINGS

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

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

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

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 SLEEVES

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

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

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

2.5 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.
PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and 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. Diagonal runs are prohibited unless specifically indicated otherwise.

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors.

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

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07 72 00 "Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 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.

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.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

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

C. Field Welding: Comply with AWS D1.1.

3.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.
3.7 ACCESS DOORS

A. Access doors to match surrounding surface, provided with recess to accept matching finish. Provide UL rated doors in fire rated construction.

B. Provide 12”x12” access doors for maintenance or adjustments purposes for all mechanical system components including valves, volume dampers, fire dampers, fire/smoke dampers, clean outs, traps and controls.

C. Refer to Section 08 31 00 "Access Doors and Panels".

END OF SECTION 230500
SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Thermometers
   2. Pressure gauges.
   3. Test Plugs

1.2 PERFORMANCE REQUIREMENTS

A. Provide thermometers, pressure gauges and test plugs in plumbing system piping and equipment as required to adjust and monitor system performance.

1.3 SUBMITTALS

A. Product data: For each type of thermometer and pressure gauge.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Metal-Case, Liquid-in-Glass Type: Aluminum or Brass case, mercury or organic-liquid filled.

B. Plastic-Case, Liquid-in-Glass Type: Mercury or organic-liquid filled.

C. Direct-Mounting, Vapor-Actuated Dial Type: Dry or Liquid-filled type, steel or aluminum metal case.

D. Remote-Reading, Vapor-Actuated Dial Type: Dry type, steel or aluminum case.

E. Bimetallic-Actuated Dial Type: Dry or Liquid-filled type, stainless-steel case.

F. Thermowells to hold thermometers.

2.2 PRESSURE GUAGES

A. Direct-Mounting Dial Type: Dry or Liquid-filled type, drawn-steel or cast-aluminum, metal case; Grade A accuracy.

B. Remote-Mounting Dial Type: Dry type, drawn-steel or cast-aluminum case; Grade A accuracy.

C. Fittings: Needle valves and Snubbers.

2.3 TEST PLUGS

A. Test Plugs: Corrosion-resistant brass or stainless-steel body with core inserts.
   1. Test kit containing pressure gage, low- and high-range thermometers, and carrying case.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermometers, pressure gauges and test plugs where required per the plumbing design and in accordance with the manufacturer’s recommendations.

PART 4 - END OF SECTION 220519
SECTON 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
1. Valves for plumbing piping systems.

1.2 PERFORMANCE REQUIREMENTS

A. Provide plumbing system valves as required for complete and fully serviceable plumbing system, including isolation valves and check valves. Valves shall be provided to isolate every individual piece of plumbing equipment and to isolate major branches of plumbing distribution piping, including each plumbing room battery and other groups of fixtures.

1.3 SUBMITTALS

A. Product data: For each type of valve.

PART 2 - PRODUCTS

2.1 DOMESTIC, HOT- AND COLD-WATER VALVES

A. Pipe NPS 2 (DN 50) and Smaller:
1. Ball Valves.
2. Bronze Swing Check Valves.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Ball Valves:
2. Iron, Single-Flange Butterfly Valves
4. Iron Swing Check Valves.
5. Iron, Grooved-End Swing Check Valves: 300 CWP.
6. Iron, Center-Guided Check Valves
7. Iron Gate Valves.

PART 3 - EXECUTION

3.1 (Not used)

END OF SECTION 220523
SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
   A. Hangers and supports for plumbing system piping and equipment.

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

1.3 PERFORMANCE REQUIREMENTS
   A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   C. Design supports for multiple pipes and equipment.

1.4 SUBMITTALS
   A. Product Data: For each type of hanger and accessories.

PART 2 - PRODUCTS

2.1 COMPONENTS
   A. Steel pipe hangers and supports.
   B. Trapeze pipe hangers.
   C. Fiberglass pipe hangers.
   D. Metal framing systems.
   E. Fiberglass strut systems.
   F. Thermal-hanger shield inserts.
   G. Pipe Stands
   H. Pipe positioning systems.
   I. Equipment supports.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install hanger and supports in accordance with manufacturer's standards and building code requirements.

END OF SECTION 220529
SECTION 220548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

1.1 SUMMARY

A. This section includes the following:
   1. Vibration control for piping systems.
   2. Seismic controls for piping systems and equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC:  D.
   2. Coordinate with structural engineer for other requirements.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

B. Seismic Restraints shall be determined based on local site seismic criteria and shall be designed by a company that specializes in Seismic Controls.

1.4 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."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings.  Ratings based on independent testing are preferred to ratings based on calculations.  If preapproved ratings are not available, submittals based on independent testing are preferred.  Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.5 COMPONENTS

A. Vibration Isolators:
   1. Isolator Pads: Neoprene.
   3. Restrained Mounts: All directional mountings with seismic restraint; cast-ductile-iron housing.
   4. Spring Isolators: Freestanding, laterally stable, open-spring type.
   5. Restrained Spring Isolators: Freestanding, steel, open-spring type with seismic restraint.
   6. Housed Spring Mounts: Ductile-iron or steel housing, with integral, vertically adjustable seismic snubbers.
8. Spring Hangers: Combination coil-spring and elastomeric-insert hangers with spring and insert in compression.
11. Resilient pipe guides.

B. Vibration Isolation Equipment Bases:

C. Seismic-Restraint Devices:
1. Snubbers: Welded structural-steel shapes and replaceable resilient isolation washers and bushings.
2. Channel Support System: MFMA-3 slotted steel channels.
4. Anchor Bolts: Mechanical type, seismic rated.
5. Resilient Isolation Washers and Bushings: Molded neoprene.

1.6 FIELD QUALITY CONTROL
A. Testing: By Contractor.

END OF SECTION 220548
SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
   A. This section includes the following:
      1. Equipment labels.
      2. Piping identification.
      3. Valve tags.

1.2 PERFORMANCE REQUIREMENTS
   A. Provide piping and equipment identification to assist in system start-up, commissioning and Owner operation.

1.3 SUBMITTALS
   A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
   B. Product data: Equipment and pipe labels and valve tags.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PRODUCTS
   B. Warning Signs and Labels: 1/16 inch (1.6 mm) thick with adhesive.
   C. Pipe Labels: Pretensioned or Self-adhesive.
   D. Stencils: Fiberboard or metal.
   E. Valve Tags: Brass, 0.032-inch (0.8-mm) Stainless steel, 0.025-inch (0.64-mm) Aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness.
   F. Warning Tags: 3 by 5-1/4 inches (75 by 133 mm) minimum, reinforced grommet and wire fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

END OF SECTION 220553
SECTION 220700
PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Pipe and plumbing equipment insulation and accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Provide thermal insulation on HVAC systems to meet energy codes and to minimize system energy losses and/or prevent condensation on cold surfaces.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors; according to ASTM E 84.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General
   1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
   2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
   3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
   4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

B. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I or II with factory-applied jacket.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied factory.

E. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied jacket.

F. Adhesive materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

G. Factory Applied Jackets: Coordinate types of factory-applied jacket insulation materials selected and types of factory-applied jackets indicated in insulation system schedules. For insulation materials with factory-applied jackets for use on applications above 140 deg F (60 deg C), provide sufficient insulation thickness.
to maintain outer surface temperature of insulation below 140 deg F (60 deg C). 140 deg F (60 deg C) surface temperature is set by OSHA for personnel protection. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.2 EQUIPMENT INSULATION SCHEDULE

A. Domestic Hot-Water Storage Tank Insulation: Factory Insulated or Mineral-fiber board or mineral-fiber pipe and tank.

2.3 PIPING INSULATION SCHEDULE, GENERAL

A. Plumbing Piping requiring insulation:
   1. Domestic hot, cold and recirculation hot water – aboveground.
   2. Storm Drainage Piping (roof drains) and roof drain bodies - aboveground.
   3. Handicapped plumbing fixtures with exposed piping.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Sanitary drainage and vent piping – aboveground.
   4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe insulation in accordance with manufacturer’s recommendations, and in thickness according to the applicable energy code standards.
   1. Provide protective metal jacketing on all piping located outdoors.
SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Domestic water piping.
   2. Flow balance valves.

1.2 PERFORMANCE REQUIREMENTS

A. Provide domestic water distribution piping system to serve all building plumbing facilities and equipment.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

B. Product data: For each type of pipe material, fittings and joint methods.

1.4 QUALITY ASSURANCE

A. Comply with the IPC and other applicable local and state codes.

PART 2 - PRODUCTS

2.1 UNDER-BUILDING-SLAB, DOMESTIC WATER, BUILDING SERVICE PIPING,

A. Pipe NPS 3 (DN 80) and Smaller:
   1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper solder-joint fittings; and brazed joints.
   2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.

2.2 UNDER-BUILDING SLAB, COMBINED DOMESTIC WATER, BUILDING-SERVICE, AND FIRE-SERVICE-MAIN PIPING

A. Pipe NPS 6 to NPS 12 (DN 150 to DN 300):
   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.

2.3 UNDER-BUILDING-SLAB, DOMESTIC WATER PIPING

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Hard or soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.

2.4 ABOVEGROUND DOMESTIC WATER PIPING

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) cast- or wrought-copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, [ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, [ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.

B. Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100):
   1. Hard copper tube, [ASTM B 88, Type L (ASTM B 88M, Type B)] cast- or wrought-copper solder-joint fittings; and soldered joints.
   2. Hard copper tube, [ASTM B 88, Type L (ASTM B 88M, Type B)]; copper pressure-seal-joint fittings; and pressure-sealed joints.
   3. Hard copper tube, [ASTM B 88, Type L (ASTM B 88M, Type B)]; grooved-joint copper-tube appurtenances; and grooved joints.

2.5 ABOVEGROUND, COMBINED DOMESTIC-WATER-SERVICE AND FIRE-SERVICE-MAIN PIPING

A. Pipe NPS 6 to NPS 12 (DN 150 to DN300):
   1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
   2. Galvanized-steel pipe, galvanized fittings, and threaded joints.
   3. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

2.6 MANUFACTURED UNITS


B. Flexible Connectors: Stainless-steel hose.

2.7 PRODUCTS

A. Wall Penetrations below Grade: Sleeve and sleeve seal.

PART 3 - EXECUTION

(NOT USED)

END OF SECTION 221116
SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:
   1. Vacuum breakers.
   2. Backflow preventers.
   3. Pressure reducing valves.
   5. Mixing valves.
   7. Outlet boxes.
   8. Hose stations.
   9. Hose bibs and freeze-proof wall hydrants.
   10. Water hammer arrestors.
   11. Trap primers.

1.2 PERFORMANCE REQUIREMENTS

A. Provide domestic water piping system specialties in order to create a fully functional and serviceable system.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

   B. Product data: For each plumbing system specialty item.

1.4 QUALITY ASSURANCE

A. Local and State Plumbing Codes and standards.


   C. Drinking Water System Components: NSF 61.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Vacuum Breakers:
   1. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   2. Hose-Connection Vacuum Breakers:
   3. Pressure vacuum breakers.
   4. Spill-resistant vacuum breakers.

B. Backflow Preventers:
   1. Intermediate Atmospheric-Vent Backflow Preventers:
   2. Reduced-Pressure-Principle Backflow Preventers:
   3. Double-Check Backflow-Prevention Assemblies:
   4. Beverage-dispensing-equipment backflow preventers.
   5. Dual-check-valve backflow preventers.
   7. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:
8. Double-Check, Detector-Assembly Backflow Preventers:

C. Water Pressure-Reducing Valves:
   1. Water Regulators:
   2. Water Control Valves:

D. Balancing Valves:
   1. Copper-Alloy Calibrated Balancing Valves:
   2. Cast-iron calibrated balancing valves.
   3. Accessories: Meter kit.
   4. Memory-stop balancing valves.

E. Temperature-Actuated Water Mixing Valves:
   1. Water-Temperature Limiting Devices:
   2. Primary, Thermostatic, Water Mixing Valves:
   3. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:
   5. Individual-fixture, water tempering valves.
   6. Primary water tempering valves.

F. Strainers for Domestic Water Piping:

G. Outlet Boxes:
   1. Clothes Washer Outlet Boxes:
   2. Icemaker Outlet Boxes.

H. Hose Stations:
   1. Single-Temperature-Water Hose Stations:
   2. Hot- and Cold-Water Hose Stations:
   3. Cold-Water and Steam Hose Stations:

I. Hose Bibbs with vacuum breaker:

J. Wall Hydrants:
   1. Nonfreeze Wall Hydrants:
   2. Nonfreeze, Hot- and Cold-Water Wall Hydrants:
   3. Moderate-Climate Wall Hydrants:
   4. Vacuum Breaker Wall Hydrants:

K. Drain Valves.

L. Water Hammer Arresters.

M. Air Vents.

N. Trap-Seal Primer Valves.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install domestic water system specialties according to manufacturer's recommendations and where required to meet established design standards and applicable codes.

END OF SECTION 221119
SECTION 221123
DOMESTIC WATER PUMPS

1.1 SUMMARY
   A. Centrifugal pumps for domestic cold- and hot-water systems.

1.2 PERFORMANCE REQUIREMENTS
   A. Provide domestic water pumps as required to support the domestic water distribution and water heating system.

1.3 SUBMITTALS
   A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
   B. Product data: For each type of pump.

1.4 PRODUCTS
   A. Close-Coupled, In-Line, Sealless Centrifugal Pumps:
   B. Separately Coupled, In-Line Centrifugal Pumps:
   C. Separately Coupled, Horizontally Mounted, In-Line Centrifugal Pumps:
   D. Close-Coupled, Horizontally Mounted, In-Line Centrifugal Pumps
   E. Close-Coupled, Vertically Mounted, In-Line Centrifugal Pumps:
   F. Controls as required.
   G. Flexible connectors.
   H. Building-automation-system interface with on-off and alarm status for each pump.

END OF SECTION 221123
SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Soil, waste, vent piping inside the building.

1.2 PERFORMANCE REQUIREMENTS
   A. Provide sanitary waste and vent piping system to connect to building plumbing fixtures and equipment.

1.3 SUBMITTALS
   A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
   B. Product data: For each type of pipe material, fittings and joint methods.

1.4 QUALITY ASSURANCE
   A. Design and installation shall comply with local and state plumbing codes.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Cast-Iron Pipe and Fittings:
      1. Hub-and-spigot class.
      2. Hubless.
   B. Steel Pipe and Fittings: Standard Weight and Schedule 40, galvanized.
   C. Stainless-steel pipe and fittings with socket and spigot ends.
   D. Ductile-iron pipe and fittings.
   E. Copper Tubing and Fittings:
      1. DWV tube with solder-joint fittings.
      2. Hard copper tube.
      3. Soft copper tube with copper pressure fittings.
   F. ABS Pipe and Fittings.
   G. PVC Pipe and Fittings
   H. Special pipe fittings:
      1. Flexible, nonpressure pipe couplings.
      2. Shielded, nonpressure pipe couplings.
      3. Rigid, unshielded, nonpressure pipe couplings.
      4. Pressure pipe couplings.
      5. Flexible ball joints.
      7. Wall-penetration fittings.
   I. Encasement for Underground Metal Piping: PE film.
PART 3 - EXECUTION

3.1  (NOT USED)

END OF SECTION 221316
SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Cleanouts.
   2. Floor drains.
   3. Floor sinks.

1.2 PERFORMANCE REQUIREMENTS

A. Provide sanitary waste piping specialties as required to create a complete and fully functional and serviceable system.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
   B. Product data: For each waste piping specialty item.

1.4 QUALITY ASSURANCE

A. Local and State Plumbing Codes.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Cleanouts.

B. Floor Drains:
   1. Cast-Iron Floor Drains.
   2. Stainless-Steel Floor Drains.

C. Channel Drainage Systems:
   1. Polymer-Concrete Channel Drainage Systems: Modular system of channel sections, grates, and appurtenances.

D. Air-Admittance Valves.

E. Roof Flashing Assemblies:

F. Through-Penetration Firestop Assemblies: Listed and labeled assembly of sleeve and stack fitting with firestopping plug.

G. Miscellaneous Sanitary Drainage Piping Specialties:
   1. Open drains, shop or field fabricate from Service class, hub-and-spigot, cast-iron, soil-pipe fittings.
   2. Cast-iron or bronze deep-seal traps.
   3. Floor-drain, trap-seal primer fittings.
   4. Air-gap fittings.
   5. Counterflashing-type, cast-iron stack flashing fittings.
6. Cast-iron body vent caps.

H. Flashing Materials:

2.2 MANUFACTURED UNITS

A. Grease Interceptors – Design, sizing and configuration as required by local jurisdiction:

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION 221319
SECTION 221413
FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
A. Storm drainage piping inside the building.

1.2 PERFORMANCE REQUIREMENTS
A. Provide interior, above and below ground, storm drainage piping from roof drains and overflow drains to exterior underground storm drainage piping or to perimeter overflow discharge nozzles.

B. Minimum Working-Pressure Ratings:
   1. Storm Drainage Piping: 10-foot head of water (30 kPa).
   2. Storm Drainage, Force-Main Piping: 50 psig (345 kPa) or as required.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
B. Product data: For each type of pipe material, fittings and joint methods.

1.4 QUALITY ASSURANCE
B. Seismic Performance: ASCE 7.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Cast-Iron Pipe and Fittings:
   1. Hub-and-spigot, Service class.

B. Steel Pipe and Fittings: Standard Weight and Schedule 40, galvanized grooved-end fittings.

C. Ductile-iron pipe and fittings with mechanical or grooved-end fittings.

D. Copper Tubing and Fittings:
   1. DWV tube with solder-joint fittings.

E. ABS Pipe and Fittings: Solid-wall pipe with socket fittings.

F. PVC Pipe and Fittings: Solid-wall pipe with socket fittings.

G. Special Pipe Fittings:
   1. Flexible, nonpressure pipe couplings.
   2. Shielded, nonpressure pipe couplings.
   3. Rigid, nonpressure pipe couplings.
   4. Pressure pipe couplings.
   5. Flexible ball joints.
7. Wall-penetration fittings.

H. Encasement for Underground Metal Piping: PE film.

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION 221413
SECTION 221423
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY
A. This section includes the following:
   1. Roof drains.

1.2 PERFORMANCE REQUIREMENTS
A. Provide a storm drainage piping system as necessary to accommodate the building roof drainage system.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
B. Product data: For each type of pipe material, fittings and joint methods.

1.4 QUALITY ASSURANCE
A. Design and installation shall comply with local and state plumbing codes.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Cleanouts.
B. Through-Penetration Firestop Assemblies: Listed and labeled assembly of sleeve and stack fitting with firestopping plug.
C. Roof Drains:
   1. Metal Roof Drains:
D. Miscellaneous Drainage Piping Specialties:
   1. Expansion joints.
   2. Downspout boots.
   3. Bronze body conductor nozzles.

PART 3 - EXECUTION

PART 4 - (NOT USED)

END OF SECTION 221423
SECTION 223400

FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY
A. Gas water heaters.

1.2 PERFORMANCE REQUIREMENTS
A. Provide commercial gas-fired domestic water heaters to furnish the required supply of hot water to the building.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 220000 and 013300.
B. Product data: For each type of water heater.

1.4 QUALITY ASSURANCE
A. Quality Standard for Performance Efficiency: ASHRAE/IESNA 90.1 and ASHRAE 90.2.
B. Water Heater Storage Tanks, Specified to Be ASME-Code Construction: Tested and inspected according to ASME Boiler and Pressure Vessel Code.

1.5 WARRANTY
A. Materials and Workmanship:
   2. Compression Tanks: One year.

PART 2 - PRODUCTS

2.1 PRODUCTS
B. Compression Tanks:
C. Water Heater Accessories:
   2. Gas Pressure Regulators: Appliance type.
   4. Combination temperature and pressure relief valves.
   5. Pressure relief valves.
   6. Water heater stand and drain pan units.
   7. Water heater stands.
   8. Water heater mounting brackets.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 223400
SECTION 224000
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Includes furnishing and installation of plumbing fixtures and related accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Provide plumbing fixtures and all associated faucets, flush valves, traps, supplies, etc. as required to serve the building facilities.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

1.4 QUALITY ASSURANCE


C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

E. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   3. Vitreous-China Fixtures: ASME A112.19.2M.

F. Comply with the following applicable standards and other requirements specified for lavatory and/or sink faucets:
   1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Hose-Connection Vacuum Breakers: ASSE 1011.

G. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   2. Brass and Copper Supplies: ASME A112.18.1.
H. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Disposers: ASSE 1008 and UL 430.
   5. Off-Floor Fixture Supports: ASME A112.6.1M.

I. Quality Standard for Electrical Components, Devices, and Accessories: NFPA 70, Article 100.

1.5 WARRANTY

A. Materials and Workmanship for Plumbing Fixtures and Accessories:

PART 2 - PRODUCTS

2.1 FAUCETS

A. Lavatory Faucets;

B. Sink Faucets;
   1. Kitchen faucet with spray, three-hole fixture, Kitchen faucet with spray, four-hole fixture, Kitchen faucet without spray, Laundry tray faucet, Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook, or Bar sink faucet as appropriate for application.

2.2 FLUSHOMETERS

A. Flushometers:
   1. Flushometer for urinal and/or water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
      a. Trip Mechanism: Manual or automatic as determined by Facility Standards.
      b. Consumption: Per energy code or high performance design standards.

2.3 TOILET SEATS

A. Toilet Seats:
   1. Commercial toilet seat for water-closet-type fixture.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers for Handicap Fixtures
   1. Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping.

2.5 FIXTURE SUPPORTS

A. Water-Closet Supports:
   1. Combination carrier designed for accessible and/or standard mounting height of wall-mounting, water-closet-type fixture.

B. Urinal Supports:
   1. Urinal carrier for wall-mounting, urinal-type fixture.
C. Lavatory Support:
   1. Lavatory carrier for wall-mounting, lavatory-type fixture.

2.6 WATER CLOSETS
A. Water Closets, Wall Mounted:
   1. Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
B. Water Closets, Floor Mounted, Floor Outlet:
   1. Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.

2.7 URINALS
A. Urinals, Bottom Outlet:
   1. Wall-mounting, bottom-outlet, vitreous-china fixture designed for flushometer valve operation.

2.8 LAVATORIES
A. Lavatories, Wall and Pedestal:
B. Lavatories, Counter-Mounting:
   1. Counter-mounting vitreous-china fixture.
C. Lavatories, Accessible:
   1. Accessible, wall-mounting, vitreous-china fixture designed for people in wheelchairs.

2.9 COMMERCIAL SINKS
A. Commercial Sinks, Counter-Mounting, Stainless Steel:
   1. One, two or three-compartment, counter-mounting, stainless-steel commercial sink with backsplash.
B. Commercial Sinks, Wall-mounting, handwash sink:
   1. Wall-mounting, stainless-steel, commercial, handwash-sink fixture.

2.10 KITCHEN SINKS
A. Kitchen Sinks:
   1. One or two-bowl, residential, counter-mounting, stainless-steel kitchen sink.
B. Bar Sinks:

2.11 SERVICE SINKS
A. Service Sinks, Wall-Mounting:
B. Service Sinks, Floor-Mounting:
   1. Floor-mounting, enameled, cast-iron fixture with front apron, raised back, and coated, wire rim guard.

2.12 SERVICE BASINS (MOP SINKS)
A. Service Basins:
   1. Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.
2.13 FOOD SERVICE FIXTURES

A. Food service fixtures shall be defined by individual food service suite design.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 224000
SECTION 23 00 00
HVAC-GENERAL PROVISIONS

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

A. Refer to BIDDING REQUIREMENTS, CONDITIONS OF THE CONTRACT, SUPPLEMENTARY
CONDITIONS and DIVISION 01 of these specifications, which govern work under DIVISION 23.
Refer to other sections of these specifications for additional related requirements.

1.2 SCOPE OF REQUIREMENTS

A. The work covered by Division 23 of the specifications shall include but not be limited to:
1. Furnishing all materials and supplying all labor, equipment and services to install the
complete mechanical system as shown on the accompanied drawings and specified
herein.

1.3 DESCRIPTION OF WORK

A. The contract documents including specifications and construction drawings are intended to provide
all material and labor to install complete plumbing, heating ventilating and air conditioning systems
for the building.
B. Every effort has been made on the design to meet or exceed the minimum requirements of the
Codes; therefore, unless Contractor before signing his Contract, shall have notified the Architect,
in writing, of any items in conflict with said Codes, he shall thereafter make any minor adjustments
necessary to meet said Codes at no cost to the Owner.
C. The Contractor shall refer to the architectural interior detail, floor plans, elevations, and the
structural and other Contract Drawings and he shall coordinate his work with that of the other
trades to avoid interference. The plans are diagrammatic and show generally the locations of the
equipment and are not to be scaled; all dimensions shall be checked at the building.
D. The Contractor shall comply with the project close-out requirements as detailed in General
Requirements of Division 01.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:
1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.
B. Drawings:
1. Drawings in general are diagrammatic and indicate sizes, locations, connections to
equipment and methods of installation.
2. Scaled and figured dimensions are approximate and are for estimating purposes only.
3. Before proceeding with work check and verify all dimensions.
4. Assume all responsibility for fitting of materials and equipment to other parts of equipment
and structure.
5. Make adjustments that may be necessary or requested in order to resolve space
problems, preserve headroom, and avoid architectural openings, structural members and
work of other trades.
6. If any part of Specifications or Drawings appears unclear or contradictory, apply to
Architect or Engineer for his interpretation and decision as early as possible.

1.5 CODES PERMITS AND FEES

A. Mechanical work shall be in accordance with the following:
1. The latest edition of the International Building Code, International Mechanical Code,
Disability Act and all applicable State and Local Codes and Ordinances.
2. The Contractor at his expense shall obtain permits and inspections required for the mechanical work on this project. Deliver all inspection certificates to the Owner’s Representative prior to final acceptance of the work.

3. Contractor shall pay all costs levied by utility companies and/or governing agencies associated with gas connections and include these costs within his bid. This shall include but not be limited to tap fees, service mains, meter, and vault charges.

1.6 DEFINITIONS
A. The terms “The Contractor”, when used in Division 23 shall mean the Contractor for mechanical work.

B. The term “Owners Representative” as used in Division 23 generally refers to the Architect or his designated representative in accordance with the General Conditions.

C. The term “Provide” shall mean furnish and install.

1.7 TEMPORARY HEATING
A. See Section 015000 Temporary Facilities and Controls.

1.8 SAFETY AND PROTECTION
A. Safety Measures: The Engineer has not been retained to provide design and construction services relating to the Contractor’s safety precautions, or means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement applies continuously and is not limited to normal working hours. Provide all required safety measures and consult with the State or Federal safety inspector for interpretation whenever in doubt as to whether safe conditions do or do not exist or whether compliance with State or Federal regulations exist.

B. Head protection: Where pipe hangers, equipment support angles, etc., are exposed in access ways for any maintenance, cover all such potentially injurious protrusions less than 7'-0" above the floor with padding; secure and permanently fasten, and finish to match adjacent finishes.

1.9 GUARANTEE
A. The Mechanical equipment and installation shall be guaranteed for a period of one (1) year from the date of acceptance unless and individual item or specification is otherwise noted as longer. The Contractor shall make-good at his own expense all defects in his work, and/or equipment furnished by him, which shall develop at any time during the one year guarantee period and shall stand any expense of cutting and patching and repairing made necessary by his corrections of unsatisfactory work or equipment operation.

1.10 DUCTWORK AND PIPING COORDINATION
A. Prior to installation of the new Division 23 systems, the Contractor shall coordinate the proposed installation with the Architectural and Structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension and Tile systems), and provide reasonable maintenance access requirements.

B. Provide means of access to all valves, dampers, controllers, operable devices and other apparatus which may require adjustment or servicing.

C. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owners Representative of any discrepancies between that indicated on the Drawings and that existing in the field prior to any installation. Contractor shall be responsible for all costs associated with the removal or relocation of installed systems that have been installed without prior notification of the Owners Representative.

1.11 SHOP DRAWINGS AND SUBMITTALS
A. Submit Shop Drawings and Product Data per the requirements of Section 013300 Submittals Procedures.

B. See individual Division 23 specification sections for additional submittal requirements.

C. Submittals of Product Data shall be bound in a black 3-ring binder with the project name on the cover. Data within this binder shall be arranged as follows:
   1. Provide index tabs for each specification section in the same order and using the same name as appears in the Specifications.
   2. Data shall be black and white, on 8 ½” x 11“ or 11” x 17”, single, one-sided sheets suitable for copying. Diagrams and drawings larger than 11” x 17” shall be submitted in reproducible form (translucent bond paper).
   3. Drawings and catalog data must be clean, neat copies. Fax material or other poor quality copies will not be acceptable.

D. If material or equipment is not as specified or submittal is not complete, it will be rejected. Only completed submittal including all applicable specification sections will be reviewed.

E. Indicate manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Indicate sizes, types, model numbers, ratings, capacities and options actually being proposed.

F. Include dimensional data for roughing in and installation, and technical data sufficient to confirm that equipment meets requirements of drawings and specifications.

G. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.

H. Submit five (5) copies of each shop drawing. The Engineer will retain one stamped copy, one will be provided to the Architect, one will be provided to the owner and a two stamped copies will be returned to the Contractor. The Contractor shall be responsible for distribution of required number of reviewed copies to parties other than the Owner’s Representative(s).

1.12 RECORD DRAWINGS
A. Refer to Division 01.

B. Keep on site, an extra set of drawings and specifications recording changes and deviations daily. Return these drawings to the Owner’s Representative at the completion of the Project. These drawings shall not be used for any other purposes.

1.13 OPERATING AND MAINTENANCE MANUALS
A. Refer to Section 017800 Closeout Submittals.

B. See individual Division 23 specification sections for additional Operating and Maintenance Manual requirements.

1.14 OPERATION AND MAINTENANCE TRAINING/STARTUP
A. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual.

B. Individuals present shall include Contractors, subcontractors and equipment factory representatives. These individuals shall assist in instruction and start-up.

C. Instruction period shall occur after final inspection when systems are properly working.

D. Prepare statement and check list to be included in the Operation and Maintenance Manual. This Statement shall read as follows:
   “The Contractor, associated factory representatives and subcontractors, have started each system and the total system and have proved their normal operation to the Owner’s representative and have instructed him in the operation and maintenance thereof.”
PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS – STANDARDS/CODES

A. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Each item of equipment shall conform to the latest Standard Specifications of the American Society for Testing Materials and shall conform to any applicable standards of the United States Department of Commerce.

B. Instruct the Owners representative(s) in operation and maintenance of mechanical systems utilizing the Operation and Maintenance Manual. Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when the Project is turned over to the Owner.

C. All electrically driven or connected equipment shall be provided with UL or equivalent label and/or listing in accordance with the requirements of the NEC.

D. All control panels shall be provided with UL or equivalent Label and/or listing in accordance with the requirements of the NEC an applicable local codes.

2.2 EQUIPMENT/MATERIAL SUBSTITUTIONS

A. Refer to Section 012500 Substitution Procedures for product prior approval and substitution requirements.

B. Throughout these specifications and drawings, various materials, equipment, apparatus, etc., are specified or scheduled by manufacturer, brand name, type or catalog number. Such designation is to establish standards of desired quality and construction and shall be the basis of design and the bid.

C. Submit proposals to supply alternative materials or equipment in writing, in accordance with Section 012500 Substitution Procedures.

D. Equipment manufacturers listed in individual sections are approved alternatives for this project and are subject to requirements of drawings and specifications. Revisions required to adapt alternatives shall be the responsibility of the Contractor.

E. Products furnished other than the (basis of design) shall have similar electrical characteristics as the scheduled or specified equipment. Contractor shall be responsible for any electrical changes caused by products not in accordance with this requirement.

PART 3 - EXECUTION

3.1 EQUIPMENT PROTECTION AND CLEAN-UP

A. Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts and duct systems.

B. Protect equipment with polyethylene covers and crates.

C. Operate, drain and flush bearings and refill with change of lubricant before final acceptance.

D. Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Provide extended nipples for lubrication.

E. Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not re-use existing materials and equipment unless specifically indicated.

3.2 LOCATIONS
A. Coordination of Division 23 equipment and systems to the available space, with other trades. The access routes through the construction shall be the Contractor’s responsibility.

B. Drawings are diagrammatic. Make offsets, transitions, and changes in direction of pipes and ducts, as required to maintain proper headroom and pitch of sloping lines and avoid structural, electrical, pipe and duct interference’s whether or not indicated on Drawings. Furnish fittings, etc., as required to make these offsets, transitions and changes in direction at no additional cost to the Owner.

C. Determine exact route and location of ducts and coordinate and obtain approval for changes from the layout indicated on the drawings with the Owner’s Representative prior to fabrication.

D. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Verify the physical dimensions of each item of mechanical equipment to fit the available space and promptly notify the Owner’s Representative prior to roughing-in if conflicts appear.

E. All wiring, equipment, ductwork, tubing, etc., shall be concealed within building construction unless otherwise noted, or in mechanical rooms.

F. Arrange ducts, and equipment to permit ready access to starters, motors, control components, and to clear openings of doors and access panels.

3.3 CUTTING AND PATCHING

A. All cutting and patching of new and existing construction required for the installation of systems and equipment specified in Division 23 shall be the responsibility of the Division 23 Contractor. All cutting shall be accomplished with masonry saws, drills or similar equipment to provide neat uniform openings.

B. Patch and repair walls, floors, ceilings and roof with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials. All patching shall meet the approval of the Owner’s Representative.

C. All cutting and patching made necessary to repair defective equipment, defective workmanship or be neglect of this Contractor to properly anticipate his requirements shall be included in Division 23.

D. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses or other structural members without the Owner Representative’s written approval.

E. Cutting, patching, repairing, and replacing pavement, sidewalks, roads, and curbs to permit installation of work specified or indicated under this Division is responsibility of Division 23.

3.4 SCHEDULING

A. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner’s Representative. Should conditions arise where certain changes would be advisable, secure approval from Owner’s Representative for those changes before proceeding with work.

B. Coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, make proper provision to avoid interference’s. Changes required in work specified in Division 23 caused by neglect to do so shall be made at no cost to Owner.

C. Furnish and install inserts and supports required by Division 23 unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 23.
3.5 EXISTING UTILITIES

A. The locations of existing concealed lines and connection points have been indicated as closely as possible from available information. The Contractor shall assume that such connection points are within a Ten foot (10') radius of the indicated location. Where connection points are not within this radius, the Contractor shall contact the Owner’s Representative for a decision before proceeding or may proceed at his own expense.

B. Connection points to existing work shall be located and verified prior to starting new work.

C. Prior to commencing any excavation or ditching activity, the Contractor shall verify the exact location and inverts of all existing utilities and connection points in the area of his proposed excavation. Notify Owner’s representative for further direction if actual inverts will not allow the proper installation of new work.

D. The Contractor shall be responsible for damages, which might be caused by his failure to exactly locate and preserve underground utilities.

3.6 PROJECT FINALIZATION & STARTUP

A. Upon completion of the equipment and systems installation and connections, the Contractor shall assemble all major equipment factory representatives (Exhaust fans) and subcontractors together for system start-up and Owner instructional period.

B. These individuals shall assist in start-up and check out of their systems and shall remain at the site until the system operation is acceptable and understood to the Owner's maintenance and/or operation personnel.

C. To provide acceptance of operation and instruction by the Owner’s representative, the Contractor shall prepare a written statement of acceptance explaining same for the Owner's signature. The statement should read as follows:

"I, the Contractor, associated factory representative and subcontractor, have started each system and the total system and have proved their normal operation to the Owner's representative and have instructed him in the operation and maintenance thereof."

________________________  __________________________
Owner's Representative    Contractor

D. Copies of this acceptance shall be sent to the Engineer and the Architect and one copy shall be put in each maintenance manual.

3.7 PUNCH LIST PROCEDURES

A. The Contractor shall notify the Owner’s Representative in wiring when the project is ready for punch lists. After punch lists are complete, written notice must be forwarded to the Owner’s Representative requesting final checkout.

B. At the time of final observation, the project foreman shall accompany the observation party and shall remove access panels as required, to allow complete observation of the entire mechanical system.

END OF SECTION  23 00 00
SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Sleeves.
   3. Escutcheons.
   4. Equipment installation requirements common to equipment sections.
   5. Supports and anchorages.
   6. Access doors.

1.2 DEFINITIONS

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

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

1.3 SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PRODUCTS

1.5 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

1.6 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

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

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

1.7 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.

1.8 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.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

PART 2 - EXECUTION

2.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install escutcheons for penetrations of walls, ceilings, and floors.
M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Section 07 72 00 “Firestopping” for materials.
O. Verify final equipment locations for roughing-in.
P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

2.2 PIPING JOINT CONSTRUCTION
A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
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.

2.3 PIPING CONNECTIONS
A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
2.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

2.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

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

C. Field Welding: Comply with AWS D1.1.

2.6 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

2.7 ACCESS DOORS

A. Access doors to match surrounding surface, provided with recess to accept matching finish. Provide UL rated doors in fire rated construction.

B. Provide 12"x12" access doors for maintenance or adjustments purposes for all mechanical system components including valves, volume dampers, fire dampers, fire/smoke dampers, clean outs, traps and controls.

C. Refer to Section 08 31 00 "Access Doors and Panels".

END OF SECTION 230500
SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes common requirements and features for motors utilized for HVAC equipment.

1.2 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.3 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

1.4 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at the project site altitude.

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyphase Motors: Design B, medium induction motors.

1. Efficiency: Energy efficient.

2. Service Factor: 1.15.

3. Multispeed Motors: Separate winding for each speed.


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


7. Insulation: Class F.

8. Code Letter Designation:
   a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   b. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

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

B. Polyphase Motors with Additional Requirements:

1. Motors used with reduced-voltage and multispeed controllers.

2. Energy- and premium-efficient and Inverter-duty motors used with variable frequency controllers.

3. Severe-duty motors.

C. Single-Phase Motors:

1. Motors Larger than 1/20 HP: Permanent-split capacitor; split phase; capacitor start, inductor run; or capacitor start, capacitor run to suit starting torque and requirements of specific motor application.


3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
5. Internal thermal protection.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230513
SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Hangers and supports for HVAC system piping and equipment.

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

1.3 PERFORMANCE REQUIREMENTS
A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
C. Design supports for multiple pipes and equipment.

1.4 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

PART 2 - PRODUCTS

2.1 COMPONENTS
A. Steel pipe hangers and supports.
B. Trapeze pipe hangers.
C. Metal framing systems.
D. Thermal-hanger shield inserts.
E. Fastener Systems
F. Pipe Stands.
G. Equipment supports.
H. Miscellaneous Metals.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install hanger and supports in accordance with manufacturer’s standards and building code requirements.

END OF SECTION 230529
SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes vibration isolation controls for HVAC equipment.
B. Seismic restraint requirements for project locations that require seismic restraint controls.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: D.
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: II.
      a. Component Importance Factor: 1.0.
      b. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0] <Insert value>.
      c. Component Amplification Factor: [1.0] [2.5] <Insert value>.
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): <Insert percent>.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.
B. Seismic Restraints shall be determined based on local site seismic criteria and shall be designed by a company that specializes in Seismic Controls.

1.4 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."
C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Vibration Isolators:
   1. Isolator Pads: Neoprene.
   3. Restrained Mounts: All directional mountings with seismic restraint; cast-ductile-iron housing.
   4. Spring Isolators: Freestanding, laterally stable, open-spring type.
   5. Restrained Spring Isolators: Freestanding, steel, open-spring type with seismic restraint.
   6. Housed Spring Mounts: Ductile-iron or steel housing, with integral, vertically adjustable seismic snubbers.
8. Spring Hangers: Combination coil-spring and elastomeric-insert hangers with spring and insert in compression.
11. Resilient pipe guides.

B. Air-Mounting Systems:
1. Air Mounts: Freestanding, single or multiple, compressed-air bellows.
2. Restrained Air Mounts: Housed compressed-air bellows.

C. Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail; with spring isolators mounted on elastomeric isolation pads, and snubber bushings.

D. Vibration Isolation Equipment Bases:

E. Seismic-Restraint Devices:
1. Snubbers: Welded structural-steel shapes and replaceable resilient isolation washers and bushings.
2. Channel Support System: MFMA-3 slotted steel channels.
4. Anchor Bolts: Mechanical type, seismic rated.
5. Resilient Isolation Washers and Bushings: Molded neoprene.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Testing: By Contractor-engaged agency.

END OF SECTION 230548
SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
A. Furnish and install pipe, ductwork and equipment labels.

1.2 PERFORMANCE REQUIREMENTS
A. Provide piping, ductwork and equipment identification to assist in system start-up, commissioning and Owner operation.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PRODUCTS
B. Warning Signs and Labels: 1/16 inch (1.6 mm) thick with adhesive.
C. Pipe Labels: Pretensioned or Self-adhesive.
D. Duct Labels: 1/16 inch (1.6 mm) thick with adhesive.
E. Stencils: Fiberboard or metal.
F. Valve Tags: Brass, 0.032-inch (0.8-mm) Stainless steel, 0.025-inch (0.64-mm) Aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness.
G. Warning Tags: 3 by 5-1/4 inches (75 by 133 mm) minimum, reinforced grommet and wire fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION
A. 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 (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

B. Install duct labels with permanent adhesive on air ducts with separate color codes for each system.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION 230553
SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Testing, adjusting, and balancing for the following:
   1. Air Systems: Constant-volume and variable-air-volume systems.
   2. Exhaust Systems.
   3. Air Distribution systems, outlets and inlets.
   4. Motors.
   5. Split-System AC units.
   6. Temperature measurements.
   7. Commercial kitchen exhaust hoods.
   8. Space pressurization measurements and adjustments.
   10. Sound-level measurements.
   11. Indoor-air quality measurements.
   12. Temperature-control verification.

1.2 PERFORMANCE REQUIREMENTS

A. Perform HVAC system testing, adjusting and balancing in order to verify a properly operating and correctly adjusted system in order to assure that the intended design conditions are being met.

1.3 SUBMITTALS

A. Provide Test and Balance Report in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

A. Testing, Adjusting, and Balancing Agent Qualifications: AABC or NEBB certified.

1.5 WARRANTY

A. Guarantee: AABC national project performance or NEBB guarantee that a certified agent has performed TAB and optimum performance capabilities have been achieved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXECUTION

A. Examination: Contract Documents, approved submittal data, Project Record Documents, design data, equipment performance data, system and equipment installations, systems and equipment test reports, and automatic controls for deficiencies that may preclude proper TAB of systems and equipment.
   1. Deficiencies report.

B. Testing, adjusting, and balancing plan.

C. Systems readiness checks.

Adjusting, and Balancing of Environmental Systems." In conjunction with SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing."

E. Equipment settings marked to show final settings.

F. HVAC Systems Airflow Rate Tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 percent to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.

G. Reporting:
   1. Initial Construction-Phase Report: Based on examination of the Contract Documents, on adequacy of design for systems’ balancing devices.
   3. Final Report: Certification sheet with content and format according to AABC or NEBB standard forms.

H. Inspections:
   1. Initial Inspections: Random checks by TAB firm to verify final TAB report.
   2. Final Inspections: Random checks by Owner/Architect to verify final TAB report.

I. Additional Tests:
   1. Performed within 90 days to verify that balance conditions are being maintained.
   2. Seasonal tests.

END OF SECTION 230593
SEGMENT 230700

HVAC INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install thermal insulation for HVAC systems.

1.2 PERFORMANCE REQUIREMENTS

A. Provide thermal insulation on HVAC systems to meet all local, state and ASHRAE 90.1 energy codes, and to minimize system energy losses and/or prevent condensation on cold surfaces.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Flame-spread index of 25, and smoke-developed index of 50 for insulation installed indoors according to ASTM E 84.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General

1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

B. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I or II with factory-applied jacket.

D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied factory.

E. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied jacket.

F. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

G. Adhesive materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
H. Factory Applied Jackets: Coordinate types of factory-applied jacket insulation materials selected and types of factory-applied jackets indicated in insulation system schedules. For insulation materials with factory-applied jackets for use on applications above 140 deg F (60 deg C), provide sufficient insulation thickness to maintain outer surface temperature of insulation below 140 deg F (60 deg C). 140 deg F (60 deg C) surface temperature is set by OSHA for personnel protection. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.2 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

2.3 PIPING INSULATION SCHEDULE, GENERAL

A. HVAC piping requiring insulation:
1. Refrigerant Piping

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Underground piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct and pipe insulation in accordance with manufacturer’s recommendations, and in thickness according to the applicable energy code standards.
1. Provide protective metal jacketing on all ductwork and piping located outdoors.

END OF SECTION 230700
SECTION 230800

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Provide HVAC system commissioning to assure correct and proper operation of HVAC equipment, systems and controls and to optimize performance characteristics, energy efficiency, thermal comfort and noise control.

1.2 Performance Requirements

A. Requirements for commissioning HVAC&R systems, assemblies, and equipment.

B. Allowances for labor, instrumentation, tools, and equipment costs for technicians for performance of commissioning testing.

C. Unit prices for adjusting allowances.

D. Contractor's Responsibilities:
   1. Perform commissioning tests at the direction of the CxA.
   2. Attend construction phase controls coordination meeting.
   3. Attend testing, adjusting, and balancing review and coordination meeting.
   4. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection.
   5. Provide information to CxA for final commissioning documentation.
   6. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data.

E. CxA's Responsibilities:
   1. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components.
   2. Direct commissioning testing.
   3. Verify testing, adjusting, and balancing of Work are complete.

1.3 SUBMITTALS

A. Commissioning Documentation
   1. Submittals delivery and review plan.
   2. Identification of installed systems, assemblies, equipment, and components.
   3. Construction checklists.
   5. Certificate of readiness.
   6. Test and inspection reports and certificates.
   7. Corrective action documents.
   8. Verification of testing, adjusting, and balancing reports..

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXECUTION

A. Testing Preparation: Certification and verification that systems, subsystems, and equipment are ready for testing.
B. Testing and Balance Verification:
   1. CxA witnesses testing and balance Work.
   2. Verification of final testing and balance report.

C. Scope of Testing:
   1. Provide testing technicians, instrumentation, and tools.
   2. Entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space.
   3. All modes of operation.
   4. Assist in preparation of testing procedures.
   5. Simulation of conditions when required.
   6. HVAC&R instrumentation and control system testing.
   7. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment.
   8. Energy supply system testing.
   9. Refrigeration system testing.
  10. HVAC&R distribution system testing.
  11. Vibration and sound tests.

END OF SECTION 230800
SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.2 PERFORMANCE REQUIREMENTS

A. Provide a Building Automation System to provide control of HVAC systems and optimize performance in order to maximize occupant comfort and minimize energy usage.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

A. Quality Standard: Comply with ASHRAE 135 for DDC system components.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Distributed system to control mechanical systems including the following:
   1. Building HVAC and plumbing systems.
   2. Energy and utility consumption monitoring.
      a. Electricity
      b. Domestic Water
      c. Natural Gas

2.2 COMPONENTS

A. DDC Equipment:
   1. Operator Workstation: One microcomputer(s) with printer.
   2. Printer: Color, ink-jet type.
   3. Application Software: With dynamic color graphic displays, alarm and event processing, automatic restart, and data collection.
   4. Diagnostic Terminal Unit: Portable notebook-style microcomputer.
   5. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   6. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
8. Power supplies.

B. Unitary Controllers: Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

C. Alarm Panels: Unitized cabinet with suitable brackets for wall or floor mounting. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

D. Analog Controllers:
1. 6- or 10-stage-type step controllers.
2. Remote-bulb or bimetal rod-and-tube-type, electric outdoor-reset controllers.
3. Wheatstone-bridge-amplifier-type electronic controllers.
5. Single- or multiple-input receiver controllers.

E. Electronic Sensors: Wall, immersion, or duct mounting.
1. Thermistor temperature sensors and transmitters.
2. RTDs and transmitters.
3. Humidity sensors.
4. Pressure transmitters/transducers.

F. Status Sensors:
2. Status inputs for pumps.
4. Voltage transmitters (100- to 600-V ac).
5. Power monitors.
7. Electronic valve/damper position indicators.
8. Water-flow switches.

G. Gas Detection Equipment:
1. Carbon dioxide sensor and transmitters.
2. Occupancy sensors.

H. Duct airflow station.

I. Thermostats:
1. Combination thermostat and fan switches.
2. Electric, solid-state, microcomputer-based room thermostats.
3. Low-voltage, on-off thermostats.
4. Line-voltage, on-off thermostats.
5. Remote-bulb thermostats.
7. Pneumatic room thermostats.
8. Immersion thermostats.
10. Electric, low-limit duct thermostats.
11. Electric, high-limit duct thermostats.

J. Humidistats: Duct-mounting electronic type.

K. Actuators:
1. Electric motors.
2. Electronic actuators.

L. Control Valves:
1. Globe Valves: Bronze body for NPS 2 (DN 50) and smaller; iron body for NPS 2-1/2 (DN 65) and larger.
2. Butterfly Valves: Cast-iron or ductile-iron body.
3. Terminal Unit Control Valves: Bronze body.

M. Dampers: AMCA-rated, [parallel] [opposed]-blade design, for standard-pressure and low-leak applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Building Automation System shall be designed and installed to perform the required sequences of operation for the HVAC systems as necessary, and shall provide appropriate monitoring and control of all systems and energy consumption.

END OF SECTION 230900
Definitions:

a. Advanced Metering Data Management System Installation Level front end. This term as used in the specification refers to the system that will collect, manage, and display the meter data for the local energy engineer. It may be a new system or it may consist of the existing Legacy Utility Monitoring and Control System/Energy Monitoring and Control System (UMCS/EMCS) and its associated building level controllers that have been upgraded with the necessary hardware/software as required. The intent of the Army Metering Program is to provide the metering data to the local engineering staff first within the building automation system that can execute application programs to affect savings, and then transmit to the Enterprise Meter Data Management System, when activated.

b. Advanced Electrical Meters. For this specification, Advanced meters are those that have the capability to measure and record interval data (at least hourly for electricity), and communicate the data to a remote location in a format that can be easily integrated into an advanced meter data management system. Most advanced meters offer additional features which may be attractive to system owners.

GENERAL OUTLINE

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   1.1 BACnet Open Protocol
   1.2 Meter Data Schema
   1.3 Meter Identification and Location Data
   1.4 Workstation Display
   1.5 Energy Reports

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   2.1 Meter To Installation Level Front End
   2.2 Installation Level Front End To MDMS
   2.3 IA Requirements

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      3.2.1 Communication Protocol and Methods
      3.2.2 Pulse Input Data Ports
      3.2.3 Data Storage and Trend Logs
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   3.6.3 Installation
   3.6.4 Tests
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1.0 INSTALLATION LEVEL FRONT END COMPUTER

1.1 BACnet Open Protocol. Where no existing UMCS/EMCS can satisfy the Advanced Metering Data Management System Installation Level requirements the design shall include a BACnet Based Open System Host for the front end data management system.

1.2 Meter Data Schema. The metering data shall be stored per the defined schema and set in a full version Microsoft SQL data base for future retrieval by others to a site Meter Data Management System (MDMS) Gateway that will report to an Enterprise Army Meter Data Management System. The Microsoft SQL data base may be an entirely separate SQL data base dedicated to meter data only or native to the Host UMCS/Metering Front end.
   a. Define in the following format: /BLCx/Buildingy_Meterz_point_15

Where:

BLC is the building level controller used. It may be a JACE or an NAE or a router or other.
x is the building number containing the BLC
y is the building number containing the meter
z is the meter number within the building
point is the name of the measured variable:
   KW for electrical demand/power
   KWH for electrical energy
   PF_AVG for power factor
   PULSE_aaa for a consumption meter, aaa refers to the input designation. Contractor shall provide the necessary point name mapping and conversion information.
   Others as required
The _15 indicates that these values came from 15 minute history data.

Note also that the building level controller name, /JACEx/, may be automatically pre-pended by UMCS host. The future Meter Data Management System (MDMS) Gateway will repackage the required data into a CSV file form for transmission to the MDMS Enterprise Server.

b. Provide the following meter data:

<table>
<thead>
<tr>
<th>Metric</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR-TOT</td>
<td>Real Power (Total)</td>
<td>KW</td>
</tr>
<tr>
<td>KWH-TOT</td>
<td>Total KWH (Total Energy)</td>
<td>KWH</td>
</tr>
<tr>
<td>PWR-DEMAND-PEAK</td>
<td>Historical Peak Demand Power</td>
<td>KW</td>
</tr>
<tr>
<td>PWR-DEMAND</td>
<td>Demand Power</td>
<td>KW</td>
</tr>
<tr>
<td>VOLT-A</td>
<td>Rms Voltage For Phase A</td>
<td>VOLTS</td>
</tr>
<tr>
<td>VOLT-B</td>
<td>Rms Voltage For Phase B</td>
<td>VOLTS</td>
</tr>
<tr>
<td>VOLT-C</td>
<td>Rms Voltage For Phase C</td>
<td>VOLTS</td>
</tr>
<tr>
<td>AMP-A</td>
<td>Rms Current For Phase A</td>
<td>AMPS</td>
</tr>
<tr>
<td>AMP-B</td>
<td>Rms Current For Phase B</td>
<td>AMPS</td>
</tr>
<tr>
<td>AMP-C</td>
<td>Rms Current For Phase C</td>
<td>AMPS</td>
</tr>
<tr>
<td>HZ-AVG</td>
<td>Average Line Frequency</td>
<td>HZ</td>
</tr>
<tr>
<td>PF-AVG</td>
<td>Average Power Factor</td>
<td>N/A</td>
</tr>
</tbody>
</table>
1.3 Meter Identification and Location Data. Contractor shall populate the sample information document shown in the table below and display and store at Installation Level Front End Computer.

<table>
<thead>
<tr>
<th>Bldg No.</th>
<th>Bldg Name</th>
<th>Bldg Sqft</th>
<th>Category Code</th>
<th>Meter Name</th>
<th>Commodity Type</th>
<th>Area served by meter (sqft)</th>
<th>Reimbursable (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>EXCH MAIN STORE</td>
<td>74,053</td>
<td>74053</td>
<td>0001E00071EMON</td>
<td>Electricity</td>
<td>74,053</td>
<td>y</td>
</tr>
<tr>
<td>01440</td>
<td>HAAF HEALTH CLINIC</td>
<td>49,679</td>
<td>55010</td>
<td>0033E1440HEMON</td>
<td>Electricity</td>
<td>49,679</td>
<td>N</td>
</tr>
<tr>
<td>2905</td>
<td>OPEN STR INST</td>
<td>40,264</td>
<td>45210</td>
<td>0034E02905EMON</td>
<td>Electricity</td>
<td>40,264</td>
<td>N</td>
</tr>
<tr>
<td>4541</td>
<td>VEH MAINT SHOP</td>
<td>32,648</td>
<td>21410</td>
<td>0035E04541EMON</td>
<td>Electricity</td>
<td>32,648</td>
<td>N</td>
</tr>
<tr>
<td>06007</td>
<td>HAAF ARMY LODGING</td>
<td>43,732</td>
<td>72010</td>
<td>0038E6007HEMON</td>
<td>Electricity</td>
<td>43,732</td>
<td>N</td>
</tr>
<tr>
<td>7560</td>
<td>DEPENDENT SCH</td>
<td>31,040</td>
<td>73046</td>
<td>0043E07560EMON</td>
<td>Electricity</td>
<td>31,040</td>
<td>y</td>
</tr>
<tr>
<td>7742</td>
<td>CO HQ BLDG</td>
<td>30,000</td>
<td>14185</td>
<td>0044E07742EMON</td>
<td>Electricity</td>
<td>30,000</td>
<td>N</td>
</tr>
<tr>
<td>10501</td>
<td>CSMS/MATES</td>
<td>31,093</td>
<td>21419</td>
<td>0045E10501EMON</td>
<td>Electricity</td>
<td>31,093</td>
<td>y</td>
</tr>
<tr>
<td>10531</td>
<td>CSMS/MATES</td>
<td>34,843</td>
<td>21419</td>
<td>0046E10531EMON</td>
<td>Electricity</td>
<td>34,843</td>
<td>Y</td>
</tr>
</tbody>
</table>

1.4 Storage of Metered Data. The Advanced Metering Data Management System Installation Level Front End shall store all required meter data for a minimum of two years.

1.5 Workstation Display

   a. System shall display all mandatory metering data (power, water, gas and steam) upon request in an organized and easily readable format. Data shall be displayed in no less than 15 minutes intervals.

   b. Final install of front end equipment shall, at minimum, display accurate data readings for each meter in a text format. Display capability shall include multiple graphical formats such as data vs. time (minutes, hours, days, weeks, months, and year) comparison between metered data from two or more meters and other standard meter data. Site specific graphics shall be created that display the required metered value, meter location, meter serial number and building square footage served by that meter. In addition, contractor shall differentiate by an asterisk on the graphic display those meters that were not installed by the Army Metering Program.

   c. Contractor shall provide two hardcopies and two copies on electronic media (DVD or CD) of detailed instructions for customization and integration of additional display features that are not prepared at the time of final install.

1.6 Energy Reports. The Installation Level Front End Computer shall be configured to provide monthly energy reports that show:

   a. Specific building kWh and max kW use and time and day the max occurred.

   b. A building’s monthly kWh and max monthly kW with history over previous 24 months. Include Heating Degree-Days (HDD) and Cooling Degree-Days (CDD) for each month.

   c. Summary of what all buildings are using on an installation relative to their square footage (energy consumption density) as a function of kWh and kW peak; when meters are available include the Natural Gas and water including their maximum rate of use for that month. Include HDD and CDD.

   d. A bar chart showing the 24 month history of what the installation is using total (kWh, KW peak, NG, and water) and the energy density based on square footage of metered buildings. Include HDD and CDD for each month.
e. A bar chart showing dollar cost for the commodities from the chart above over a 24 month period. Include HDD and CDD for each month.

f. A dirty dozen list of the buildings using the highest energy based on square footage, occupancy rates, hours of use, and a factor coefficient to decrease the rating for high energy density demand type missions. This mission coefficient shall be the same for the same type of mission and applied the same on every installation.

2.0 COMMUNICATIONS

2.1 Between Meters and Installation Level Front End

a. The communications medium shall be compatible with the Installation Level Front End Computer and the Enterprise Energy Reporting Data System (EERDS) Security Functional Architecture available as separate electronic media: Enterprise Energy Data Reporting System Security Functional Architecture.doc. The installation of wire, fiber optic cable, wireless network equipment, network switches, and media converters is required where existing communications infrastructure is non-existent to support communications between the buildings to be metered and the nearest base network access point. If fiber optic cable is required, coordinate with the site NEC for installation guidance and sizing (25 pair is preferred). All IP, Ethernet, or wireless communication design and implementation plans shall be approved by the site NEC.

b. RF transceivers shall be DoD/NETCOM approved and have an existing J/F number. Contractor shall be responsible for obtaining installation Frequency Manager/Officer and host nation approval.

c. Coordinate with the Activity and provide specific requirements "to match existing systems" when necessary. Contractor shall verify that the electricity meter installed on any building site is compatible with the post-wide metering system with respect to the types of meters selected and the method used to program the meters for initial use. Software and meter programming tools are necessary to setup the meters described by this specification. New software tools different from the meter programming methods currently used by post personnel shall require separate approval for use. Contractor shall verify that the metering system installed on any building site is compatible with the facility-wide or post-wide communication and meter reading protocol system.

2.2 Between Installation Level Front End and Enterprise MDMS System

See Paragraph 1.2. The MDMS Contractor shall execute a retrieval of the data in the Microsoft SQL data base. The MDMS Contractor shall format the meter data to include the site specific information that uniquely identifies the installation (Fort Carson, Fort Hood, etc.). IPSec tunneling may be used to securely transport data. There will likely be a gateway between the Installation Level Front End Computer and the Enterprise MDMS.

2.3 Information Assurance Requirements

a. The process and related requirements to attain certification and accreditation for metering systems are under revision. Any standard procedure issued as part of this specification will likely need modification soon. The DoD Information Assurance guidance (DoDI 8500 series) and UFGS 25 10 10, Utility Monitoring and Control System are being rewritten and have major revisions that affect communication protocol and security engineering. Once those changes get published and implemented, some standard procedures can be set.

b. The Information Assurance and Security Engineering Directorate (IASED) in Fort Huachuca, AZ, is conducting testing and hardening for a limited number of metering host configurations that may assist in final IA certification and accreditation documents. As the documentation is created for individual systems there exist opportunities to leverage this knowledge to engineer a metering system that will more easily be approved by the NEC.

c. Networthiness: The contractor shall provide and prepare documentation as required by AR 25-1 and submit a request for a Certificate of Networthiness (CoN). Networthiness certification is required before connecting hardware/software to the Army Enterprise Network. The selection of system components from the Defense Information Systems Agency (DISA) Approved Products List is required, when available. There is also a list of preapproved software that identifies those that have CoNs. The Contractor shall coordinate all Networthiness efforts with the appropriate installation NEC as well as higher NETCOM headquarters. When issued and certified, the Contractor shall comply with the applicable IATO (Interim Authority to Operate) configuration stand-up guide.

d. In the eyes of a security engineer, IP meters have been regarded as vulnerable and assumed to create a higher risk to the defense in depth architecture. This unfortunately denies the use of a powerful device that has the advantage of web based services and time stamps. The IP meter interface also offers a more robust transfer of data and the ability to remotely reset counters. This risk assessment is subject to change as testing is completed.
e. While in the design and planning stage, contact the UMCS-MCX for the most recent update on metering system configurations and their affect on information assurance.

3.0 METERS

Note: Reimbursable facilities/customers that require metering devices which exceed the requirements detailed in this specification shall be installed per written request as approved and provided in pre-proposal documentation.

3.1 Environmental Tolerances of Metering Devices

a. Power Meters:

(1) Outdoor/exterior devices shall be rated for operation and storage from minus 40 degrees C to plus 70 degrees C or better and 5 to 100% relative humidity (non-condensing). Exterior meters shall be provided with or installed within a NEMA 4 enclosure. Enclosures shall be NEMA 4X for coastal and corrosive environments. When ambient temperature extremes exceed the rating above, provide enclosures with heat strips to maintain operable temperatures. Enclosures shall be lockable for information security issues.

(2) Indoor/interior devices shall be rated for operation and storage from 0 degrees C to plus 50 degrees C or better and 5 to 90% relative humidity (non-condensing). Interior meters or meters located in mechanical rooms shall be provided with or installed within a NEMA 12 lockable enclosure.

b. Water Meter Operating Temperatures: 0 degrees C to plus 50 degrees C or better. Water Meter Humidity Operating Range: 5% to 90% RH (non-condensing). When above frost line and exterior mounting is required, consider the local ambient temperature extremes and protect from freezing with insulated, moisture proof enclosures and heat tracing as required.

c. Gas Meter Operating Temperatures: minus 40 degrees C to plus 70 degrees C.
Gas Meter Humidity Operating Range: 5% to 90% RH (non-condensing).

d. Steam Meter Ambient Operating Temperatures: minus 40 degrees C to plus 80 degrees C. Steam Meter Medium Operating Temperatures: minus 40 degrees C to plus 240 degrees C.
Humidity Operating Range: 5% to 90% RH (non-condensing)

e. All interior meters and/or remote interface displays shall be provided with or installed within a NEMA 12 enclosure.

3.2 Smart Meter Capability

a. All meters as installed shall provide smart meter capabilities, either as a single product, or as installed in conjunction and collocated with another product such that the combined installation provides smart meter capabilities.

b. Meters that do not provide factory smart capabilities shall provide a pulse output for interfacing to a smart meter. The minimum and maximum pulse rate and pulse width of the receiving digital input device and software, i.e., electric meter, digital input card on the UMCS or any other accumulator shall be determined by the contractor. The contractor shall provide pulse rate convertors if required. Depending on the product used, relay isolation may be required when connecting to the I/O device. In addition, the contractor shall determine and eliminate false triggers caused by distance or routing near other voltage sources. It is strongly advised to adhere to the manufacturers’ recommendations and industry practices and install isolation relays as field conditions dictate.

3.2.1 Communication Protocol and Methods. Meters shall communicate via ASHREA-135 (BACnet) protocols to the existing or new Advanced Metering Data Management System Installation Level Front End (or UMCS/EMCS System Host). In locations where a legacy UMCS system currently exists utilizing non-compliant communication protocol, i.e. N2, additional protocols may be used if approved by the Government. In that case the designer should consider meters with changeable interface communication cards so that future UMCS upgrades can be accomplished with minor changes.
3.2.2 Pulse Input Data Port Interface

a. Meters shall have a data port connection compatible with the selected protocol which communicates to the existing or new Advanced Metering Data Management System Installation Level front end. The meter’s interface must be compatible with the conditions at any given site. Analog current loops shall not be used.

b. Auxiliary data ports. Unless otherwise specified, smart meters shall have a minimum of two pulse inputs for incorporation of other external meter data.

3.2.3 Data Storage and Trend Logs

a. Unless otherwise specified, the meter must be capable of providing and storing 15 minute interval data for 20 distinct points for minimum of 30 days to non-volatile memory. The measured energy consumption shall be retained in non-volatile memory. The maximum demand and time of maximum demand shall be stored in non-volatile memory and can be reset.

b. Field Interface Tool: Contractor shall provide a field interface tool with the compatible software to extract stored trend data and logs from meters. This is a separate hand-carried device that directly connects with the meter at the installed site.

3.2.4 Meter display. Meters that are required to display data shall provide face plate configurable menus to select the desired data for display. Display requirements may be met with the installation of a local display panel connected to the meter. All collected data shall be capable of display.

3.3 Electric Meter

3.3.1 Requirements

a. The meters must comply with the applicable requirements of ASHRAE 189.1. Where conflicts occur between this guidance and the ASHRAE standard, ASHRAE 189.1 shall prevail.

b. Power Systems: Meter shall be designed for multifunction electrical measurement on either single or 3 phase power systems. Meter shall support the power configuration as identified at site specific government facilities: single phase (120 or 240 volt); 3 Phase, 3 Wire Delta; 3 Phase, 4 Wire Delta; 3 Phase, 4 Wire Wye (2.5 Element); 3 Phase, 4 Wire Wye (3.0 Element). For three phase application voltage range is 208 – 600V. All meters shall be UL 508 Listed, CSA approved, have CE marking, and meet safety standards UL1244 or UL 1010-1.

3.3.2 Mandatory measured variables: See Electric Meter points list: Advanced Meter Points List.xls for details and additional requirements. Points list assumes a 4 wire delta power configuration. Modify to match site specific requirements.

<table>
<thead>
<tr>
<th>PWR-TOT</th>
<th>Real Power (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KWH-TOT</td>
<td>Total KWH (Total Energy)</td>
</tr>
<tr>
<td>PWR-DEMAND-PEAK</td>
<td>Historical Peak Demand Power</td>
</tr>
<tr>
<td>PWR-DEMAND</td>
<td>Demand Power</td>
</tr>
<tr>
<td>VOLT-A</td>
<td>Rms Voltage For Phase A</td>
</tr>
<tr>
<td>VOLT-B</td>
<td>Rms Voltage For Phase B</td>
</tr>
<tr>
<td>VOLT-C</td>
<td>Rms Voltage For Phase C</td>
</tr>
<tr>
<td>AMP-A</td>
<td>Rms Current For Phase A</td>
</tr>
<tr>
<td>AMP-B</td>
<td>Rms Current For Phase B</td>
</tr>
<tr>
<td>AMP-C</td>
<td>Rms Current For Phase C</td>
</tr>
<tr>
<td>HZ-AVG</td>
<td>Average Line Frequency</td>
</tr>
<tr>
<td>PF-AVG</td>
<td>Average Power Factor</td>
</tr>
</tbody>
</table>
Optional Measured values:

<table>
<thead>
<tr>
<th>Optional Measured values:</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWR-A</td>
<td>Real Power For Phase A</td>
</tr>
<tr>
<td>PWR-B</td>
<td>Real Power For Phase B</td>
</tr>
<tr>
<td>PWR-C</td>
<td>Real Power For Phase C</td>
</tr>
<tr>
<td>HZ-A</td>
<td>Frequency For Phase A</td>
</tr>
<tr>
<td>HZ-B</td>
<td>Frequency For Phase B</td>
</tr>
<tr>
<td>HZ-C</td>
<td>Frequency For Phase C</td>
</tr>
<tr>
<td>KVA-TOT</td>
<td>Total Kva</td>
</tr>
<tr>
<td>KVA-A</td>
<td>Kva For Phase A</td>
</tr>
<tr>
<td>KVA-B</td>
<td>Kva For Phase B</td>
</tr>
<tr>
<td>KVA-C</td>
<td>Kva For Phase C</td>
</tr>
<tr>
<td>KVAR-TOT</td>
<td>Total Reactive Power</td>
</tr>
<tr>
<td>KVAR-A</td>
<td>Reactive Power For Phase A</td>
</tr>
<tr>
<td>KVAR-B</td>
<td>Reactive Power For Phase B</td>
</tr>
<tr>
<td>KVAR-C</td>
<td>Reactive Power For Phase C</td>
</tr>
<tr>
<td>KVARH-TOT</td>
<td>Total Kvarh (Total Reactive Energy)</td>
</tr>
<tr>
<td>KVARH-A</td>
<td>Kvarh (Total Reactive Energy) For Phase A</td>
</tr>
<tr>
<td>KVARH-B</td>
<td>Kvarh (Total Reactive Energy) For Phase B</td>
</tr>
<tr>
<td>KVARH-C</td>
<td>Kvarh (Total Reactive Energy) For Phase C</td>
</tr>
<tr>
<td>PF-A</td>
<td>Power Factor For Phase A</td>
</tr>
<tr>
<td>PF-B</td>
<td>Power Factor For Phase B</td>
</tr>
<tr>
<td>PF-C</td>
<td>Power Factor For Phase C</td>
</tr>
</tbody>
</table>

3.3.3 Accuracy

a. System Accuracy: System accuracy for the meter product devices including instrument transformers shall not exceed plus or minus 1.5% as calculated using the Root Sum Square (RSS) method and assuming normal distribution.

b. Meter Accuracy: Meter certification shall be IEEE/ANSI C12.20, Accuracy class 0.5% or the meter shall be calibrated with NIST traceable standards to an accuracy of 0.5% or better.

c. For reimbursable tenants meter certification shall be NEMA/ANSI C12.20, Accuracy class 0.2%. These meters shall include a Meter display that can display all recorded values.

3.3.4 Surge Protection: Meters shall comply with IEEE/ANSI C37.90.1, Standard surge withstand capability (SWC) tests for relays and relay systems associated with electric power apparatus and IEEE C62.41.

3.3.5 Instrumentation (CTs and PTs)

a. Current transformers (CTs) sized properly so that the meter secondary of the transformer shall output current to ensure at least a plus or minus 0.6% accuracy of current when measured between 10% and 90% of full amperage range.

b. CTs shall not exceed 5 amps on the secondary side.

c. Burden on CTs shall not exceed rated burden for the accuracy class.

d. CTs shall be provided in solid or split core configurations.

e. CTs shall be provided in the appropriate ranges to meet the service entrance amperage requirements.
f. CTs shall revenue grade and certified per IEEE/ANSI C57.13 or IEC 185.

g. CTs shall be provided that are rated for the appropriate matching frequency of the power generation (60 Hertz CONUS and 50 Hertz OCONUS where applicable).

h. Current sensors shall be sized properly for the application and provide a voltage (normally 0-2 volts) to the meter that results in at least a plus or minus 0.6% accuracy of current when measured between 10% and 90% of full amperage range.

i. Voltage or Potential Transformers (PTs) sized properly so that the meter secondary of the transformer shall output voltage to ensure at least a plus or minus 0.6% accuracy of voltage when measured from zero to the IEEE/ANSI C57.13 or IEC 185 specified standard burden, at the specified standard burden power factor, and at any value from 90% to 110% of rated voltage.

j. PTs shall be revenue grade and certified per IEEE/ANSI C57.13 or IEC 185.

k. Burden on PTs shall not exceed rated burden for accuracy class.

3.3.6 Disconnects and Shorting Blocks

a. The appropriate metering accessories, terminal blocks, shorting blocks, and fuses shall be built into each enclosure and the enclosure shall have an appropriate grounding termination point per standard industry practices. Disconnecting wiring blocks shall be provided between the current transformer and the meter where 5 AMP current transformers are used. A shorting mechanism shall be built into the wiring block to allow the current transformer wiring to be changed between shorting block and meter without removing power to the transformer. The wiring blocks shall be located where they are accessible without the necessity of disconnecting power to the transformer. For multi-ratio current transformers, provide a shorting block from each tap to the common lead. The shorting mechanism must be capable of carrying the current of each current transformer so that the electric meter can be safely removed from the circuit for testing or repair. Low voltage, 0-5 volt current sensors are exempt from the shorting block requirement.

b. Voltage-monitoring circuits shall be equipped with disconnect switches to isolate the meter base or socket from the voltage source.

c. Short circuit protection for each power supply circuit or measuring voltage circuit entering the enclosure must be included in the enclosure. This shall be appropriately sized to protect equipment and personnel should an accidental short occur during maintenance inside the enclosure. Fuses or breakers with appropriate UL ratings shall be used. Fuse type and rating shall be depicted on the As-Built drawings.

d. Switching mechanisms adequate to de-energize all power supply and voltage circuits entering the enclosure must be included in the enclosure. If a breaker is utilized for the short circuit protection that can fulfill this function, no additional hardware will be required.

3.4 Gas Meter

3.4.1 Requirements

a. The meters must comply with the applicable requirements of ASHRAE 189.1. Where conflicts occur between this guidance and the ASHRAE standard, ASHRAE 189.1 shall prevail.

b. In addition to the requirements listed below, Natural Gas Distribution and Monitoring Equipment shall be in accordance with UFGS SECTION 33 51 03.00 10. Gases are more difficult to measure than liquids, as measured volumes are highly affected by temperature and pressure. Gas meters measure a defined volume, regardless of the pressurized quantity or quality of the gas flowing through the meter. Temperature, pressure and heating value compensation must be made to measure actual amount and value of gas moving through a meter.

c. Gas distribution equipment shall be installed in accordance with all applicable federal, state and local codes and regulations. Gas distribution equipment shall be installed in conformance with the manufacturer’s recommendations and applicable sections of ASME B31.8, AGA XR0104 and 49 CFR 192. Gas distribution equipment installed in areas where they will be subject to damage shall be protected by appropriate physical barriers (i.e. bollards).

d. Natural Gas Meters shall be the Diaphragm, Rotary, or for high volume applications Turbine type with pulse output chosen to meet the specific application.
Quantity Measured: Cubic Feet of Natural Gas

Accuracy: plus or minus 1% of scale.

Resolution: minimum of 100 cubic feet of gas

Measurement Configuration: Natural Gas service to a building. For buildings that already have a gas meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a natural gas meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output to a data gathering device. If the existing gas meter will not accept a pulse kit or if no meter exists a new natural gas meter shall be installed, also requiring a pulse output to a data gathering device. Ensure the pulse frequency and electronic characteristics are compatible with the existing data gathering device, if any.

3.4.2 Gas Meter Types

a. Provide gas meters for the natural gas service line to the building. Natural gas meters shall be the Diaphragm, Rotary, or for high volume applications Turbine type with pulse output chosen to meet the specific application. Temperature, pressure and heating value compensation must be made to measure actual amount and value of gas moving through a meter.

b. Diaphragm Gas Meters with flow rates less than 500 cubic feet per hour shall conform to AGA B109.1. Diaphragm Gas Meters with flow rates of 500 cubic feet per hour and higher shall conform to AGA B109.2. Rotary Type Gas Meters shall conform to AGA B109.3. Turbine Type Gas Meters shall conform to ASME MFC-4M. Meters shall be pipe or pedestal mounted and be provided with a strainer immediately upstream. Meters shall be provided with over-pressure protection as specified in ASME B31.8. Include tamper-proof protection, frost protection and fungus-proof protection as applicable. Meters shall be suitable for accurately measuring and handling gas at pressures, temperatures, and flow rates present. Meters shall have a pulse switch initiator capable of operating up to speeds of 500 pulses per minute with no false pulses and shall require no field adjustments or calibration. Initiators shall provide the maximum number of pulses up to 500 per minute that is obtainable from the manufacturer. The minimum pulse rate shall not be less than one pulse per 100 cubic feet of gas.

3.4.3 Valves and Regulators

a. Valves shall be suitable for shutoff or isolation service and shall conform to the following: Steel valves 1-1/2 inches and smaller installed above ground shall conform to ASME B16.34, carbon steel, socket weld or threaded ends with handwheel or wrench operator. Steel valves 2 inches and larger installed above ground shall conform to API Spec 6D, carbon steel, butt weld or flanged ends, with handwheel or wrench operator.

b. Valves and pressure regulators are necessary at all points where pressure reduction or regulation is required by the user. Install a shut-off valve upstream of the regulator and both upstream and downstream of the meter. Provide a gas meter bypass line with a lockable valve for buildings with critical service.

c. Service Line Regulators. Pressure regulators for individual service lines shall have ferrous bodies. Regulator shall be capable of reducing distribution line pressure to pressures required for users. Regulators shall be provided where gas will be distributed at pressures in excess of 10 inches of water column. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulator shall have single port with orifice diameter no greater than that recommended by the manufacturer for the maximum gas pressure at the regulator inlet. Regulator valve vent shall be of resilient materials designed to withstand flow conditions when pressed against the valve port. Regulator shall be capable of regulating downstream pressure within limits of accuracy and shall be capable of limiting the buildup of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Regulator shall have a self contained service regulator. Regulator pipe connections shall not exceed 2 inch size.
3.4.4 Installation

a. A shutoff valve, meter set assembly, and service regulator shall be installed on the service line outside the building, 18 inches above the ground on the riser. An insulating joint (dielectric connection) shall be installed on the inlet side of the meter set assembly and service regulator and shall be constructed to prevent flow of electrical current. A 3/8 inch tapped fitting equipped with a plug shall be provided on both sides of the service regulator for installation of pressure gauges for adjusting the regulator. All service regulator vents and relief vents shall terminate in the outside air in rain and insect resistant fittings. The open end of the vent shall be located where gas can escape freely into the atmosphere, away from any openings into the building and above areas subject to flooding.

b. Meters shall be installed in accordance with ASME B31.8. Permanent gas meters shall be installed with provisions for isolation and removal for calibration and maintenance, and shall be suitable for operation in conjunction with an energy monitoring and control system.

3.4.5 Connections

a. Connections to Publicly or Privately Operated Gas Utility Lines: The contractor shall include all materials for the connections to the existing gas lines. Final connections and the turning on of gas shall be made by the utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of gas lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new gas lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

b. Connection to Government Owned/Operated Gas Lines: Provide the name and location of the utility or operating agency of the existing gas lines. Show on the drawings, the location of valves to be operated for existing system deactivation. The Contractor shall provide connections to the existing gas lines in accordance with approved procedures. Reactivation of any existing gas lines will only be done by the Government. The Contractor's Connection Plan shall be submitted and approved prior to making any connections to existing gas lines. This plan shall include the Operating Agency's required procedures which may be obtained from the Contracting Officer. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made.

3.4.6 Pressure and Leak Tests

a. Prior to returning the gas line back to service it shall be tested in accordance with ASME B31.8. Test pressures should recognize the weakest component of each system tested for the actual pressure, the maximum allowable operating pressure, and the gas supplier's maximum operating pressure. The test pressure will be 150 percent of the maximum operating pressure or 50 psig, whichever is greater. However, the maximum test pressure must not be more than three times the design pressure of the pipe. The service lines shall be tested after modifications and before being placed in service using air as the test medium. Prior to testing the system, the interior shall be blown out, cleaned and cleared of all foreign materials. All meters, regulators, and controls shall be removed before blowing out and cleaning and reinstalled after clearing of all foreign materials.

b. Testing of gas service lines shall be done with due regard for the safety of employees and the public during the test. Persons not working on the test operations shall be kept out of the testing area while testing is proceeding. The test shall be made on the system as a whole or on sections that can be isolated. The test shall continue for at least 24 hours from the time of the initial readings to the final readings of pressure and temperature. The initial test readings of the instrument shall not be made for at least 1 hour after the pipe has been subjected to the full test pressure, and neither the initial nor final readings shall be made at times of rapid changes in atmospheric conditions. The temperatures shall be representative of the actual trench conditions. There shall be no indication of reduction of pressure during the test after corrections have been made for changes in atmospheric conditions in conformity with the relationship $T(1)P(2)=T(2)P(1)$, in which $T$ and $P$ denote absolute temperature and pressure, respectively, and the numbers denote initial and final readings. During the test, the entire system shall be completely isolated from all compressors and other sources of air pressure. Each joint shall be tested by means of soap and water or an equivalent nonflammable solution prior to backfilling or concealing any work. The testing instruments shall be approved by the Contracting Officer. All labor, materials and equipment for conducting the tests shall be furnished by the Contractor and shall be subject to inspection at all times during the tests. The Contractor shall maintain safety precautions for air pressure testing at all times during the tests.
3.5 Water Meter

3.5.1 Requirements:

a. The meters must comply with the applicable requirements of ASHRAE 189.1. Where conflicts occur between this guidance and the ASHRAE standard, ASHRAE 189.1 shall prevail.

b. In addition to the requirements listed below Water Meters shall be in accordance with UFGS SECTION 43 21 29. Water Meters shall be the turbine, propeller, or displacement type with pulse output chosen to meet the specific application (pipe size, flow, pressure, etc.). Water Meters shall be manufactured by Neptune, SeaMetrics, Badger Meter, Inc., DLJ or approved equal. The location of meters and meter boxes shall be shown on the drawings. The meters shall be centered in the boxes to allow for reading and ease of removal or maintenance.

Quantities Measured: Gallons of Water (pulse for every 10 gallons)

Accuracy: 1.5% of scale.

Resolution: 1 GPM

Measurement Configuration: Water Supply to a building. For buildings that already have a water meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a water meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output into a data gathering device. If the existing meter will not accept a pulse kit or if no meter exists, a new water meter shall be installed, also requiring a pulse output to a data gathering device.

3.5.2 Water Meter Types

a. Turbine Type Meters: Turbine type meters shall conform to AWWA C701 Class I or Class II depending on the application. The main casing shall be bronze or cast iron protected by corrosion resistant coating with stainless steel external fasteners. Registers shall be straight-reading type, shall be permanently sealed and shall read in U.S. gallons. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707 but must be compatible with the local Utility Monitoring and Control System. Meters shall comply with the accuracy and capacity requirements of AWWA C701.

b. Propeller Type Meters: Propeller type meters shall conform to AWWA C704. Registers shall be straight-reading type, shall be permanently sealed and shall read in U.S. gallons. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct-reading remote register designed in accordance with AWWA C706 or an encoder-type remote register designed in accordance with AWWA C707 but must be compatible with the local Utility Monitoring and Control System. Meters shall comply with the accuracy and capacity requirements of AWWA C703.

c. Displacement Type Meters: Displacement type meters shall conform to AWWA C700. Registers shall be straight-reading and shall read in U.S. gallons. Meters in sizes 1/2 through 1 shall be frost-protection design as required by the local environmental conditions. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707 but must be compatible with the local Utility Monitoring and Control System. Meters shall comply with the accuracy and capacity requirements of AWWA C700.

d. Compound Type Meters: Compound type meters shall conform to AWWA C702 and shall be furnished with strainers. The main casing shall be bronze or cast iron protected by corrosion resistant coating with stainless steel external fasteners. The main casing shall be tapped for field testing purposes. Registers shall be straight-reading type, shall be permanently sealed and shall read in U.S. gallons. The meter shall be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707 but must be compatible with the local Utility Monitoring and Control System. Meters shall comply with the accuracy and capacity requirements of AWWA C702.
e. Fire Service Type Meters: Provide Fire Service Type Meters as required by the Installation. Fire service type meters shall be proportional type or turbine type conforming to AWWA C703 and shall be furnished with strainers. The main casing shall be bronze or cast iron protected by corrosion resistant coating with stainless steel external fasteners. Registers shall be straight-reading type, shall be permanently sealed and shall read in U.S. gallons. The meter shall be equipped with a coordinating register. Connections shall be suitable to the type of pipe and conditions encountered. Register type shall be a direct reading remote register designed in accordance with AWWA C706 or an encoder type remote register designed in accordance with AWWA C707 but must be compatible with the local Utility Monitoring and Control System. Meters shall comply with the accuracy and capacity requirements of AWWA C703. When turbine type main line meters are used, the meter shall be supplied with a separate check valve, as a unit.

3.5.3 Water Meter Installation

a. Meter Boxes: Meter boxes shall be of cast iron, concrete, or plastic. The boxes shall be of sufficient size to completely enclose the meter and shutoff valve or service stop. Meter boxes set in paved areas subject to vehicular traffic shall be cast iron, or concrete with cast iron lid and cast iron meter reader lid suitable for vehicle wheel loads. Boxes set in sidewalks, not subject to vehicular traffic, shall be concrete with cast iron lid and cast iron meter reader lid. Plastic boxes and lids can be used in unpaved areas or grass areas not subject to vehicular traffic. Box height shall extend from invert of the meter to final grade at the meter location. The lid shall have the word "WATER" cast in it.

b. Dielectric Fittings: Dielectric fittings shall be installed between threaded ferrous and nonferrous metallic pipe, fittings and valves, except where corporation stops join mains. Dielectric fittings shall prevent metal-to-metal contact of dissimilar metallic piping elements and shall be suitable for the required working pressure.

3.5.4 Valves

a. Gate Valves Smaller than 3 Inch in Size: Gate valves that are smaller than 3 inch in size shall meet MSS SP-80, Class 150 and have a solid wedge, non-rising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve. Provide hand wheel operators. Valves shall open by counterclockwise rotation of the valve stem.

b. Gate Valves 3 Inch Size and Larger: Gate valves 3 inch size and larger shall meet AWWA C500 or UL 262 and be of one manufacturer. Valves shall be AWWA C500, non-rising stem type with double-disc gates or UL 262, inside-screw type with operating nut, split wedge or double disc type gate, and designed for a hydraulic working pressure of 175 psi. Valves shall open by counterclockwise rotation of the valve stem.

3.5.5 Connections

a. Connections to Publicly or Privately Operated Water Utility Lines: Contractor shall provide materials for the connections to the existing water lines. Final connections and the turning on of water shall be made by the utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of water lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new water lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

b. Connection to Government Owned/Operated Water Lines: Provide the name and location of the utility or operating agency of the existing water lines. Show on the drawings, the location of valves to be operated for existing system deactivation. The Contractor shall provide connections to the existing water lines in accordance with approved procedures. The Contractor's Connection Plan shall be submitted and approved prior to making any connections to existing water lines. This plan shall include the Operating Agency's required procedures which may be obtained from the Contracting Officer. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made. Reactivation of any existing water lines will only be done by the Government.

3.5.6 Disinfection: Prior to disinfection, obtain Contracting Officer approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect existing water piping affected by Contractor's operations in accordance with AWWA C651. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into
service. Disinfection of systems supplying nonpotable water is not required. Chlorinating materials shall conform to the following: Chlorine, Liquid: AWWA B301, Hypochlorite, Calcium and Sodium: AWWA B300.

3.5.7 Tests and Inspections

a. Prior to hydrostatic testing, obtain Contracting Officer approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer will conduct field inspections and witness field tests. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing, except that water and electric power needed for field tests will be furnished. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the approved Statement of Work.

b. Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage shall be allowed at copper pipe joints, copper tubing joints (soldered, compression type, brazed), plastic pipe joints, flanged joints and screwed joints.

c. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system. Hold this pressure for not less than 2 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.6 Steam Meter

3.6.1 Requirements

a. The meters must comply with the applicable requirements of ASHRAE 189.1. Where conflicts occur between this guidance and the ASHRAE standard, ASHRAE 189.1 shall prevail.

b. In addition to the requirements listed below Steam Meters shall be in accordance with UFGS SECTION 33 63 23. The vortex type or orifice plate type are recommended. Ensure that the flow meter selected meets the requirements for the specific application based on steam type (wet, saturated or superheated), flow rate, and operating conditions. Steam Meters shall be manufactured by Onicon Incorporated, Sierra Instruments, NICE Instrumentation, Inc. or approved equal.

Quantities Measured: Pounds of Steam

Accuracy: 2.0% of scale.

Resolution: 1 pound of steam

Measurement Configuration: Steam Supply to a building. For buildings that already have a steam meter with a pulse output, ensure that the pulse output is connected to a data gathering device (i.e. electric meter). For buildings where a steam meter already exists but does not have a pulse output, add a pulse kit to the existing meter and tie the output into a data gathering device. If the existing meter will not accept a pulse kit or if no meter exists, a new steam meter shall be installed, also requiring a pulse output to a data gathering device.

c. Steam Flow Meters: Meter shall be for minimum working pressure of ASME Class 150 with steel pressure chambers or ASME Class 250 with cast-iron pressure chambers. Provide meter in horizontal pipe between two ASME B16.5 welding neck flanges. Provide rotary type meter for flow integration. Working parts shall be stainless steel. Steam flow shall cause rotation of a rotor assembly at a speed directly proportional to the rate of steam flow, as controlled by a damping liquid. The rotational speed of the rotor assembly shall be reduced by gearing in the damping liquid chamber. Final drive to the exterior counter shall be by driving magnets; stuffing box shall not be allowed. Counter shall be enclosed in a dust-tight cast-aluminum housing attached to, but easily removable from the meter. For steam pipe main sizes 4 inches and smaller, provide meter directly in the steam piping. For steam pipe main sizes larger than 4 inches, provide meter in shunt bypass piping with two ASME B16.5 Class 300 welding neck orifice flanges in the steam pipe main. In the shunt bypass piping, provide two flanged gate valves calibrated by the meter manufacturer. In the steam pipe main, provide 0.125 inch thick stainless steel orifice plate sized to suit meter capacity between two ASME B16.5 Class 300 welding neck orifice flanges. Provide pressure and temperature compensated devices to automatically and continuously correct steam flow meter readings for steam pressure and temperature variations.
3.6.2 Meter Types: Steam flow is measured with several types of flow meters: Differential pressure-based (orifice plates, flow nozzles, venturi tubes, and averaging pitot tubes), vortex, Coriolis, and ultrasonic.

a. Vortex Meter: Vortex flow meters are flow sensors that detect the frequency of vortices shed by a bluff body placed in a flow stream. The frequency of the vortices is proportional to the flow velocity.

b. Orifice Plate: Orifice Plate flow meters are differential producing type orifice plate with a circular hole for insertion into the steam piping between two ASME B16.5 Class 300 welding neck orifice flanges. Orifice plate shall be Type 304 stainless steel. Furnish a dimensional report and flow versus differential curve with accuracy of plus or minus one percent over a 5 to 1 flow range. Orifice flanges shall have at least two radially-drilled and tapped holes for metering and two jack screws.

c. Turbine Flowmeter: As a substance moves through a pipe, it acts on the vanes on a turbine to get it to spin. The rate of spin is measured to find out the speed of the flow.

d. Pitot Tube Flowmeter: The Pitot Static tube measures the total pressure (or impact pressure) at the nose of the Pitot tube and the static pressure of the gas stream at side ports. The difference of these pressures, i.e. the dynamic or velocity pressure varies with the square of the gas velocity.

3.6.3 Steam Meter Installation

a. Connections to Publicly or Privately Operated Steam Utility Lines: Contractor shall provide materials for the connections to the existing steam lines. Final connections and the turning on of steam supply shall be made by the utility. The Contractor shall notify the Contracting Officer, in writing, 10 days before final connections and turning on of steam supply lines. The Contractor shall make necessary arrangements with the Utility for tie in and activation of new steam lines. Only the Operating Agency/Utility Company may reactivate the system after tie in. The Contractor shall furnish a certification by the Operating Agency/Utility Company that all Utility work has been satisfactorily completed.

b. Connection to Government Owned/Operated Steam Lines: Provide the name and location of the utility or operating agency of the existing steam lines. Show on the drawings, the location of valves to be operated for existing system deactivation. The Contractor shall provide connections to the existing steam lines in accordance with approved procedures. The Contractor's Connection Plan shall be submitted and approved prior to making any connections to existing steam lines. This plan shall include the Operating Agency's required procedures which may be obtained from the Contracting Officer. The Contractor shall notify the Contracting Officer, in writing, 10 days before connections to existing lines are to be made. Reactivation of any existing steam supply lines will only be done by the Government.

c. Demolition: Remove materials so as not to damage materials which are to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.

d. Cleaning of Piping: Keep the interior and ends of new piping and existing piping affected by the Contractor's operations, cleaned of water and foreign matter during installation by using plugs or other approved methods. When work is not in progress, securely close open ends of pipe and fittings to prevent entry of water and foreign matter. Inspect piping before placing into position.

e. Adjustments: Upon completion of the work, furnish the services of a competent technician regularly employed by the manufacturer of the flow meter to make the necessary adjustments to place the steam flow meter in operation and to conduct performance tests which demonstrate that the flow measuring equipment is functioning. Install the steam flow meter in accordance with manufacturer's recommendations.

3.6.4 Piping Tests

a. Provide piping modifications that facilitates acceptance testing such as piping which includes flanges at appropriate locations for flanged blanks to be installed for testing. Include requirements for how the modified piping shall be pressure tested and also specify which pipe sections or equipment that will be pressure tested in the shop if absolutely necessary.

b. Before final acceptance of the work, test each system as in service to demonstrate compliance with contract requirements. Before insulation is applied, hydrostatically test each piping system at not less than 225 psig in accordance with ASME B31.1, with no leakage or reduction in gage pressure for 2 hours. The Contractor shall flush and clean piping before placing into operation. Flush piping at a minimum velocity of 8 fps. Correct defects in work provided by Contractor and repeat tests until work is in compliance with contract requirements. Furnish potable water, electricity, instruments, connecting devices, and personnel required for the tests.
4.0 EXECUTION

a. Installation: Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise. Specific installation instructions are located in each meter section above. All current, power, and voltage circuit termination points for wires entering the meter or enclosure must be clearly marked, to avoid installation error and simplify future identification of wires for maintenance purposes. These identifying markings shall be reflected on the As-Built drawings.

b. Scheduling of Work and Outages
   (1) Installation of current transformers and potential transformers shall require that power be disconnected from the transformer and/or building. No "hot work" allowed unless prior Government approval is granted.

   (2) The Contract Clauses shall govern regarding permission for power outages, scheduling of work, coordination with Government personnel, and special working conditions.

   (3) Building Schedule Concurrence Agreement: The contractor shall submit to the Contracting Officer’s Representative (COR) a list of buildings with approved, scheduled utility outages prior to beginning any meter installation. The approval authority for outages is the local Public Work engineering office.

   (4) Monthly Status Report: The contractor shall report the number of installed meters and the associated building number by the tenth of each month to the Corps of Engineers Project Manager. Major equipment installation, servers, network installation, and software installation shall be included in the report.

c. Field Applied Painting

Where field painting of enclosures is required to correct damage to the manufacturer’s factory-applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

d. Field Quality Control

Prior to system acceptance, the Contractor shall demonstrate and confirm the meter is properly wired and displaying correct and accurate electrical, gas, steam or water use values. The Contractor shall demonstrate to the Government that the actual flow or power utilized by the meter is calculated and displayed correctly and accurately on the local display or host and/or software. The meter installation being verified will be a sample selected by the Government. This demonstration shall utilize suitable test equipment connected to the service being metered. For electrical service the test equipment shall be capable of displaying instantaneous 3-Phase values of Voltage, Current, Phase Power Factor and/or Phase Angle, Volt Amperes, Watts, and Vars. Other meter types shall be tested for output values per their respective requirements. All test equipment shall have verified calibration within the past six months. All test equipment shall be furnished by the contractor. All safety measures for connectivity to an energized source shall be followed as outlined in the most recent version of Safety Manual EM 385-1-1, Section 11B. Connectivity to an energized source is contingent on approval from the local site Safety Officer and designated Project Manager. Depending on the quantity of meters installed this requirement may be removed with the written permission of the Government. The Contractor shall provide to the Government advance notice of 10 working days prior to the scheduled dates for testing.

e. Cleanup

Upon completion of the installation all debris and surplus materials resulting from the work shall be removed.

5.0 TRAINING

The Contractor shall conduct a training course for meter configuration, operation, and maintenance of the system as specified. The training shall be oriented for all components and systems installed under this contract. Training manuals shall be delivered for five trainees with two additional copies delivered for archiving at the project site. The Contractor shall furnish all audiovisual equipment and all other training materials and supplies. A training day is defined as eight hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that attendees have a high school education or equivalent, and are familiar with utility systems. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.
Training: The course shall be taught at the project site within thirty days after completion of the installation for a period of one day. A maximum of five personnel will attend the course. The training shall include:

a. Physical layout of each piece of hardware.
b. Meter configuration, troubleshooting and diagnostics procedures.
c. Repair instructions.
d. Preventive maintenance procedures and schedules.
e. Testing and calibration procedures.

END OF SECTION 230910
PART 1 - GENERAL

1.1 SUMMARY

A. Natural-gas piping within the building.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
   1. Piping and Valves: 100 psig (690 kPa).
   3. Service Meters: 5 psig (34.5 kPa).

B. Natural-Gas System Pressures within Buildings:
   1. Two Pressure Ranges: More than 0.5 psig (3.45 kPa) but not more than 5 psig (34.5 kPa), and 0.5
      psig (3.45 kPa) or less.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping Specialties:
   1. Appliance flexible connectors.
   2. Quick-disconnect devices.
   3. Y-Pattern strainers.
   4. Weatherproof vent cap.

B. Manual Gas Shutoff Valves:
   1. One- and two-piece ball valves.
   2. Two-piece, regular-port bronze ball valves with bronze trim.
   5. PE ball valves.
   6. Valve boxes.

C. Electrically operated motorized gas valves.

D. Earthquake Valves: Cast-aluminum body with nickel-plated chrome steel or stainless-steel internal parts.

E. Pressure Regulators:
   1. Service pressure regulators.
   2. Line pressure regulators.
   3. Appliance pressure regulators.

F. Service Meters:
   1. Furnished by natural-gas supplier.
   2. Diaphragm type.
   3. Rotary type.
   4. Turbine.
   5. Service-meter bars.

G. Dielectric Fittings: Dielectric unions.

H. Sleeves: Steel and cast-iron pipe.

I. Mechanical sleeve seals.

J. Escutcheons: To conceal pipe penetrations.

2.2 OUTDOOR PIPING SCHEDULE

A. Aboveground Piping: Steel pipe with threaded joints (2" and below) or steel pipe with welded joints (larger than 2").

2.3 INDOOR PIPING SCHEDULE FOR PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground Branch Piping NPS 1 (DN 25)) and Smaller: Corrugated stainless-steel tubing with mechanical fittings (at final unit connections only). Steel pipe with threaded joints.

B. Aboveground Distribution Piping: Steel pipe with threaded joints (2" and below) or steel pipe with welded joint (larger than 2").

2.4 INDOOR PIPING SCHEDULE FOR PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground Branch Piping NPS 1 ((DN 25)) and Smaller: Steel pipe with threaded joints.

B. Aboveground Distribution Piping: Steel pipe with welded joints.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 231123
SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install refrigerant piping for split-system DX air conditioning units.

1.2 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.3 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 PRODUCTS

A. Valves and Specialties (furnished with line-sets or integral with split-system air conditioning units):
   1. Service valves.
   2. Thermostatic expansion valves
   4. Permanent filter dryers with activated media.

B. Pre-charged piping line-sets as recommended by unit manufacturer may be used in lieu of field piping.

2.2 PIPING APPLICATIONS

A. Piping Applications for Refrigerant R-134a: Maximum NPS 4 (DN 100).

B. Piping Applications for Refrigerant R-407C: Maximum NPS 4 (DN 100).

C. Piping Applications for Refrigerant R-410A: Maximum NPS 4 (DN 100).
   2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
      a. NPS 2 (DN 50) and Smaller: Copper with brazed joints.
      b. NPS 2-1/2 (DN 65) and Larger: Schedule 40, black steel with welded joints.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 232300
SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes furnishing and installation of metal ductwork and related accessories.

1.2 PERFORMANCE REQUIREMENTS

A. Provide air distribution system for HVAC systems that is correctly sized for optimized system performance relative to energy, leakage and noise.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 220000 and 013300.

1.4 QUALITY ASSURANCE

A. Comply with SMACNA Standards, NFPA 90A, ASHRAE and the IMC, for ductwork design, construction and optimization.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Single-wall rectangular ducts and fittings.

B. Double-wall rectangular ducts and fittings.
   1. Fibrous-glass or Flexible elastomeric duct liner for interstitial insulation.

C. Single-wall round ducts and fittings.

D. Sheet Metal Materials:
   2. Carbon-steel sheets.
   4. Aluminum sheets.
   5. Factory-applied antimicrobial coating.

E. Duct Liner:
   1. Fibrous glass, Type I, flexible.
      a. With antimicrobial erosion-resistant coating.
   2. Flexible elastomeric.

F. Sealant Materials:
   1. Two-part tape sealing system.
   2. Water-based joint and seam sealant.
   4. Flanged joint sealant.
   5. Flange gaskets.
   6. Round duct joint O-ring seals.

2.2 SEISMIC-RESTRAINT DEVICES

A. Channel support system.
B. Stainless-steel restraint cables.

C. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

2.3 DUCT SCHEDULE

A. All ducts shall be galvanized steel except as follows:
   1. Commercial Kitchen Hood Exhaust Ducts:
      a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
      c. Welded seams and joints.
   2. Dishwasher Hood Exhaust Ducts:
      a. Type 304, stainless-steel sheet.
      b. Exposed to View: No. 4 finish.
      c. Concealed: No. 2D finish.
      d. Welded seams and flanged joints with watertight EPDM gaskets.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All ducts shall be fabricated and installed in accordance with the appropriate standards of ASHRAE, IMC, NFPA 90A and SMACNA.

END OF SECTION 233113
SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY
A. Furnish and install HVAC air distribution system duct accessories.

1.2 PERFORMANCE REQUIREMENTS
A. Provide air duct accessories as required to optimize air distribution and delivery of the various HVAC systems, and to provide for means to properly proportion the air flow quantity and direction.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE
A. Installation Standards: SMACNA, IMC, ASHRAE and NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Backdraft and Pressure Relief Dampers: Multiple blade, parallel action, gravity balanced.
B. Barometric Relief Dampers: Horizontal or vertical mounting.
C. Manual Volume Dampers: Standard steel, multiple or single blade, parallel- or opposed-blade design.
D. Control Dampers: Parallel or Opposed blade design.
E. Flange connectors.
F. Duct Silencers: Factory fabricated and tested, round or rectangular.
H. Remote damper operators.
J. Flexible Connectors: Indoor and outdoor, high temperature.
K. Flexible Ducts: Insulated.
L. Duct accessory hardware.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install duct accessories in accordance with manufacturer’s recommendations and per SMACNA, IMC and ASHRAE Standards.
END OF SECTION 233300
SECTION 233423
HVAC POWER VENTILATORS

PART 1 - PRODUCTS

1.1 SUMMARY

A. Power Ventilators:
   1. Centrifugal roof ventilators.
   2. Ceiling-mounting ventilators.
   3. In-line centrifugal fans.

1.2 PERFORMANCE REQUIREMENTS

A. Provide HVAC system power ventilators and exhaust fans to meet the ventilation requirements of the facility, indoor air quality levels and contamination control requirements.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

A. Performance Requirements: AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Direct- or belt-driven centrifugal type, with housing, wheel, motor, drive assembly, and curb base.
   2. Fan Wheels: Aluminum with backward-inclined blades.
   3. Belt-Driven Drive Assembly: Steel shaft, permanently lubricated and sealed bearings, and cast-iron adjustable-pitch pulley.
   4. Accessories:
      a. Variable-speed controller.
      b. Disconnect switch inside or outside fan housing.
      c. Bird screens.
      d. Backdraft dampers.
      e. Motorized dampers.
   5. Roof Curbs: Galvanized steel; self-flashing without cant strip and with mounting flange.
      a. Overall Height: [8 inches (200 mm)] [9-1/2 inches (240 mm)] [12 inches (300 mm)] [16 inches (400 mm)] [18 inches (450 mm)].
      b. Options: Vented for range hood exhaust applications.

2.2 CEILING-MOUNTING VENTILATORS

A. Housing: Steel with acoustical insulation.

B. Fan Wheels: Centrifugal.

C. Grilles: Aluminum, louvered.

D. Accessories:
   1. Variable-speed controller.
   3. Time-delay switch.
4. Motion sensor.
5. Ceiling radiation damper.
7. Vibration isolators.
8. Roof jack or wall cap and transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

A. In-line, direct-driven centrifugal type, with housing, wheel, outlet guide vanes, motor, and drive assembly.
2. Direct-Driven Units: Motor mounted in airstream.
3. Belt-Driven Units: Motor mounted on adjustable base.
5. Accessories:
   a. Variable-speed controller.
   b. Volume-control damper.
   c. Companion flanges.
   d. Fan guards.
   e. Motor and drive cover (belt guard).

PART 3 - PRODUCTS (NOT USED)

END OF SECTION 233423
SECTION 233433

AIR CURTAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Air curtains without heat.

1.2 PERFORMANCE REQUIREMENTS

A. Provide air curtains at key building entrances and loading docks which are subject to high traffic volume or are left open for periods of time, in order to minimize air infiltration and/or contaminants and insects.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE


C. Quality Standard for Air Curtains in Food Service Establishments: NSF 37.

1.5 WARRANTY

A. Materials and Workmanship: One year.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Housing Materials: Galvanized steel; with intake louvers and discharge nozzle.

B. Fans: Direct drive, galvanized steel, centrifugal.

C. Motors: Two speed open, dripproof.

D. Accessories:
   1. Automatic door switch.
   2. Start-stop, push-button switch.
   3. Time-delay relay.
   4. Motor-control panel.

E. Mounting brackets.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 233433
SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - PRODUCTS

1.1 SUMMARY

A. Ceiling- and wall-mounted diffusers, registers, and grilles.

1.2 PERFORMANCE REQUIREMENTS

A. Provide air distribution devices to optimize air distribution and thermal comfort and to minimize drafts and
noise.

1.3 SUBMITTALS

A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE

A. Tested for performance according to ASHRAE 70.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. General

1. Commercial grade, manufactured air distribution inlets and outlets suitable for the installation
application location (ceiling, wall, floor, etc.).

2. Balancing volume dampers shall be provided at the main branch duct take-off to each air outlet,
rather than be integral with each device, in order to minimize airborne noise levels.

Adjustable Bar Grille

B. Fixed Face Grille

C. Linear Slot Diffuser

D. Round Ceiling Diffuser

E. Perforated Return Grille

F. Louver Face Diffuser

PART 3 - PRODUCTS (NOT USED)

END OF SECTION 233713
SECTION 233813

COMMERCIAL-KITCHEN HOODS

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 Type I and Type II commercial kitchen hoods.

1.3 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

D. Type II Hood: A hood designed for heat and steam removal and for other nongrease applications.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:
   2. Filters/baffles.
   3. Fire-suppression systems.
   4. Lighting fixtures.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
   1. Shop Drawing Scale: 1/4 inch = 1 foot
   2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
   3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
   4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
   5. Show water-supply and drain piping connections.
   6. Show control cabinets.
   7. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
   8. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   11. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

   a. Piping Diagram Scale: 1/4 inch = 1 foot
1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Coordination Drawing Scale: 1/4 inch = 1 foot
   2. Suspended ceiling assembly components.
   3. Structural members to which equipment will be attached.
   4. Roof framing and support members for duct penetrations.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Moldings on hoods and accessory equipment.

B. Welding certificates.

C. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.


C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.7 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish one complete set(s) of grease filters/baffles.
PART 2 - PRODUCTS

2.1 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.
   1. Minimum Thickness: 0.050 inch
   2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
      a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
   3. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).
   4. Exposed Surfaces: ASTM A 480/A 480M, No. 4 finish (directional satin).
   5. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Carbon-Steel Sheets: ASTM A 1008/A 1008M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.
   1. Minimum Thickness: [0.043 inch] [0.0478 inch] <Insert thickness>.

C. Galvanized-Steel Sheet: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation.
   1. Minimum Thickness: [0.052 inch] <Insert thickness>.

D. Zinc-Coated Steel Shapes: ASTM A 36/A 36M, zinc coated according to ASTM A 123/A 123M requirements.

E. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.
   1. Color: As selected by Architect from manufacturer's full range.
   2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

F. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

G. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.2 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
   1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
   2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
   3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
   5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.
D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.


K. Fabricate equipment edges and backsplashes according to SMACNA’s "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

L. Fabricate enclosure panels to ceiling and wall as follows:
   1. Fabricate panels on three side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
   2. Wall Offset Spacer: Minimum of 3 inches.

2.3 TYPE I EXHAUST HOOD FABRICATION

A. **Basis-of-Design Product:** Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Greenheck
   2. Halton Company
   3. Vent Master

B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.
   1. Fabricate hoods according to NSF 2, "Food Equipment."
   2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
   3. Hoods shall be designed, fabricated, and installed according to NFPA 96.
   4. Include access panels as required for access to fire dampers and fusible links.
   5. Duct Collars: Minimum 0.0598-inch- thick steel at least 3 inches long, continuously welded to top of hood and at corners. Fabricate a collar with a 0.5-inch- wide duct flange.

C. Hood Configuration: Exhaust only.

D. Hood Style: Back shelf.

E. Filters/Baffles: Removable, stainless-steel, with spring-loaded fastening. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

F. Lighting Fixtures: Surface-mounted, LED fixtures and lamps with lenses sealed vaporlight. Wiring shall be installed in conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc at 30 inches above finished floor.
1. Light switches shall be mounted on front panel of hood canopy.

G. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for hood controls.

H. Hood Controls: Wall-mounting control cabinet, fabricated of stainless steel.
   1. Exhaust Fan: On-off switches shall start and stop the exhaust fan. Interlock exhaust fan with makeup air supply fan to operate simultaneously. Interlock exhaust fan with fire-suppression system to operate fan(s) during fire-suppression-agent release and to remain in operation until manually stopped. Include red pilot light to indicate fan operation. Motor starters shall comply with Section 262913 "Enclosed Controllers."
   2. Photocell and Temperature Control: Cycle makeup air and exhaust-air fans on and off, based on temperature at hood discharge and opacity of smoke in hood. Interlock fan control with fire-suppression system to operate during fire-suppression-agent release and to remain in operation until manually stopped. Provide air-purge fan and conduit to photocell and reflector to avoid grease accumulation that will negatively affect performance of system.
   3. High-Temperature Control: Alarm shall sound and cooking equipment shall shut down before hood discharge temperature rises to actuation temperature of fire-suppression system.

2.4 TYPE II EXHAUST HOOD FABRICATION

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Greenheck
   2. Halton Company
   3. Vent Master

B. Fabricate hoods according to NSF 2, "Food Equipment."

C. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible."

D. Hood Configuration: Exhaust only.

E. Hood Type: Heat and vapor removal.

F. Hood Style: Wall-mounted canopy.

2.5 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Ansul Incorporated; a Tyco International Ltd. Company.

B. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.
   3. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
   5. Furnish electric-operated gas shutoff valve; refer to Section 231123 "Facility Natural-Gas Piping.
   6. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.
   7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
   8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and
control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Complete field assembly of hoods where required.
   1. Make closed butt and contact joints that do not require filler.
   2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.

B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.

D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

E. Install hoods to operate free from vibration.


G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

J. Set initial temperatures, and calibrate sensors.

K. Set field-adjustable switches.

3.3 CONNECTIONS

A. Install piping with clearance to allow service and maintenance.

B. Connect ducts according to requirements in Section 233300 "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.

C. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."
3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
   4. Perform hood performance tests required by authorities having jurisdiction.
   5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods.

END OF SECTION 233813
SECTION 234100
PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY
A. Factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.2 PERFORMANCE REQUIREMENTS
A. Provide particulate air filtration devices to meet the indoor air quality levels required by the HVAC system design, as well as local and state indoor air quality standards.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE
A. Installation Standard: NFPA 90A or NFPA 90B.
B. Quality Standard: ARI 850.
C. Testing and Rating Standard: ASHRAE 52.2.

PART 2 - PRODUCTS

2.1 PRODUCTS
A. Disposable Panel Filters: Viscous-coated, flat-panel type, with holding frames.
   1. Media: Interlaced glass fibers.
   2. Frame: Cardboard frame with perforated metal retainer.
B. Extended-Surface, Disposable Panel Filters: Dry, with holding frames.
   1. Media: Fibrous material formed into deep V-shaped pleats.
C. Filter holding frames and mounting racks integral to air handling units shall be coordinated with filter sizes and depths.
D. Front- and Rear-Access Filter Frames: Aluminum framing with prefilters in a separate track.
E. Side-Service Housings: Galvanized steel with prefilters and access doors.
F. Filter Gages: Diaphragm type.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 234100
SECTION 237413
PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY
A. Furnish and install packaged, outdoor roof-top HVAC units.

1.2 PERFORMANCE REQUIREMENTS
A. HVAC systems shall be designed and sized to provide adequate heating, cooling and ventilation to the facility, in accordance with the Design Criteria and appropriate building codes and energy standards.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

1.4 QUALITY ASSURANCE
A. ARI Compliance:
   1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.
B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigerant system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with ASHRAE/IESNA 90.1 for minimum efficiency of heating and cooling.
C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY
A. 5-year limited compressor warranty.
B. 5-year limited heat exchanger warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS
A. General:
   1. Packaged outdoor, roof-top HVAC units for building heating, cooling and ventilation. Electric (DX) cooling with gas, electric resistance or heat pump heating as location and utility rates/availability dictate based on LLC analysis.
B. Casing: Insulated
C. Supply-Air Fan: Belt driven, double width, forward curved, centrifugal.
D. Condenser-Coil Fan: Direct-driven propeller.
E. Relief-Air Fan: Propeller or Forward curved.

F. Supply-Air Refrigerant Coil:
   1. Aluminum-plate fins and seamless copper tube.
   2. Baked phenolic coating for coastal locations.

G. Outdoor-Air Refrigerant Coil:
   1. Aluminum plate fins and seamless copper tube.
   2. Baked phenolic coating for coastal locations.

H. Refrigerant Circuit Components:
   1. Number of Refrigerant Circuits: One.
   2. Compressor: Hermetic scroll.
   3. Refrigerant Charge: R-407C or R-410A.
   4. Four-way reversing valve (heat pump units).

I. Filtration
   1. Supply airstream:
      a. Prefilters: 2" thick, disposable type air filters with 25 - 30% efficiency (MERV 8).
      b. Final: As required by IAQ standards.

J. Gas Furnace (where applicable):
   3. Ignition: Electronic.
   4. High-altitude [model] [kit].
   5. Power venter.

K. Outdoor- and Return-Air Mixing Dampers: 0 to 100 percent economizer with motorized dampers and hood.

L. Electrical Power Connection: Single with unit-mounted disconnect.

M. Basic Unit Refrigeration and Safety Controls:
   1. Safety controls.
   2. Refrigerant circuit controls.
   3. Hot-gas reheat-coil controls.
   4. Gas furnace controls.
   5. Electric-heating-coil controls.

N. DDC Controllers:
   1. Scheduled controls.
   2. Unoccupied period controls.
   3. Supply fan controls.
   4. Fixed minimum outdoor-air controls.
   5. Economizer dry-bulb or enthalpy-based controls.
   6. Carbon dioxide sensor.
   7. Interface with HVAC instrumentation and control system.

O. Accessories:
   1. Duplex electrical outlet.
   2. Low-ambient kit (where applicable)
   3. High altitude kit (where applicable).
   4. Filter gauges.
   5. Hail guards.

P. Roof Curbs
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install packaged roof-top units on roof curb and connect ductwork, gas piping and power in accordance with manufacturer’s recommendations.

END OF SECTION 237413
PART 1 - GENERAL

1.1 SUMMARY
   A. Split-system air-conditioning and heat pump units with separate evaporator-fan and compressor-condenser components.

1.2 PERFORMANCE REQUIREMENTS
   A. HVAC systems shall be designed and sized to provide adequate heating, cooling and ventilation to the facility, in accordance with the Design Criteria and appropriate building codes and energy standards.

1.3 SUBMITTALS
   A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

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.
   C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
   D. Units shall be designed to operate with HCFC-free refrigerants.

1.5 WARRANTY
   A. Materials and Workmanship: Five years.

PART 2 - PRODUCTS

2.1 COMPONENTS
   A. Concealed Evaporator Fan: Galvanized-steel chassis and drain pan, insulated, with copper-tube refrigerant coil, forward-curved galvanized fan, multispeed motor, and disposable filters.
      1. Heating Coil: Gas.
   B. Air-Cooled, Compressor-Condenser: Enamel-steel casing, hermetically sealed scroll compressor, copper-tube refrigerant coil, heat pump components (where applicable), and aluminum-propeller fan.
C. Accessories: Low voltage thermostat or wireless infrared thermostat, refrigerant line kits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s recommendations.

END OF SECTION 238126
SECTION 238239
UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY
A. Propeller type unit heaters, gas or electric.

1.2 PERFORMANCE REQUIREMENTS
A. Provide point-of-use heating to equipment rooms and other non-air conditioned spaces as required to maintain space temperatures per the Design Criteria.

1.3 SUBMITTALS
A. Provide product data and shop drawings in accordance with Section 230000 and 013300.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS
A. Propeller Unit Heaters:
   1. Cabinet: Removable panels for maintenance access to controls, with manufacturer's standard baked-enamel finish.
   3. Gas heater (where applicable): Indirect natural gas-fired heater with aluminized steel heat exchanger, seal combustion burner, vent and intake air assembly, gas train and gas safeties.
   4. Fan: Propeller type with aluminum wheel.
   5. Fan Motors: Multispeed.
   6. Controls: [Unit-mounted fan-speed switch.
   7. Controls: Wall-mounting thermostat.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install units in accordance with manufacturer’s recommendations.

END OF SECTION 238239
SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

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 work under this division includes furnishing all materials, equipment, labor, supervision, tools and items necessary for the construction, installation, connection, testing and operation of all electrical work for this project as shown on the Electrical Drawings specified herein.

B. Related Work Described Elsewhere: Where other divisions require electrical materials or installations comply with all applicable requirements herein. Provide all electrical materials and installation work required to connect, test and operate equipment required by other divisions. Electrical installations required by other divisions but not shown on the electrical drawings shall be provided.

C. Itemized Schedule of Costs: Furnish a contract cost breakdown by specification section to the Architect with a copy to the Engineer to allow evaluation of partial payment requests. Refer to Division 1 for requirements.

1. Warranty: The Contractor shall guarantee all work installed under this specification and make good, repair or replace at his own expense, any defective work, materials defect is due to imperfection in material, design or workmanship. Incandescent lamps are not warranted but all shall be operating at time of final acceptance. Warranty shall be submitted in writing as required in Division 1.

1.3 REGULATIONS

A. Codes and Ordinances: Comply with all applicable codes, ordinances and regulations including the National Electrical Code, the Washington Administrative Code, National Electrical Safety Code, WISHA, NFPA, and all other national, state and local codes and ordinances. Notify the Engineer of any non-compliance in contract documents to applicable codes and regulations prior to installation of the work. Changes in the work after initial installation due to requirements of code enforcing agencies shall be at no additional cost to the Owner.

B. Permits: Provide and pay for all permits and fees required for this project. In addition to paying for all permits and fees, the Contractor shall be responsible for contacting the various Approving Authorities, arranging for review of shop drawings where appropriate, scheduling inspections in a timely manner, and making necessary corrections as required by the Approving Authorities.

C. Approving Authority: It is the Contractor's responsibility to ascertain and contact the appropriate "Approving Authorities" for this project. Approving Authorities will include, but not be limited to the electrical inspector and the Fire Marshal having jurisdiction.

D. Certificate of Inspection: Obtain a Certificate of Electrical Inspection from the local inspecting authority indicating final acceptance. Submit to the Owner upon completion of the project as part of project closeout.
E. Safety Measures to be Taken: The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the Contractor to perform his work. The Contractor will be solely and completely responsible for conditions of the job site, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours. The duty of the Engineer to conduct construction observations of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on or near the construction site.

1.4 DRAWINGS AND SPECIFICATIONS

A. Intent: The Electrical Drawings and specifications are intended to include all labor and materials necessary to provide a complete and operating facility. Any materials shown and called for on the drawings but not mentioned in the specifications, or vice versa, which are necessary for the proper completion of the installation or operation of the equipment, shall be furnished the same as if specifically called for in both. By submitting a bid, the Contractor is acknowledging that he has made a thorough examination of the contract documents, existing site conditions, and has determined that these documents and conditions do sufficiently describe the scope of construction work required under this contract. Any questions regarding interpretation of the contract documents shall be made in writing in a timely manner prior to the bid date to allow reasonable time for resolution of the questions.

B. Diagrammatic Drawings: The Electrical Drawings are diagrammatic and do not show exact or complete raceway and wiring configurations, routing, rating or the necessary number and types of raceway fittings or pull boxes. Provide all labor and materials required to execute the work.

1.5 SUBMITTALS AND SHOP DRAWINGS

A. It is the Contractor's responsibility to thoroughly review vendor-assembled shop drawings, catalog cuts, etc. to ensure that these documents are complete and comply with the specifications.

B. Submittal Format: Submittals must be sent in complete "sets," including all specified material. Submission of individual materials will not be accepted.

C. Review: The review of a manufacturer's name or product does not relieve the Contractor of the responsibility for providing materials and equipment which comply in all details with the requirements of the contract documents. Contractor shall be solely responsible for submitting materials at such a time to allow a minimum of two weeks for Engineer's review.

1.6 OPERATIONS AND MAINTENANCE MANUALS

A. Prepare operations and maintenance manuals for all electrical equipment installed on this project. Refer to Section 017823 Operation and Maintenance Data for additional requirements.

B. Provide table of contents at front of manual indicating general content of each section. Provide index for each section of the manual with complete equipment catalog item or identification.
C. The information and diagrams included must be on the specific equipment installed for this project. General "product line" information is not acceptable. The equipment model and catalog numbers with appropriate prefixes and suffixes must be clearly indicated on the data sheets. Manuals shall contain shop drawings, schematic and wiring diagrams (showing all external connections), parts lists, operating and maintenance information. Any modifications to equipment in the field shall be updated on the drawings, diagrams, etc., to reflect the "as-built" conditions.

D. Bind with three-screw post-type binder with heavy-duty hardboard cover and cloth backing. Imprint the edge of volume with name of the project, year of completion and the words "Electrical Equipment." Front of manual shall be imprinted with the words "Electrical Equipment" the name of the project, the name of the Owner, year completed, name of the Architect, Engineer and Contractor. All printing in gold lettering. If the thickness of the manual exceeds approximately 2", provide separate volumes, each approximately 2" thick with each volume imprinted as described above and with the addition of the volume number.

E. One preliminary copy shall be submitted to the Engineer for review 30 days prior to completion of the project. Preliminary copy shall include proposed wording for cover and back edge of the manual. Submit final bound copies for distribution as required in Division 1.7 RECORD DRAWINGS

A. A record shall be made during the progress of the project indicating the work as actually installed. Corrections and changes shall be kept up to date at all times on a separate set of record drawings kept at the job site for review. Mark-ups may be schematic as related to interior raceway systems; however, all raceways shall be shown in proper relationship with junction boxes, panelboards, devices, and equipment. Raceways installed below grade shall be shown with both horizontal and vertical dimensions at an accuracy of ±6 inches.

B. Project Closeout: At completion of the project, the Contractor shall provide as-built drawings indicating work as revised, detailed and actually installed. Submit to the Architect as specified in Section 16700, "Contract Closeout."

C. Additional Record Drawings: Refer to Division 27 and 28 sections for additional record drawing requirements. AutoCAD production requirements also apply to all special system drawings.

1.8 ABBREVIATIONS AND DEFINITIONS

A. Provide: To furnish and install.

B. Wiring: Raceway, conductors and connections.

C. Exposed: Visible from occupied areas.

D. Install: To set in position and make fully operational.

E. Furnish: Purchase and deliver to the job site.

F. Required: As required by code, authority having jurisdiction or contract documents for the system and/or installation to be fully operational.

1.9 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.10 COORDINATION

A. Work of Other Trades: The Electrical Drawings do not show complete details of the building construction. Refer to the Architectural, Structural, Civil Landscape and Mechanical Drawings for those details which may affect the execution of this work. Specific locations of construction features shall be obtained from the reference drawings, field measurements, or the trade providing the material or equipment. No extra payments will be allowed for failure to obtain this information.

B. The Contractor will not be paid for work requiring reinstallation due to lack of coordination prior to installation such as removing and replacing, relocating, cutting, patching or finishing. Special attention is called to the following items and all conflicts shall be coordinated prior to installation:

1. Light switches will be located on the "strike" side of the door.
2. All electrical outlets, lighting fixtures and other electrical outlets and equipment are installed to avoid conflict with grilles, pipes, sprinkler heads, ducts and other mechanical equipment.
3. Electrical outlets, lighting fixtures and equipment are to be installed in proper relation to cabinets, counters, doors and other Architectural appurtenances.
4. Electrical characteristics (HP, KVA, voltage, phase, fusing, overload protection) of actual equipment furnished under other divisions being different from that shown on the electrical drawings.

C. Provide access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 STANDARD OF QUALITY

A. General: Whenever any material or equipment is specified by patent or proprietary name or by the name of the manufacturer, such specification shall establish the minimum standard of quality in that particular field of manufacture. The engineer shall be the sole and final judge as to quality and acceptability of substitutions, no exceptions.

2.2 PRODUCT LISTING AND LABELING

A. All electrical equipment shall be Underwriters Laboratories listed and labeled. Equipment in compliance with UL standards but not bearing their label is not acceptable. If the manufacturer cannot arrange for labeling of an assembled unit at the factory, the necessary inspection and acceptance by the testing facility shall be performed in the field at no additional cost to the Owner, and be acceptable to the authority having jurisdiction.

2.3 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
2.4 GROUT
A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION
3.1 GENERAL
A. All materials shall be new, free from defects and arrive at the job site in their original unopened container.

3.2 MATERIAL STORAGE
A. Make all necessary provisions for storing materials and equipment at site so as to insure the quality and fitness of the items to be incorporated in the work. Equipment shall be stored to prevent damage and corrosion.

3.3 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
A. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS
A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Extend sleeves installed in floors 2 inches above finished floor level.
G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
H. Seal space outside of sleeves with grout for penetrations of concrete and masonry pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.5 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 CUTTING AND PATCHING

A. Provide all cutting, demolition and patching required for the installation of the electrical work on this project. Patching shall be accomplished by utilizing the general construction trades normally providing materials and labor needed for restoration of floor, ceiling or walls. Penetrations through existing structural walls, ceiling or floor slabs shall be core drilled. Spillage from core drilling shall be contained by diking, vacuuming and covering with protective plastic sheeting as required. In no case shall structural members be penetrated without prior approval of the Architect. After installation of raceways, provide approved fire sealing materials to close spaces around raceways.

3.7 PAINTING

A. Touch up electrical equipment with factory finished surfaces as required using factory furnished paint. Coordinate field painting requirements with the Architect prior to final trim and cover installation. Do not paint screw heads, hinges, nameplates, hardware, etc. All surface-mounted raceways in finished areas will be painted as directed under the "Painting" division of the specifications.

3.8 CLEANING:

A. Promptly remove waste material and rubbish resulting from electrical work. Prior to energizing equipment, remove all chipping materials, construction dirt and debris, vacuum and wipe-down all internal areas. At completion of the project, clean all equipment and fixtures installed under this Contract.

3.9 CONSTRUCTION OBSERVATION AND FINAL ACCEPTANCE

A. Site Review: On-site meetings or reviews of construction by the Engineer shall not be construed as acceptance by these parties as related to quantities, rough-in locations, and compliance with code enforcing authorities.
B. Testing: The Contractor shall test all wiring and all electrical equipment to verify absence of grounds and short circuits and verify proper operation, rotation, and phase relationship. Contractor will be responsible for scheduling of tests and demonstrations at times mutually acceptable to the Owner. All equipment shall be demonstrated to operate in accordance with the requirements of this specification and the manufacturer's recommendations. Operate every device manually and automatically in accordance with its purpose. Tests shall be performed in the presence of the Owner or his designated representative. All instruments and personnel required to conduct the test shall be provided by the Contractor. Any test not witnessed by the Owner shall be waived by written document. All such documents must become the property of the Owner upon completion of construction.

3.10 INSTRUCTION FOR OWNER'S PERSONNEL

A. Scope: Following initial operation of all electrical equipment and prior to acceptance of the electrical work, conduct demonstrations of equipment operation and instruction periods for the Owner's representatives.

B. Instruction Periods: Shall include preliminary discussion and presentation of information from maintenance manuals with appropriate references to drawings, followed by tours of equipment spaces explaining maintenance requirements, access methods, servicing and maintenance procedures, settings and available system and equipment adjustments.

C. Contractor's representatives, in general, who conduct these instructions and demonstrations shall be qualified foremen or superintendents acquainted with this project and from the trade involved. For major equipment, the representative shall be the manufacturer's representatives with operating experience and substantial design experience on this project. Their qualifications shall be submitted to the Architect and Engineer before conducting the instruction period.

D. Minimum Duration of Instruction Periods:
   1. Electrical Distribution System: 4 hours.
   2. Low-Voltage Systems: 4 hours each unless noted otherwise.
   3. Refer to other section of the specification for additional testing requirements.

E. Scheduling of Instruction Periods: Provide notice of Contractor's readiness to conduct such instruction and demonstration periods to the Owner at least two weeks prior to each instruction period and reach agreement on the date of each instruction period.

F. Prepare a written statement of acceptance for the Owner's signature. The statement shall be substantially as follows:

"I (the Contractor), the associated factory representatives and the subcontractor, have thoroughly tested each of the following systems and have proved their normal operation to the Owner's representative and have instructed him in the operation and maintenance thereof."

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<thead>
<tr>
<th>Owner's System</th>
<th>Demonstrator</th>
<th>Representative</th>
<th>Date</th>
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<tbody>
<tr>
<td>Electrical Distribution &amp; Lighting</td>
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<td>Fire Alarm</td>
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<tr>
<td>Owner's Representative Date</td>
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<tr>
<td>Electrical Contractor Date</td>
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G. Send copies of this acceptance to the Architect and the Engineer and place one copy in each maintenance manual.

H. Completion of Work: When requesting final inspection, provide ten day notice. Submit written certifications that the work has been fully completed in strict accordance with the plans and specifications.

3.11 FINAL ACCEPTANCE

A. The Electrical Contractor shall submit to the Architect a Project Closeout Form (form at end of this section) properly filled out prior to the time final acceptance of the electrical work is requested. At this time also submit copies of final inspection certificates and receipts for loose materials (spare wiring devices, fuses, etc.) turned over to the Owner.

JOB CLOSEOUT FORM

1. Electrical Inspector's Final Acceptance:
   □ Copy of certificate attached.
   □ Transmitted previously to ____________________________
     Date

2. Fire Marshall's Final Acceptance of Fire Alarm System:
   □ Copy of certificate attached.
   □ Transmitted previously to ____________________________
     Date

3. As-Built Drawings:
   □ Attached
   □ Transmitted previously to ____________________________
     Date

4. O & M Manuals
   □ Attached
   □ Transmitted previously to ____________________________
     Date

5. Spare Parts:
   □ Delivered to ____________________________
     Date

Note: Provide separate letter of transmittal with itemized list of parts for each set of spare parts. Each transmittal must be signed by an authorized representative of the Owner.

6. As-Built Fire Alarm Shop Drawings:
   □ Attached
   □ Transmitted previously to ____________________________
     Date
7. As-Built Intercom/Clock Shop Drawings:
   - Attached
   - Transmitted previously to ____________________________ Date

8. As-Built Nurse Call Shop Drawings:
   - Attached
   - Transmitted previously to ____________________________ Date

9. As-Built Security Shop Drawings:
   - Attached
   - Transmitted previously to ____________________________ Date

10. As-Built CATV Shop Drawings:
    - Attached
    - Transmitted previously to ____________________________ Date

11. As-Built Public Address Shop Drawings
    - Attached
    - Transmitted previously to ____________________________ Date

12. Testing and Owner Training:
    - Copy of written certification attached.
    - Transmitted previously to ____________________________ Date

13. The work is complete in accordance with the contract documents and authorized changes except for the following (attach a separate sheet):

   Electrical Contractor Date

   General Contractor Date

END OF SECTION 26 05 00
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 DEFINITIONS

1.3 SUBMITTALS
A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.
B. Field quality-control test reports.

1.4 QUALITY ASSURANCE
A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.
B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency’s Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with IEEE C2 and NFPA 70.
1.5 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cables:
   b. General Cable Technologies Corporation.
   c. Okonite Company (The).
   d. Pirelli Cables & Systems NA.
   e. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:
   a. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
   b. RTE Components; Cooper Power Systems, Inc.
   c. Thomas & Betts Corporation/Elastimold.
   d. 3M; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 15 kV.
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.

G. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

H. Cable Jacket: Sunlight-resistant PVC.
2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.


2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 26 Section "Common Work Results for Electrical."

E. Install direct-buried cables on leveled and tamped bed of 3-inch-thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.
I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."

K. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

L. Identify cables according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 13
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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 DEFINITIONS
A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS
A. Product Data: For each type of product provided.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. General Cable Corporation.
B. Copper Conductors: Stranded, comply with NEMA WC 70.
C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.2 CONNECTORS AND SPLICES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. O-Z/Gedney; EGS Electrical Group LLC.
   2. 3M; Electrical Products Division.
   3. Tyco Electronics Corp.
B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Stranded Copper.
B. Branch Circuits: Stranded Copper.

3.2 CONDUCTOR INSULATION AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.
B. Feeders: Type THHN-THWN, single conductors in raceway.
C. Branch Circuits: Type THHN-THWN, MC cabling.
D. Minimum Conductor Size:
   1. Neutral: #10 AWG (#12 AWG minimum for dedicated neutrals and lighting circuits).
   2. Ground: #12 AWG.
   3. Phase Conductors (more than six in a raceway): #10 AWG.
   4. Phase Conductors (six or less in a raceway): #12 AWG.
   5. Branch Circuit Homeruns (longer than 75 feet): #10 AWG.
E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application.
F. Class 1 Control Circuits: Type THHN-THWN.
G. Class 2 Control Circuits: Type THHN-THWN.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
B. Provide insulated screw-on type connectors on lighting and receptacle branch circuit splices. Hydraulically-set compression lugs for terminations at panel and switchboard busses.
C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
D. Below-grade splices shall be made in handholes and shall be made watertight with epoxy resin type splicing kits. Scotchcast or equal.
E. Termination at busses and transformers to be made with hydraulically set compression lugs.
3.5 BRANCH CIRCUITS

A. Homeruns greater than 75 feet to first outlet shall be No. 10 AWG minimum. Make no splices in home runs. Wiring from separate raceway systems shall not be intermixed in common junction boxes. Wiring shown in separate raceway systems shall not be combined.

3.6 FEEDERS

A. Make no splices unless shown on the plans.

END OF SECTION 26 05 19
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL 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 SUBMITTALS
   A. Product Data: For each type of product provided.

PART 2 - PRODUCTS

2.1 CONDUCTORS
   A. Insulated Conductors: Stranded Copper wire or cable insulated for 600 V.
   B. Bare Copper Conductors: Stranded Copper wire or cable.
   C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches by 12 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS
   A. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES
   A. Ground Rods: Copper-clad, ¾ inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS
   A. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
      1. Bury at least 24 inches below grade.
      2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
   3. Connections to Structural Steel: Welded connectors.

3.2 BONDING

A. Insulated grounding bushings shall be installed to bond all feeder conduits to the switchboard ground bus or panel ground bus at both ends of feeder raceways. Insulated grounding bushings shall also be installed in all feeder pull boxes to bond all conduits together. Jumpers or bonds shall be copper and sized in accordance with Table 250-95 of the National Electrical Code.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

B. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
C. **Signal and Communication Equipment:** For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. **Service and Central Equipment Locations and Wiring Closets:** Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. **Terminal Cabinets:** Terminate grounding conductor on cabinet grounding terminal.

D. **Poles Supporting Outdoor Lighting Fixtures:** Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.5 **INSTALLATION**

A. **Grounding Conductors:** Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. **Ground Rods:** Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. **Bonding Straps and Jumpers:** Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. **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. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. **Water Meter Piping:** Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. **Grounding for Steel Building Structure:** Bond the steel columns to the foundation rebar.
1. Install tinned-copper conductor not less than No. 2/0 AWG for taps to building steel from foundation rebar.

F. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

END OF SECTION 26 05 26
SECTION 26 05 29
HANGERS AND BONDING FOR ELECTRICAL 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 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.3 SUBMITTALS
A. Product Data: Submit for each of the products being provided.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS
A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.; a division of Cooper Industries.
      b. Thomas & Betts Corporation.
      c. Unistrut; Tyco International, Ltd.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) Simpson Strong-Tie Co., Inc.; MasterSet Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Hilti Inc.
      3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.


PART 3 - EXECUTION

3.1 APPLICATION

A. Equipment Anchorage, Support and Bracing:

1. General: Provide complete seismic anchorage and bracing for all electrical raceways, fixtures and equipment required by the International Building code (IBC), Section 1621. Contractor shall retain and pay for the services of a licensed structural engineer to design the required anchorage and bracing to comply with the requirements of the IBC.

2. Conduit Crossing Structural Separation: Conduit that crosses structural or seismic separations between building units shall be installed with flexible connections, suitable to accommodate longitudinal and transverse displacements. Secure raceways each side of joint and provide minimum of 36 inches length flexible conduit between building units.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, RMC, and MC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits. Secure raceways and cables to these supports with two-bolt conduit clamps.
D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

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

B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

C. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section.

C. Anchor equipment to concrete base.

3.4 PAINTING

A. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 26 05 29
SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL 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 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. ENT: Electrical nonmetallic tubing.
C. EPDM: Ethylene-propylene-diene terpolymer rubber.
D. FMC: Flexible metal conduit.
E. IMC: Intermediate metal conduit.
F. LFMC: Liquidtight flexible metal conduit.
G. LFNC: Liquidtight flexible nonmetallic conduit.
H. NBR: Acrylonitrile-butadiene rubber.
I. RNC: Rigid nonmetallic conduit.

1.3 SUBMITTALS

A. Product Data: Submit for each type of product being provided.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   3. Electri-Flex Co.
B. Rigid Steel Conduit: ANSI C80.1.
C. EMT: ANSI C80.3.
D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

2. Fittings for EMT:
   a. Couplings: Threaded metallic type of the same material as the conduit.
   b. Locknuts: Steel up to 2 inches, malleable iron for 2-1/2 inches and larger.
   c. Bushings: Bakelite or plastic up to 2 inches, malleable iron with insulating collar for 2-1/2 inches and larger.
   d. Unions: Zinc plated malleable iron, 3 piece conduit coupling. Running threads are not acceptable.
   e. Electrical Metallic Tubing (EMT): 1-1/2" and smaller shall be set-screw type steel employing a split corrugated ring and tightening nut. Cast metal will not be accepted. Fittings 2" and larger shall be steel and may be setscrew type containing dual setscrews on each side of coupling.
   f. Rigid Nonmetallic Conduit: Slip-on, nonthreaded type of same material as conduit.
   g. Flexible Metallic Conduit: Steel, one- or two-screw clamp type.
   h. Liquidtight Flexible Metallic Conduit: Galvanized steel, compression type.

G. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.
   3. Electri-Flex Co.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard ivory enamel finish.
2.4 ONE-COMPARTMENT SURFACE METAL RACEWAYS

A. The raceway shall consist of a base and cover section; factory assembled and designed to accommodate pulling conductors through the raceway. The base section shall have a nominal thickness of .040" and be manufactured of zinc plated or galvanized steel. The cover section shall have a nominal thickness of 0.40" and be painted with a baked enamel ivory finish which is capable of being over-painted in the field if required. The overall dimensions of the raceway shall be 3/4" wide x 21/32" high. Wiremold V700 series.

2.5 TWO-COMPARTMENT SURFACE METAL RACEWAYS

A. The raceway shall consist of a base section having a nominal thickness of .050". The cover section shall have a nominal thickness of 0.40". The base and cover sections shall be manufactured of galvanized steel and painted with a baked enamel ivory finish which is capable of being over-painted in the field if required. The overall dimensions of the raceway shall be 4-3/4" wide x 1-3/4" high. Wiremold V-4000 series.

1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. Retain one of two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Thomas & Betts Corporation.

2.6 POWER POLES

A. Power pole raceways shall be used in all island applications requiring data and power. Basis of design is Legrand Tele-Power Pole system. Size raceway to have base fasten to the surface of the island and the top fastened to the ceiling. Heights will vary in clearstory. Provide extenders to match varying ceiling heights. Coordinate finish with architect prior to ordering.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Legrand Wiremold
   b. Approved equivalent.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Division of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Hoffman.
   5. RACO; a Hubbell Company.

B. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

C. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.8 FLOOR BOXES

A. Concrete Floors: Recessed steel floor boxes with all accessories to mount the receptacles and data outlets shown on the drawings. Floor box shall be flush with the top of the finished floor. Cover shall be suitable for the floor covering in the room. Manufacturer T&B 667SC series with UL listed "scrubwater" rated cover. Coat boxes mounted on grade with bitumastic coal tar epoxy sealant, Carboline 300M series, or equal.

B. Wooden Floors: Recessed steel floor boxes with all accessories to mount the receptacles and data outlets shown on the drawings. Floor box shall be flush with the top of the finished floor. Cover shall be suitable for the floor covering in the room. Manufacturer T&B AFM-6 series with UL listed "scrubwater" rated cover.

2.9 MULTI-SYSTEM WALL BOX

A. Recessed wall box with module faceplates to accommodate receptacles and special systems devices as shown on the drawings. Provide barrier to divide box for high and low-voltage wiring. Provide four-gang box for up to three devices. Provide six-gang box for four or more devices. Hubbell Multi-Connect HBLWSCSX series wall box with wall flange and faceplates to accommodate devices shown on the drawings. Flange and faceplates to be white.

B. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

2.10 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. See Editing Instruction No. 3 in the Evaluations. Verify with manufacturers that units of types specified are available in sizes required. Indicate the size of each enclosure on Drawings, and use a symbol or other notation to differentiate between handholes and pull boxes.

B. Description: Comply with SCTE 77.
   1. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
   2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   4. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE." as indicated for each service.
   5. Retain first subparagraph below if conduit will enter enclosure through the side. Otherwise, entry will be made through an open bottom or through side openings cut in the field, as specified in Part 3. Coordinate with Drawings.
   6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
C. Retain one or more of three paragraphs and associated subparagraphs below to select enclosure type(s) for areas not subject to traffic by vehicles. Coordinate selection with Part 3 "Raceway Application" Article. For enclosures with cover options, verify that selected cover is available with load rating specified in Part 3 "Raceway Application" Article, subparagraph "Application of Handholes and Boxes for Underground Wiring."

D. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Carson Industries LLC.
      b. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

E. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of fiberglass.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Carson Industries LLC.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Above Ground: Rigid steel conduit.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Above Ground: NEMA 250, Type 3R.
   6. Application of Handholes and Boxes for Underground Wiring:
      a. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
      b. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: MC cable.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: Rigid steel conduit.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size:
1. Exterior – 1" - inch trade size
2. Interior – ½" - inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

1. Planning: The layout of all raceways shall be carefully planned by the Contractor to ensure an installation which is neatly done and workmanlike. Any work showing improper care in planning will be ordered removed by the Architect, and shall be replaced in a neat and proper manner, without any additional cost to the Owner.

2. Concealment: All raceways shall be concealed in finished areas unless approved otherwise by the Architect. Where existing wall surfaces are inaccessible, surface metal raceways for these exceptions may be provided when approved by the Architect. Raceways may be surface mounted in unfinished equipment spaces such as mechanical rooms, electrical rooms, elevator machine rooms, and attic spaces.

3. Cutting and Bending: Raceways shall have smooth interior, ends cut square and reamed. Bends shall be carefully made to avoid injuring or flattening raceways.

4. Exposed Raceways: Install exposed raceways as high as possible, above ductwork, parallel or at right angles to building lines.

5. Raceways shall not be installed in concrete slab or wall construction when passing through an expansion or earthquake joint.

6. Raceways shall be installed in furred or suspended ceiling spaces with a minimum of 36 inches of flexible conduit crossing the expansion or earthquake joints. Secure raceways each side of joint.

7. Routing: All raceways shall be installed parallel or at right angles to the building construction unless prohibited by a physical obstruction. This applies to all exposed raceways as well as all raceways above suspended ceiling.

8. Conduit Location: Conduit shall not be run under heavy equipment, footings or other structural elements that might adversely affect the integrity of the raceways system or building footing. All raceways installed above suspended ceilings must be kept a minimum of 6" clear above top of ceiling system.

9. Floor Slabs and Columns: Conduits installed in structural floor slabs shall be coordinated with structural steel and shall be routed to provide a maximum concrete cover. In general, conduit shall not be installed in structural columns, unless special permission is granted by the Architect.

10. Pullboxes with Covers: Shall be provided as shown on the drawings or as required by Code. All pullboxes shall be located so as to be accessible.

11. Flexible Conduit: Shall be used only for lighting fixture pigtails in accessible ceilings, flush-mounted speaker pigtails in accessible ceilings, sound control, motor connections and at building expansion joints as specified. Any other proposed use of flexible conduit must be approved by the Architect's representative.

12. Concrete Encased Conduit: All feeder and service conduits in ground, under or exterior to the building, shall be encased in concrete a minimum of 3 inches in thickness.

13. Sealing: All conduit, sleeves, blockouts or openings around raceway and cable systems that penetrate building walls, floors and ceilings shall be sealed. Sealing materials shall
be fire-rated, non-combustible type, specifically designed for this type of installation and shall be approved by the authority having jurisdiction.

14. Penetrations: Raceways which pass through building roof, exterior walls of building above or below grade and floor slabs on grade shall be sealed on the interior side of the building using non-hardening sealing compound after all conductors have been installed in the raceway. Sealing material shall be specifically designed for electrical wiring systems.

15. Conduit Passing Through Building Roof: Provide a 4 lb. lead plumbing vent flashing with a counterflashing attached above using a galvanized steel clamp.

16. Conduit Penetrating Membranes: All conduits penetrating walls or slabs with membranes shall be installed with approved membrane clamping devices in order to provide necessary seal.

17. Exterior Walls: Conduits passing through exterior walls below grade and/or bridging an area which was previously excavated and backfilled shall be rigidly supported by a structurally reinforced concrete duct bank spanning between the building wall and a bearing surface on undisturbed earth.

18. Cleaning of Raceways: The interior and exterior of all conduits and other raceways shall be thoroughly cleaned of all material. All conduits shall be capped or plugged after installation to ensure that they remain clean.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degrees bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Use PVC-coated RGS for elbows rising through concrete.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer’s written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a
blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 degrees F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 degrees F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 degrees F temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 degrees F temperature change.
   d. Attics: 135 degrees F temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

N. Flexible Conduit Connections: Use maximum of 8 ft. flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

P. Set metal floor boxes level and flush with finished floor surface.

3.3 RACEWAYS AND CABLE INSTALLATION PATHWAYS FOR LOW VOLTAGE SYSTEMS

A. Installation of Raceways/Pathways for low-voltage systems shall be in accordance with the applicable portions of ANSI/TIA/EIA-569-A, Commercial Building Standards for Telecommunications Pathways and Spaces.

B. Conduits above lay-in ceilings: Do not install cables in conduits that are supported from the ceiling suspension system. All conduits shall be supported independently of the ceiling support system.

C. Conduit fill shall not exceed 40 percent.

D. Bend radii for conduits shall meet the following requirements:

1. If the conduit has an internal diameter of 2 inches or less, the bend radius must be at least 6 times the internal conduit diameter.
2. If the conduit has an internal diameter of more than 2 inches, the bend radius must be at least 10 times the internal conduit diameter.
E. There shall be no more than two 90 degrees bends between pull points in telecommunications conduit, without derating of the conduit capacity. For each additional 90 degrees bend, the conduit capacity shall be derated by 15 percent. Increase conduit size as required to meet conduit fill requirements of this section with the derated capacity accounted for. Or, provide pull boxes to eliminate 90 degrees bends as necessary to avoid having to derate conduit. Offsets shall be considered as equivalent to a 90 degrees bend. Pull boxes added to conduit runs as of result of this requirement shall be in accordance with this section.

F. Conduits which are terminated at cable trays shall be supported from structure with a maximum distance of 24 inches from the tray. Conduits terminated at cable trays shall be bonded to the tray.


H. Use of flexible conduit for telecommunications shall be kept to a minimum and shall be at the discretion of the Contracting Agency. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used.

I. Conduits entering the MDF room through the floor shall be terminated 4 inches above finished floor. Conduits entering the MDF room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate greater than 12 inches above the cable tray or distribution frame.

J. Conduits and cut-out openings between floors shall be sealed with firestopping material which is removable and reusable, to accommodate adds, moves and changes in the cabling system.

K. All conduits used for routing of low voltage cables shall have bushings at all stubouts.

3.4 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
   5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.5 INSTALLATION OF UNDERGROUND HANDBOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33
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 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

PART 2 - PRODUCTS

2.1 RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:
   2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable. Uses permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
1. Compounded for permanent direct-burial service.
2. Embedded continuous metallic strip or core.
3. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.5 EQUIPMENT NAMEPLATES

A. General: Nameplates shall be engraved in 1/16 inches thick phenolic letters, a minimum of 3/16 inches high with white letters on black background for all equipment and signal and communications systems except fire alarm. Provide white letters on a red background for fire alarm.

B. Mounting: Nameplates shall be attached with a minimum of two 6-32 roundhead screws, lockwasher and nuts in exterior locations and contact-type permanent self-adhesive in indoor locations.

2.6 SWITCHBOARDS AND DISTRIBUTION PANELBOARDS

A. General: Provide nameplate which identifies the switchboard/distribution panel and the source panel. (Example: Distribution Panel No. 1/Fed from Main Service Switchboard - Bkr. No. 1.)

B. Overcurrent Devices: Provide nameplate at each overcurrent device that identifies the device number and the load served. (Example: Bkr. No. 1/Panel A.)

2.7 PANELBOARDS

A. Provide nameplate on the front of the panel room which identifies the panel. (Example: Panel A.) Provide a nameplate concealed behind the door which identifies the panel, and the source panel. (Example: Panel A, Fed from Distribution Panel 1-Bkr. No. 2).

2.8 TRANSFORMER

A. Provide nameplate identifying the transformer, the source panel and the panel served. (Example: Transformer T1/Fed from Distribution Panel 1, Bkr. No. 1/Serves Panel A)

2.9 DISCONNECT SWITCHES AND MOTOR STARTERS

A. Provide nameplate which identifies the source panel, load served and the fuse size where applicable. (Example: Panel A-1, 3, 5/Exhaust Fan No. 1/10 amp, RK1 fuses.)
2.10 Junction and Pull Box Identification

A. Mark the cover of all junction boxes and pull boxes to identify the system, circuits, or feeders contained within the box. Use red color for fire alarm. Circuits shall be identified by panelboards and specific circuit numbers contained within the junction box. Refer to specification Sections 16130 and 16700.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus -40 to plus +185 degrees Fahrenheit.

B. Fasteners for Labels and Signs: Stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

C. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   - Power transfer switches.
   - Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

2. Equipment to Be Labeled:
   a. Access doors and panels for concealed electrical items.
   b. Electrical switchgear and switchboards.
   c. Transformers.
   d. Emergency system boxes and enclosures.
   e. Motor-control centers.
   f. Disconnect switches.
   g. Enclosed circuit breakers.
   h. Motor starters.
   i. Push-button stations.
   j. Power transfer equipment.
   k. Contactors.
   l. Remote-controlled switches, dimmer modules, and control devices.
   m. Battery inverter units.
   n. Battery racks.
   o. Power-generating units.
   p. Voice and data cable terminal equipment.
   q. Master clock and program equipment.
   r. Intercommunication and call system master and staff stations.
   s. Television/audio components, racks, and controls.
   t. Fire-alarm control panel and annunciators.
   u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
v. Monitoring and control equipment.
w. Uninterruptible power supply equipment.
x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600V and Less: Use the colors listed below for ungrounded conductors.
   1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-Volt Circuits:
      a. Phase A: Black
      b. Phase B: Red
      c. Phase C: Blue
      d. Neutral: White
      e. Ground: Green
      f. Travelers: Yellow
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown
      b. Phase B: Orange
      c. Phase C: Yellow
      d. Neutral: Gray
      e. Ground: Green
      f. Travelers: Lavender
   4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
I. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 26 05 53
SECTION 26 09 23
LIGHTING CONTROL DEVICES

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 DEFINITIONS

A. LED: Light-emitting diode.
B. PIR: Passive infrared.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Refer to Section 017823 Operation and Maintenance Data for additional requirements.

1.4 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 DISTRIBUTED LIGHTING CONTROL SYSTEM

A. The work covered in this section is subject to all of the requirements in the General Conditions of the specifications. Contractor shall coordinate all of the work in this section with all the trades covered in the other sections of the specification to provide a complete and operative system.

B. Extent of lighting control system work is indicated by drawings, and by the requirements of this subsection. It is defined to include low voltage lighting control panels, switch inputs, and wiring. Type of lighting control equipment and wiring specified in this section include Distributed, Low Voltage Lighting Control Network.

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring.

D. Quality Assurance:
1. **UL & ULC Approvals:** The control panels shall be tested and listed under the UL 916 Energy Management Equipment standard and CSA C22.2 #205 by a nationally recognized testing laboratory.

2. **NEC Compliance:** The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

3. **NEMA Compliance:** The control system shall comply with all applicable portions of the NEMA standards regarding the types of electrical equipment enclosures.

4. **Component Pre-testing:** All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

5. **System Checkout:** A factory trained technician or factory authorized personnel or contractor shall functionally test the control system and verify performance after installation.

6. **Manufacturer:** Manufacturer shall have a minimum of 10 years experience in control systems. Manufacturer shall provide off the shelf control products from its inventory. Control systems that require custom assembly and sizing shall not be acceptable.

**E. Acceptable manufacturers shall be:**

1. Greengate/Cooper Controls
2. Sensor Switch
3. Approved

**F. Submittals:**

1. **Product Data:** Submit manufacturer’s data on lighting control system and components.
2. **Shop Drawings:** Submit drawings of lighting control panel and accessories including, but not necessarily limited to the low voltage relay panels, power wiring, and switch inputs.

**G. Material and Components – System Description:**

1. The lighting control system shall be a distributed lighting control system, with distributed intelligence. Relays controlling interior lighting loads for a room or space shall be local to that room or space. The behavior (programming) for a room or space shall also reside locally to that room or space. Systems that control all spaces via a central processor are not acceptable. Although the lighting control system and intelligence shall be distributed, the various elements must still be able to communicate via a common lighting control network.

2. All elements of an area’s lighting control shall be coordinated through that area’s portion of the distributed control system and shall communicate via the system’s lighting control network. This includes relay control, occupancy detection, 0-10V dimming, photosensor input, user switch stations, and time sweep control. Standalone occupancy sensors and photosensors that directly wire to 0-10V ballasts are not acceptable.

3. Relay control of exterior loads and some interior areas such as corridors may be achieved through a central relay panel. These instances shall be indicated on the engineering drawings and shall be the only exception to distributed control.

4. The system shall conform to and shall be able to achieve all elements of the lighting control behavior called out in this specification and on the engineering drawings. Any system that cannot meet the behavioral specification is not acceptable.

5. The lighting control system shall have the following general capabilities but must also be able to achieve the specific behavioral requirements of the project.
   a. **Time Of Day Scheduling** - Ability to turn relays on/off based upon the time of day, date, and/or whether that day is a holiday.
   b. **Holidays** - Ability to specify up to 32 holiday dates.
   c. **Warn Off** - Ability to flash lights prior to a timed event turning them off and giving the user the ability override the off event.
   d. **Preset Levels** - Pre-programmed switch patterns and/or dimming.
e. Astronomical Clock - Longitude and latitude input with sunset-sunrise offsets to customize outdoor lighting.

f. Auto Daylight Savings - Adjust automatically adjusts the clock at the appropriate dates, selectable.

g. Analog Inputs - For 0-10V input from photosensor, etc.

6. The system shall permit lighting to be overridden On for after hours use or cleaning. The controller shall provide optional switch timer assignments or timed overrides. The override choices for various relays shall provide special event occurrences and the controller shall return to the programmed state after the override event. Also, the system shall provide priority and masking choices to customize the functions of switch inputs, thereby enabling switches to function differently at different times of the day to meet special facility operational requirements.

7. It shall be possible to program all aspects of the lighting control system from a personal computer using either browser-based or pc-based software. It shall also be possible to program and maintain the system remotely via internet access should the end user desire this capability.

8. Priorities and/or Masking shall be assigned to inputs, telephone override, and global commands to insure building integrity. Priorities enable or disable the inputs based on user actuation of overrides. Masks shall permit: On only, Off only and On & Off control for intelligent after hours utilization of the controlled facility based on Time-Of-Day scheduling in the controller.

9. The lighting control system shall log all control events. The controller shall monitor all relay actuations, switch inputs and user intervention.

H. Hardware Features

1. Diagnostic Aids: Each control panel shall incorporate diagnostic aids for confirmation of proper operation, or in case of failure these aids shall guide the individual in rapid troubleshooting of the system.

2. Memory Back-up: The system shall utilize a memory back-up device that is system integrated and shall be non-serviceable. The data in Flash Memory shall be protected against power interruptions for the life of the product. The power interrupt protection circuit shall be entirely maintenance-free.

3. Lockable Enclosure: In systems where an enclosure is used the enclosure shall be a lockable NEMA class 1 enclosure. The enclosure shall be manufactured out of 1/16” steel and shall provide pre-punched knockouts for efficient installation.

I. Manufacturer’s Responsibility to the Customer

1. Manufacturer will supply one TCP/IP connection is for the system. Instructions on how to install and configure the ethernet interface shall be supplied by the manufacturer.

J. Customer’s Responsibility

1. The customer will provide an IP address, Subnet Mask, Default Gateway, and a TCP Port Number for should they desire ethernet access to the system. The customer shall provide a qualified Network Administrator to properly configure the device(s). Any future changes to the customers TCP/IP network that affect the operation of the device(s) will be the customer’s responsibility. The customer will be responsible for any Internet and Virus Protection Security measures. This includes, but is not limited to, Firewall, Proxy Servers, and Virus Protection Software. The customer will provide a qualified Technician to inter-tie the lighting control system to the building’s LAN.
2.2 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Watt Stopper
   2. Approved

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
   1. Contact Rating: 30-A inductive or resistive, 240-V ac.
   2. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
   3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
   4. Astronomic Time: All channels.
   5. Battery Backup: For schedules and time clock.

2.3 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Watt Stopper
   2. Sensor Switch
   3. Approved

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
   1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   4. Mounting:
      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
   5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
   6. Bypass Switch: Override the on function in case of sensor failure.
   7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.
C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

2.4 LIGHTING CONTACTORS

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

1. Square-D
2. Approved

B. Description: Electrically operated and electrically held, combination type with fusible switch non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings or scheduled, matching the NEMA type specified for the enclosure.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
3.2 DISTRIBUTED LIGHTING CONTROL SYSTEM INSTALLATION

A. Equipment Installation and Documentation

1. Installation: The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits and override wiring.

2. Documentation: The contractor shall provide accurate “as-built” drawings to the owner for correct programming and proper maintenance of the control system. The “as-buils” shall indicate the load controlled by each relay and the relay panel number.

3. Operation and Service Manuals: The factory shall supply all operation and service manuals.

4. Commissioning of the lighting control system shall completed by a factory trained and authorized representative.

B. Product Support and Service

1. Factory Support: Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

C. System Delivery and Acceptance

1. Delivery: The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:
   a. All system equipment shall operate in accordance with specification and industrial standard procedures.
   b. An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
   c. Demonstration of program integrity during normal operation and pursuant to a power outage.
   d. Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

D. Warranty

1. Warranty: Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on all relay cards. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

3.3 WIRING INSTALLATION


B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer’s written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

C. Installed Spare Devices: Provide the following spare occupancy sensors including associated raceways and wiring:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Technology</td>
<td>8</td>
</tr>
<tr>
<td>Ultrasonic</td>
<td>8</td>
</tr>
</tbody>
</table>

END OF SECTION 26 09 23
SECTION 26 12 00
MEDIUM-VOLTAGE TRANSFORMERS

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 types of transformers with medium-voltage primaries:
   1. Pad-mounted, liquid-filled transformers.

1.3 SUBMITTALS
A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum
   clearances, installed devices and features, location of each field connection, and performance
   for each type and size of transformer indicated.
B. Shop Drawings: Diagram power signal and control wiring.
C. Operation and Maintenance Data: For transformer and accessories to include in emergency,
   operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
A. Product Options: Drawings indicate size, profiles, and dimensional requirements of
   transformers and are based on the specific system indicated. Refer to Division 01 Section
   "Product Requirements."
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70,
   Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for
   intended use.
C. Comply with IEEE C2.
E. Comply with NFPA 70.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.6 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
   1. Exposure to significant solar radiation.
   2. Altitudes above 3300 feet.
   3. Exposure to fumes, vapors, or dust.
   4. Exposure to explosive environments.
   5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
   6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
   7. Exposure to excessively high or low temperatures.
   8. Unusual transportation or storage conditions.
  10. Unusual space limitations.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Industries; Cooper Power Systems Division.
   2. Square D; Schneider Electric.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS


B. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47.
   2. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.

H. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
   1. Bushing-Well Inserts: One for each high-voltage bushing well.
   2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
   3. Parking Stands: One for each high-voltage bushing well.
   4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section “Identification for Electrical Systems.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install transformers on concrete bases.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
   2. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
   3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
   4. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

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

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

END OF SECTION 26 12 00
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 DEFINITIONS

A. EMI: Electromagnetic interference.

B. RFI: Radio-frequency interference.

C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. UL listing for series rating of installed devices.
      e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

   2. Wiring Diagrams: Power, signal, and control wiring.

C. Panelboard Schedules: For installation in panelboards.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Architect no fewer than two days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Architect's written permission.
E. Refer to Section 01 78 23 Operation and Maintenance Data for additional requirements for the operations and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Cutler-Hammer
   c. Siemens Energy & Automation, Inc.
   d. Square D.

2. Transient Voltage Suppression Panelboards:
   a. Cutler-Hammer
   c. Siemens Energy & Automation, Inc.
   d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures:

1. Rated for environmental conditions at installed location.
   a. Outdoor Locations: NEMA 250, Type 3R.
   c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2. Hinged Front Cover: Door within door.
3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

B. Phase and Ground Buses:

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Compression type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

D. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING
A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS
A. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.
B. Main Overcurrent Protective Devices: Circuit breaker.
C. Branch Overcurrent Protective Devices:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
   2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 TRANSIENT VOLTAGE SUPPRESSION PANELBOARDS
A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
B. Main Overcurrent Devices: Thermal-magnetic circuit breaker.
C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.
D. Bus: Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
   1. Minimum Single-Impulse Current Ratings:
      a. Line to Neutral: 100,000 A.
      b. Line to Ground: 100,000 A.
      c. Neutral to Ground: 50,000 A.
   2. Protection modes shall be as follows:
      a. Line to neutral.
      b. Line to ground.
      c. Neutral to ground.
   3. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
4. Maximum Category C Combination Wave Clamping Voltage: 600 V, line to neutral and line to ground on 120/208 V systems.
5. Maximum UL 1449 Clamping Levels: 400 V, line to neutral and line to ground on 120/208 V, 800 V, line to neutral and line to ground on 277/480 V systems.
6. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with interrupting capacity to meet available fault currents.

2.8 SPACE FOR FUTURE CIRCUIT BREAKERS OR FUSED SWITCHES

A. Provide as indicated on the drawings. Spaces shall be completely equipped for the future addition of a circuit breaker or fused switch, including all mounting hardware and buss connections. Unless otherwise noted, spaces shall be sized to accommodate the following future circuit breaker or fused switch:

<table>
<thead>
<tr>
<th>Panel Rating</th>
<th>Minimum Space Ampacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Amps</td>
<td>70 Amps</td>
</tr>
<tr>
<td>225 Amps</td>
<td>125 Amps</td>
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<tr>
<td>400 Amps</td>
<td>225 Amps</td>
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<tr>
<td>600 Amps</td>
<td>400 Amps</td>
</tr>
<tr>
<td>800 Amps</td>
<td>600 Amps</td>
</tr>
<tr>
<td>1200 Amps</td>
<td>800 Amps</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

END OF SECTION 26 24 16
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 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
   D. RFI: Radio-frequency interference.
   E. UTP: Unshielded twisted pair.

1.3 SUBMITTALS
   A. Product Data: For each type of product provided.

1.4 COORDINATION
   A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers’ Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
      1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
      2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
      4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).
      d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; CR 5253IG.
      b. Leviton; 5362-IG.
      c. Pass & Seymour; IG6300.
   2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125V, 20A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; TR8300.
      b. Hubbell; HBL8300SG.
      c. Leviton; 8300-SGG.
      d. Pass & Seymour; 63H.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125V, 20A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; GF20.
      b. Pass & Seymour; 2084.

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277V, 20A:
   1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221PL for 120V and 277V.
   b. Hubbell; HPL1221PL for 120V and 277V.
   c. Leviton; 1221-PLR for 120V, 1221-7PLR for 277V.
   d. Pass & Seymour; PS20AC1-PLR for 120V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277V, 20A:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; 2221L.
   b. Hubbell; HBL1221L.
   c. Leviton; 1221-2L.
   d. Pass & Seymour; PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.5 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
   1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.6 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.
   3. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail, or replace all damaged conductors.
      b. Straighten conductors that remain and remove corrosion and foreign matter.
      c. Pig tailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:
   1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation: Retain subparagraph below if the position of the ground pin is important for consistency. Trade and professional literature is inconsistent in recommending benefits of either orientation.

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.

2. Install unshared neutral conductors on line and load side of dimmers according to manufacturers’ device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 SPARE DEVICES

A. Provide the following spare devices:

<table>
<thead>
<tr>
<th>Device</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated Duplex Receptacle</td>
<td>8</td>
</tr>
</tbody>
</table>

B. Spare devices shall include 75’ of conduit, faceplates, all required wire, cutting, patching and panting for a complete installation. Location of these units to be determined by the Owner’s representative at the site. The Contractor shall assume that these devices will be installed after all other work is completed. Installation shall occur on an accelerated (night/weekend) schedule. Unused devices are to be turned over to the Owner.

END OF SECTION 26 27 26
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
   1. Fusible switches.
   2. Nonfusible switches.

1.3 DEFINITIONS
A. GD: General duty.
B. HD: Heavy duty.

1.4 SUBMITTALS
A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   4. UL listing for series rating of installed devices.
   5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.
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. Comply with NFPA 70.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:
   2. Siemens Energy & Automation, Inc.
   3. Square D/Group Schneider.

B. Fusible Switch, 600A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch, 600A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:
   2. Siemens Energy & Automation, Inc.
   3. Square D/Group Schneider.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
   1. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

C. Molded-Case Circuit-Breaker Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical style with compression lug kits suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

D. Molded-Case Switches: Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

E. Molded-Case Switch Accessories:
   1. Lugs: Mechanical style, with compression lug kits suitable for number, size, trip ratings, and material of conductors.
   2. Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

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

3.2 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
3.3 INSTALLATION

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Identification for Electrical Systems."

3.5 ADJUSTING

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

END OF SECTION 26 28 16
SECTION 26 29 13
ENCLOSED CONTROLLERS

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 SUBMITTALS

A. Product Data: Provide for each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

C. Operation and Maintenance Data: Provide for enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

E. Refer to Section 017823 Operation and Maintenance Data for additional requirements.

1.3 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Electrical Company; GE Industrial Systems.
   2. Siemens/Furnas Controls.
   3. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
   1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
   1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
   2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 20 30 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
   1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.
2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.


2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

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

3.2 INSTALLATION

A. Control Equipment at Walls: Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. Controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.3 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
3.4 IDENTIFICATION
   A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.5 CONTROL WIRING INSTALLATION
   A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   B. Bundle, train, and support wiring in enclosures.
   C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
      1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
      2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS
   A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
   B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 DEMONSTRATION
   A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 29 13
SECTION 26 51 00
INTERIOR LIGHTING

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 DEFINITIONS
A. BF: Ballast factor.
B. CRI: Color-rendering index.
C. HID: High-intensity discharge.
D. LER: Luminaire efficacy rating.
E. Luminaire: Complete lighting luminaire, including ballast housing if provided.

1.3 SUBMITTALS
A. Product Data: Submit for each type of lighting luminaire, arranged in order of luminaire designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting luminaire including dimensions.
   2. Emergency lighting units including battery and charger.
   5. Specification Sheets for life, output, and energy-efficiency data for lamps.
   6. Photometric data, in IESNA format, based on laboratory tests of each lighting luminaire type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting luminaire as applied in this Project.
      a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by the manufacturer.
      b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.
B. Shop Drawings: Show details of nonstandard or custom lighting luminaires. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
C. Warranties: Special warranties specified in this Section.
D. Refer to Section 01 78 23 Operation and Maintenance Data for additional requirements for the operations and maintenance manuals.
1.4 COORDINATION

A. Coordinate layout and installation of lighting luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Ten (10) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven (7) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five (5) years from date of Substantial Completion.

2. Warranty Period for Electromagnetic Ballasts: Three (3) years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LIGHTING LUMINAIRES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.

B. Incandescent Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. HID Luminaires: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

E. Metal Parts: Free of burrs and sharp corners and edges.
F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metalized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

J. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic-interference as required by MIL-STD-461E. Fabricate lighting luminaires with one filter on each ballast indicated to require a filter.

2.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
   1. Sound Rating: A.
   2. Total Harmonic Distortion Rating: Less than 10 percent.
   3. Transient Voltage Protection: IEEE C62.41, Category A or better.
   4. Operating Frequency: 42 kHz or higher.
   5. Lamp Current Crest Factor: 1.7 or less.
   6. BF: 0.85 or higher unless otherwise specified.
   7. Power Factor: 0.98 or higher.
   8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Electronic Programmed-Start Ballasts for T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:
   1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher, unless otherwise specified.
   9. Power Factor: 0.98 or higher.
C. Ballasts for Low-Temperature Environments:
   1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F
      starting and operating temperature with indicated lamp types.

D. Ballasts for Dimmer-Controlled Lighting Luminaires: Electronic type.
   1. Dimming Range: 100 to one percent of rated lamp lumens or as specified.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and
      lamp type indicated.

2.3 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic programmed rapid-start type, complying with ANSI C 82.11, designed
   for type and quantity of lamps indicated. Ballast shall be designed for full light output unless
   dimmer or bi-level control is indicated:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: A.
   4. Total Harmonic Distortion Rating: Less than 20 percent.
   5. Transient Voltage Protection: IEEE C62.41, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. BF: 0.95 or higher, unless otherwise specified.
   9. Power Factor: 0.98 or higher.
   10. Interference: Comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on
        electromagnetic and radio-frequency interference for non-consumer equipment.

B. Ballasts for Dimmer-Controlled Lighting Luminaires: Electronic type.
   1. Dimming Range: 100 to 5 percent of rated lamp lumens or as specified.
   2. Ballast Input Watts: Can be reduced to 20 percent of normal.
   3. Compatibility: Certified by manufacturer for use with specific dimming control system and
      lamp type indicated.

2.4 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting
   luminaire body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate 1 ballast for 1 or 2 fluorescent lamp(s) continuously at an
      output of 1100 lumens each or as specified. Connect unswitched circuit to battery-inverter
      unit and switched circuit to luminaire ballast.
   2. Test Push Button and Indicator Light: Visible and accessible without opening luminaire or
      entering ceiling space.
      a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and
         demonstrates unit operability.
      b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle
         charge; bright glow indicates charging at end of discharge cycle.
   3. Battery: Sealed, maintenance-free, nickel-cadmium type or as specified.
   4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer
      relay.
5. **Integral Self-Test**: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

### 2.5 BALLASTS FOR HID LAMPS

**A. Electromagnetic Ballast for Metal-Halide Lamps**: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. **Ballast Circuit**: Constant-wattage autotransformer or regulating high-power-factor type.
2. **Minimum Starting Temperature**: Minus 22 deg F for single-lamp ballasts.
3. **Normal Ambient Operating Temperature**: 104 deg F.
4. **Open-circuit operation that will not reduce average life**.
5. **Low-Noise Ballasts**: Manufacturers’ standard epoxy-encapsulated models designed to minimize audible luminaire noise.

### 2.6 EXIT SIGNS

**A. Description**: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

**B. Internally Lighted Signs**:

1. **Lamps for AC Operation**: LEDs, 70,000 hours minimum rated lamp life.
2. **Self-Powered Exit Signs (Battery Type)**: Integral automatic charger in a self-contained power pack.
   a. **Battery**: Sealed, maintenance-free, nickel-cadmium type.
   b. **Charger**: Fully automatic, solid-state type with sealed transfer relay.
   c. **Operation**: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. **Test Push Button**: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. **LED Indicator Light**: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   f. **Integral Self-Test**: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

### 2.7 EMERGENCY LIGHTING UNITS

**A. Description**: Self-contained units complying with UL 924.

1. **Battery**: Sealed, maintenance-free, lead-acid type.
2. **Charger**: Fully automatic, solid-state type with sealed transfer relay.
3. **Operation**: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. **Test Push Button**: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is announced by an integral audible alarm and flashing red LED.

2.8 FLUORESCENT LAMPS – Minimum Requirements:

A. Low-Mercury Lamps: Comply with EPA’s toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000 K, and average rated life of 20,000 hours, unless otherwise indicated.

E. T5HO rapid-start, high-output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

F. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
   1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
   2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
   6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

2.9 HID LAMPS – Minimum Requirements:

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65 and color temperature 4000 K.

2.10 LIGHTING LUMINAIRE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All luminaires and accessories shall be installed per manufacturer’s installation sheets. Manufacturer’s installation sheets shall be on site during installation period and shall be saved and included in the O & M manual.

B. Lighting luminaires: Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.

C. Support for Lighting Luminaires in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each luminaire. Locate not more than 6 inches from lighting luminaire corners.
   2. Support Clips: Fasten to lighting luminaires and to ceiling grid members at or near each luminaire corner with clips that are UL listed for the application.
   3. Luminaires of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support luminaires independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting luminaire. Wire or rod shall have breaking strength of the weight of luminaire at a safety factor of 3.

D. Suspended Lighting Luminaire Support:
   1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
   2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis unless otherwise specified, including one at each end.

E. Adjust aimable lighting luminaires to provide required light intensities.

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 SPARE QUANTITIES

A. Provide the following spare quantities:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each lamp type identified on luminaire schedule</td>
<td>10%</td>
</tr>
<tr>
<td>Each ballast identified on luminaire schedule</td>
<td>10%</td>
</tr>
</tbody>
</table>

B. Include 100 feet of conduit and wiring. Unused quantities are to be turned over to the Owner.

END OF SECTION 26 51 00
SECTION 26 56 00
EXTERIOR LIGHTING

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. Exterior luminaries with lamps and ballasts.
   2. Luminaire-mounted photoelectric relays.
   3. Poles and accessories.

B. Related Sections include the following:
   1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

A. CRI: Color-rendering index.

B. HID: High-intensity discharge.

C. Luminaire: Complete lighting luminaire, including ballast housing if provided.

D. Pole: Luminaire support structure, including tower used for large area illumination.

E. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4.

B. Ice Load: Load of 3 lbs/sq. ft. (143.6 Pa), applied as stated in AASHTO LTS-4.

C. Wind Load: Pressure of wind on pole and luminaire, calculated and applied as stated in AASHTO LTS-4.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
   a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   b. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
11. Anchor bolts for poles.

B. Shop Drawings:
   1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
   2. Wiring Diagrams: Power and control wiring.

C. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

E. Refer to Section 01 78 23 Operation and Maintenance Data for additional requirements for the operations and maintenance manuals.

1.6 QUALITY ASSURANCE

A. 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.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
B. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion; furnish replacement lamps and fuses that fail within the second 12 months from date of Substantial Completion.
5. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer’s standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by a NRTL acceptable to authorities having jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match the finish process and color of pole or support materials.

2.2 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
   1. Relay with locking-type receptacle shall comply with NEMA C136.10.
   2. Adjustable window slide for adjusting on-off set points.

2.3 FLUORESCENT BALLASTS AND LAMPS

A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures 0 deg F and higher.

B. Ballast Characteristics:
   1. Power Factor: 90 percent, minimum.
   2. Sound Rating: A.
   3. Total Harmonic Distortion Rating: Less than 10 percent.
   6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:
   1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
   2. Minimum Starting Temperature: Minus 22 deg F.
   3. Normal Ambient Operating Temperature: 104 deg F.
   4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

B. Auxiliary, Instant-On, Quartz System: Factory-installed feature automatically switches quartz lamp on when luminaire is initially energized and when momentary power outages occur.
System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

2.5 HID LAMPS

A. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

B. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-4.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers’ mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; 1-piece construction up to 40 feet in height with access handhole in pole wall.
   1. Shape: Round, straight unless otherwise specified
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbracing.
   1. Adapter fitting welded to pole and bracket; then bolted together with stainless-steel bolts.
   2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
   3. Match pole material and finish.

D. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
E. Steps: Fixed steel, with nonslip treads, positioned for 15-inch vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet above finished grade.

F. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

G. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

H. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources.

3.2 POLE INSTALLATION

A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches.
   3. Trees: 15 feet.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."
   1. Pre-cast concrete pole foundations are acceptable – Manufacturer to be Wilbert Pre-Cast.

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
   3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.
E. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch below top of concrete slab.

F. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole, unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

END OF SECTION 26 56 00
SECTION 27 10 00
BUILDING TELECOMMUNICATIONS CABLELING SYSTEM

PART 1 – GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)
ASTM D 709  (2001; R 2007) Laminated Thermosetting Materials

Building Industry Consulting Service International (BICSI) NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling

ELECTRONIC COMPONENTS ASSOCIATION (ECA)
ECA EIA/ECA 310  (2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

INTERNATIONAL CODE COUNCIL (ICC)

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)
ICEA S-83-596  (2001) Optical Fiber Premises Distribution Cable
ICEA S-90-661  (2008) Category 3, 5, & Se Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems Technical Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
ANSI/NEMA WC 66  (2001; Errata 2003) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs
NEMA WC 63.1  (2005) Twisted Pair Premise Voice and Data Communications Cables

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70  (2011; Errata 2 2012) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA J-STD-607  (2002a) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

TIA-455-21  (1988a; R 2002) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices


TIA-568-C.3  (2008; Corrections 2008) Optical Fiber Cabling Components Standard

TIA-569-B  (2004b; Add 1 2009) Commercial Building Standard for Telecommunications Pathways and Spaces

TIA/EIA-598  (2005c) Optical Fiber Cable Color Coding

TIA/EIA-604-2  (2004b) FOCIS 2 Fiber Optic Connector Intermateability Standard

TIA/EIA-606-A  (2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure

U.S. FEDERAL Communications COMMISSION (FCC)

FCC Part 68  Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UNDERWRITERS LABORATORIES (UL)

UL 1286  (2008; Reprint Jan 2010) Office Furnishings

UL 1666  (2007) Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

UL 444  (2008; Reprint Apr 2010) Communications Cables
UL 467  (2007) Grounding and Bonding Equipment
UL 50   (2007) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 514C (1996; Reprint Nov 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 910  (1998) Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

U.S. DEPARTMENT OF AGRICULTURE (USDA)
RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)

U.S. ARMY (DA)
I3A (Feb 2010) Technical Criteria for the Installation Information Infrastructure Architecture

1.2 RELATED REQUIREMENTS

A. Section 26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT, apply to this section with additions and modifications specified herein.


C. DEFINITIONS

1. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569-B, TIA/EIA-606-A and IEEE 100 and I3A herein.

D. Telecommunications Room (TR)

1. An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

E. Entrance Facility (EF) (Telecommunications)

1. An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.
F. Entrance Room (ER) (Telecommunications)

1. A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

G. Open Cable

1. Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

H. Open Office

1. A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

I. Pathway

1. A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.3 SYSTEM DESCRIPTION

A. The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the telecommunications work area to the telecommunications room at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the telecommunications equipment room to telecommunications rooms as required. The backbone system shall be wired in a star topology with the telecommunications equipment room at the center or hub of the star. The interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00, TELECOMMUNICATIONS OUTSIDE PLANT. Provide telecommunications pathway systems referenced herein as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

1.4 SUBMITTALS

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

1. SD-02 Shop Drawings Telecommunications drawings; G
   a. Telecommunications Space Drawings; G
   b. In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS. Telecommunications
shop drawings shall be performed and stamped by an RCDD in accordance with I3A Technical Criteria.

2. SD-03 Product Data
   a. Telecommunications cabling (backbone and horizontal); G Patch panels; G
   b. Telecommunications outlet/connector assemblies; G
   c. Equipment support frame; G Connector blocks; G
   d. Spare Parts; G
   e. Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

3. SD-06 Test Reports
   a. Telecommunications cabling testing; G, NEC
   b. Test reports shall be provided in accordance with I3A Technical Criteria, TIA/EIA-568-C.1, and TIA/EIA-568-C.2.

4. SD-07 Certificates
   a. Telecommunications Contractor Qualifications; G Key Personnel Qualifications; G
   b. Manufacturer Qualifications; G
   c. Test plan; G

5. SD-09 Manufacturer's Field Reports Factory reel tests; G
6. SD-10 Operation and Maintenance Data
   a. Telecommunications cabling and pathway system Data Package 5; G

7. SD-11 Closeout Submittals
   a. Record Documentation; G

1.5 QUALITY ASSURANCE

A. Building telecommunications infrastructure and cabling shall be installed in accordance with NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling. Workmanship shall conform to the practices described in the BICSI Information Transport System Installation Methods Manual (ITSIMM) and the I3A TC.

B. Shop Drawings
   1. Shop drawings, telecommunication drawings and telecommunication space drawings shall be prepared, stamped and signed by a registered communications distribution designer with a minimum of five years experience.
C. In exception to Section 01 33 00, SUBMITTAL PROCEDURES, submit shop drawings a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. Include wiring diagrams and installation details and elevations of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1. Telecommunications Drawings
   a. Provide drawings in accordance with TIA/EIA-606-A. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA/EIA-606-A and I3A Technical Criteria. The drawings shall provide details required to demonstrate that distribution system properly support connectivity from the telecommunications equipment room and telecommunications rooms to the telecommunications work area outlets. The following drawings shall be provided as a minimum:
      1) TI - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways.
      2) Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.
      3) T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID’S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.
      4) T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

2. Telecommunications Space Drawings
   a. Provide T3 drawings in accordance with TIA/EIA-606-A and I3A Technical Criteria that include telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of TI or T2 drawings.

3. Telecommunications Qualifications
a. Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

b. Telecommunications Contractor

1) The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

c. Key Personnel

1) Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

2) Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level.

   a) Submit documentation of current BICSI certification for each of the key personnel.

   b) In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 5 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally,
the referenced project description including system size and construction complexity.

c) Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer's Representative.

d) Note that only the key personnel approved by the Contracting Officer's Representative in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer's Representative.

e) Building telecommunications infrastructure and cabling shall be installed in accordance with NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling. Workmanship shall conform to the practices described in the BICSI Information Transport System Installation Methods Manual (ITSIMM) and the I3A TC.

d. Minimum Manufacturer Qualifications

1) Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

D. Test Plan

1. Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and optical fiber components and accessories 60 days prior to the proposed test date. Include procedures for certification, validation, and testing. Provide evidence of current equipment calibration and test technician qualifications. A Registered Communications Distribution Designer (RCDD) shall review, stamp and approve both the test plan and test report.

E. Regulatory Requirements

1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and I3A Technical Criteria unless more stringent requirements are specified or indicated.

F. Standard Products

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to
bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

a. Alternative Qualifications
   1) Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

b. Material and Equipment Manufacturing Date
   1) Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 DELIVERY AND STORAGE
A. Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.7 ENVIRONMENTAL REQUIREMENTS
A. Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.8 WARRANTY
A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.9 MAINTENANCE
A. Operation and Maintenance Manuals
   1. Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system. Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package S, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION.

B. Record Documentation
1. Provide TS drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606-A. TS drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. TS drawings shall be provided on electronic media using Windows based computer cable management software.

2. A licensed copy of the cable management software including documentation, shall be provided. Provide the following TS drawing documentation as a minimum:
   a. Cables - A record of installed cable shall be provided in accordance with TIA/EIA-606-A. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA/EIA-606-A. Include manufacture date of cable with submittal.
   b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA/EIA-606-A. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606-A.

1.10 SPARE PARTS

A. In addition to the requirements of Section 01 78 23, OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

PART 2 – PRODUCTS

2.1 COMPONENTS

A. UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

A. Provide telecommunications pathways in accordance with TIA-569-B, I3A Technical Criteria and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide system furniture pathways in accordance with UL 1286.
2.3 TELECOMMUNICATIONS CABLING

A. Cabling shall be UL listed for the application and shall comply with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by I3A Technical Criteria, JBLM NEC Labeling Scheme, TIA/EIA-606-A and UL 969. Ship cable bearing manufacture date for UTP in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

1. Backbone Cabling

a. Backbone Copper: ICEA S-90-661, TIA-568-C.1, TrA-568-C.2, NEMA WC 63.1 ANSI/NEMA WC 66 and UL 444, copper backbone cable shall be solid conductor, 24 AWG, 100 ohm, 200-pair UTP (Unshielded twisted pair), formed into 25 pair binder groups covered with a gray thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 3.3 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70. Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70. Color coding shall comply with industry standards for 25 pair cables.

1) Backbone Optical Fiber: Provide in accordance with ICEA S-83-596, TIA-568-C.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches.

2) TIA-492CAAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cable. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber plenum cable (OFNP), and nonconductive optical fiber riser cable (OFNR) rated cable in accordance with NFPA 70 and UL 910. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with TIA/EIA-598.

B. Horizontal Cabling

1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.

2. Horizontal Copper

a. Provide horizontal copper cable in accordance with TIA-568-C.2, UL 444, NEMA WC 63.1 ANSI/NEMA WC 66, ICEA S-90-661 UTP (unshielded twisted pair), 100 ohm. Provide four each individually twisted pair, 24 AWG conductors, Category 6, with a blue thermoplastic jacket for data and a white thermoplastic jacket for telephone. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 3.3 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70. Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70. Cables in conduit installed inside or below slab-
on-grade concrete floors shall be UL listed for wet locations. CAT6 data cables shall be terminated on rack-mounted modular patch panels. CAT6 voice cables shall be terminated on wall mounted 110-type connector blocks.

b. Horizontal Optical Fiber
c. Provide optical fiber horizontal cable in accordance with ICEA S-83-596, TIA-568-C.3 and TIA-492CAAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cables. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 40 inches. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber riser cable (OFNR) or nonconductive optical fiber plenum cable (OFNP) in accordance with NFPA 70. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

C. Work Area Cabling

1. Work Area Copper
   a. Provide work area copper cable in accordance with TIA-568-C.2, with a blue, thermoplastic jacket for data, a white thermoplastic jacket for telephone, a green thermoplastic jacket for DDC/metering, and a black thermoplastic jacket for specialty equipment (projectors, interconnects, any off-network equipment requiring ethernet cabling).

2.4 TELECOMMUNICATIONS SPACES

A. Provide connecting hardware and termination equipment in the telecommunications entrance facility to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with TIA/EIA-606-A.

B. Backboards

1. Provide void-free, A/C interior grade plywood 3/4 inch thick 4 by 8 feet. Backboards shall be fire rated and stamped on the A-side. Backboards shall be provided on all walls in the telecommunication spaces. Do not paint backboards or cover the fire stamp on the backboard.

C. Equipment Support Frame: Provide in accordance with ECA EIA/ECA 310, UL 50 and seismically rated or braced in accordance with the ICC IBC.

1. Network equipment frames, floor mounted seismic two-post modular type, 16 gauge steel construction, minimum, treated to resist corrosion. Provide rack with 6-inch wide double-sided vertical cable management channels and horizontal jumper management channels suitable for 4U high modules, top and bottom cable troughs, and grounding lug. Rack shall be compatible with 19 inches panel mounting.

2. Cabinets, freestanding modular type, 16 gauge steel construction, minimum, treated to resist corrosion and seismically rated in accordance with the ICC IBC. Cabinet shall have removable and lockable side panels, front and rear doors, and have adjustable feet for leveling. Cabinet shall be vented in the roof and rear door. Cabinet shall have cable access in the roof and base and be compatible with 19 inches panel mounting. Provide cabinet with grounding bar, roof mounted 550 CFM fan with filter and a surge
protected power strip with 6 duplex 20 amp receptacles. All cabinets shall be keyed alike.

3. Equipment cabinets, wall-mounted modular type, 16 gauge steel construction, minimum, treated to resist corrosion and seismically rated in accordance with the ICC IBC. Cabinet shall have have lockable front door, louvered side panels, 250 CFM roof mounted fan, ground lug, and top and bottom cable access. Cabinet shall be compatible with 19 inches panel mounting. All cabinets shall be keyed alike. A fan kit and duplex AC outlet shall be provided within the cabinet.

D. Connector Blocks

1. Provide insulation displacement connector (IDC) Type 110 for Category 6 systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

E. Cable Guides

1. Provide cable guides specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on equipment racks, cabinets and telecommunications backboards. Mount cable guides with screws, or nuts and lockwashers.

F. Patch Panels

1. Provide 24- and 48-port patch panels with ports for the number of horizontal and backbone cables terminated on the panel plus 25 percent spare. Provide pre-connectorized optical fiber and copper patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with TIA-568-C.3. Patch cords shall meet minimum performance requirements specified in TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3 for cables, cable length and hardware specified.

2. Modular to 110 Block Patch Panel

a. Provide in accordance with TIA-568-C.1 and TIA-568-2. Panels shall be third party verified and shall comply with EIA/TIA Category 6 requirements. Panel shall be constructed of 0.09 inches minimum aluminum and shall be cabinet or rack mounted and compatible with an ECA EIA/ECA 310 19 inches equipment cabinet or rack. Panel shall provide 48 non-keyed, 8-pin modular ports, wired to T568B. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

3. Fiber Optic Patch Panel

a. Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of 18 gauge steel or 11 gauge aluminum minimum and shall be cabinet or rack mounted and compatible with ECA EIA/ECA 310 19 inches equipment rack. Each panel shall provide 12 single-mode adapters as ST in accordance with TIA/EIA-604-2 with metallic alignment sleeves. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.
G. Optical Fiber Distribution Panel

1. Rack mounted optical fiber distribution panel (OFDP) shall be constructed in accordance with ECA EIA/ECA 310 utilizing 16 gauge steel or 11 gauge aluminum minimum. Panel shall be divided into two sections, distribution and user. Distribution section shall have strain relief, routing guides, splice tray and shall be lockable, user section shall have a cover for patch cord protection. Each panel shall provide 12 single-mode pigtails and adapters. Provide adapters as ST with metallic alignment sleeves. Provide dust covers for adapters. Provide patch cords as specified in the paragraph PATCH PANELS.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

A. Outlet/Connector Copper

1. Outlet/connectors shall comply with FCC Part 68TIA-568-C.1, and TIA-568-C.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568-C.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired T568A. UTP outlet/connectors shall comply with TIA-568-C.2 for 200 mating cycles. UTP outlet/connectors installed in outdoor or marine environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.

B. Optical Fiber Adapters

1. Provide optical fiber adapters suitable for ST in accordance with TIA/EIA-604-2 with metallic alignment sleeves as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for 500 mating cycles.

C. Optical Fiber Connectors

1. Provide in accordance with TIA-455-21. Optical fiber connectors shall be SC in accordance with TIA/EIA-604-2 with metallic ferrule, epoxyless crimp style compatible with 8/125 single-mode fiber. The connectors shall provide a maximum attenuation of 0.3 dB@ 1310 nm with less than a 0.2 dB change after 500 mating cycles.

D. Cover Plates

1. Telecommunications cover plates shall comply with UL 514C, and TIA-568-C.1, design constructed of high impact thermoplastic material ivory in color to match color of receptacle/switch cover plates specified in Section 26 20 00

2.6 INTERIOR DISTRIBUTION SYSTEMS.

A. Provide labeling in accordance with the paragraph LABELING in this section.

2.7 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Provide MUTOA(s) where indicated in accordance with TIA-568-C.1.
2.8 TERMINAL CABINETS

A. Construct of zinc-coated sheet steel, 36 by 24 by 6 inches deep or as indicated. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors. Boxes shall be provided with 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA/EIA-606-A.

2.9 GROUNDING AND BONDING PRODUCTS

A. Provide in accordance with UL 467, TIA J-STD-607, I3A and NFPA 70. Components shall be identified as required by TIA/EIA-606-A. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEM.

2.10 FIRESTOPPING MATERIAL

A. Provide as specified in Section 07 84 00, FIRESTOPPING.

2.11 MANUFACTURER’S NAMEPLATE

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

2.12 LABELING

A. Field Fabricated Nameplates

1. ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, rack, relay, switch, and device; as specified in TIA/EIA-606-A and the JBLM NEC labeling scheme. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inches thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

B. Thermal Transfer Labels

1. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component. All labels shall be printed or generated by a mechanical device.
2.13 TESTS, INSPECTIONS, AND VERIFICATIONS

A. Factory Reel Tests

1. Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568-C.1, TIA-568-C.3, and TIA-526-7 for single mode optical fiber cables.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Building telecommunications infrastructure and cabling shall be installed in accordance with NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling. Workmanship shall conform to the practices described in the BICSI Information Transport Systems Installation Methods Manual (ITSIMM). Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with the I3A, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569-B, I3A, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

B. Cabling

1. Install Category 6 UTP, and optical fiber telecommunications cabling system as detailed in the I3A, TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet. Do not exceed manufacturers’ cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

2. Open Cable

a. Install horizontal CAT6 and fiber optic cables in EMT from the cable backbone distribution system to each outlet. Conduit shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of conduits parallel to power conductors shall be avoided, if possible; a
minimum separation of 12 inches shall be maintained when such placement cannot be avoided.

1) Plenum cable shall be used where open cables are routed through plenum areas. Plenum cables shall comply with flammability plenum requirements of NFPA 70.

3. Backbone Cable
   a. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.
   b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

4. Horizontal Cabling
   a. Install horizontal cabling as indicated on drawings between the telecommunications room and the telecommunications outlet assemblies at workstations. Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide cable slack in the form of a figure eight (not a service loop) on each end of the cable, 10 feet in the telecommunications room or telecommunications enclosure, and 12 inches at the work area outlet. Horizontal cable shall be installed in accordance with TIA-568-C.1 and TIA-568-C.2. Do not exceed cable bend radius and pulling tensions recommended by the manufacturer. Plenum cable shall be provided where open cables are routed through plenum spaces. Plenum cables shall comply with flammability requirements of NFPA 70.

C. Pathway Installations
   1. Provide in accordance with TIA-569-B and NFPA 70. Provide building pathway as specified in Section 26 20 00, INTERIOR DISTRIBUTION SYSTEMS.

D. Service Entrance Conduit, Underground
   1. Provide service entrance underground as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

E. Cable Tray Installation
   1. Install cable tray as specified in Section 27 05 28.36 40 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS. Only CMP and OFNP type cable shall be installed in a plenum.

F. Work Area Outlets
   1. Terminations
a. Terminate UTP cable in accordance with TIA-568-C.1, TIA-568-C.2 and wiring configuration as specified.

2. Cover Plates
   a. As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3. Cables
   a. Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

4. Pull Cords
   a. Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

5. Multi-User Telecommunications Outlet Assembly (MUTOA)
   a. Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs shall be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA shall be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA/EIA-606-A, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

G. Telecommunications Space Termination
   1. Install termination hardware required for Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.
   2. Connector Blocks
      a. Connector blocks shall be wall mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569-B.
   3. Patch Panels
      a. Patch panels shall be mounted in equipment racks with sufficient ports to accommodate the installed cable plant plus 25 percent spares.
      b. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel as recommended by the manufacturer to prevent movement of the cable.
      c. Fiber Optic Patch Panel. Fiber optic cable loop shall be provided as recommended by the manufacturer. The outer jacket of each cable entering a patch panel shall
be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

4. Equipment Support Frames Install in accordance with TIA-569-B:

   a. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer’s recommendations and to meet seismic requirements. Expansion or bonded anchors shall comply with ASTM E 488 and be fitted with 2 nuts each

   b. Cabinets, freestanding modular type installed to meet seismic requirements. When cabinets are connected together, remove adjoining side panels for cable routing between cabinets. Mount rack mounted fan in roof of cabinet.

   c. Cabinets, wall-mounted modular type. Mount cabinet to plywood backboard in accordance with manufacturer’s recommendations and to meet seismic requirements. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

H. Electrical Penetrations

   1. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00, FIRESTOPPING.

I. Grounding and Bonding

   1. Provide in accordance with TIA J-STD-607, NFPA 70, I3A, RUS 1755.200, and as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEMS. Bond exposed noncurrent-carrying metallic parts of telephone equipment, cable sheaths, cable splices and terminals. Incoming cable shields shall not be bonded across the splice to the cable stubs.

3.2 LABELING

A. Labels

   1. Provide labeling in accordance with TIA/EIA-606-A and JBLM NEC Labeling Scheme. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using thermal ink transfer processor laser printer. See Attachment 27 15 00-A for JBLM NEC Telecommunications Labeling System standards.

B. Cable

   1. Cables shall be labeled using black-on-white labels on both ends with identifiers in accordance with TIA/EIA-606-A. Install cable tags in the cable vault so that they are clearly visible without disturbing other cabling.

C. Termination Hardware

   1. Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA/EIA-606-A.
3.3 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FIELD FABRICATED NAMEPLATE MOUNTING

A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.5 TESTING

A. Telecommunications Cabling Testing

1. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3.

2. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

B. Inspection: Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for correct pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

1. Verification Tests

a. UTP backbone copper cabling shall be tested using TIA-568-C.2 and RUS Bull 1753F-201 for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connected.

b. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source. Perform Method B, Optical Time Domain Reflectometer (OTDR), testing to isolate optical disparities only in fiber links that fail Method A testing.

2. Performance Tests

a. Perform testing for each outlet and MUTOA as follows:

1) Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA-568-C.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

2) Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3.

3. Final Verification Tests
a. Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

1) Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

2) Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

END OF SECTION 27 15 00

Appendix A:
Joint Base Lewis McChord
Telecommunications Labeling System that Conforms to the Existing NEC/DOIM Standard I3A-2.7.2

The information in this document will identify all NEC/DOIM requirements regarding labeling of Inside Plant UTP Horizontal CAT6 Cable, Inside Plant Copper Riser/Tie (Backbone) Cable, Inside Plant Fiber Optic Riser/Tie (Backbone) Cable, Equipment Rack, Data/Voice Termination Devices and User Faceplates along with Outside Plant Fiber Optic/Copper Backbone Cable and copper Protected Entrance Terminals (PET/BET).

Purpose
This Standard provides a uniform administration approach that is independent of applications, which may change several times throughout the life of the telecommunications infrastructure. It establishes guidelines for consultants, contractors, designers, and installers, involved in the design and installation of telecommunications infrastructures. Use of this Standard is intended to increase the value of the system owner’s investment in the infrastructure by reducing the labor expense of maintaining the system, by extending the useful economic life of the system, and by providing effective service to users.

This Standard does not replace any code, either partially or wholly. The reader shall consult the Authority Having Jurisdiction concerning applicable codes that may impact the use of this Standard.

There are four classes of administration Standard identified within the TIA/EIA 606-A to accommodate diverse degrees of complexity present in telecommunications infrastructure. The most relevant factors in determining the minimum class of administration are the size and complexity of the infrastructure. The number of telecommunications room (TR), common telecommunications room (CTR), and entrance facility (EF) spaces, are all indicator of complexity. Classes are scalable and allow expansion without requiring changes to existing identifiers or labels. This documents specification are for the combination of class 1 and class 2 requirements only as identified in
the TIA/EIA 606-A Sec. 4.2.1 and 4.2.2 for identifiers, records, and labeling as required by the NEC/DOIM.

The administration system as described in the TIA/EIA 606-A shall provide a method to find the record associated with any specific identifier. Examples of report formats are provided in the TIA/EIA 606-A annex A.

The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component. All labels shall be printed or generated by a mechanical device.

The Horizontal Link Identifier is to identify a specific cable to a specific location i.e. Cable ID. Each horizontal cable will be labeled at both ends within six inches of the termination point. The following information identifies the labeling format for that cables specific function.

**Horizontal Link Identifier Data CAT6**
To be consistent for all new projects the data horizontal link identifier will follow this format fnn-rbn-pn.dnn
the \( f \) represents the floor level in the building for buildings up to nine floors. The \( nn \) in the format will represent room numbers up to 99. The \( rb \) in the format will represent the equipment rack or bay number. The \( pn.dnn \) portion of the format the \( pn \) will represent the RJ45 patch panel shelf number and the \( dnn \) will represent the Date port number. **Note:** The \( d \) of \( dnn \) portion of the identifier is mandatory to identify a Data circuit.
fnn-rbn-pn.dnn
room-rack-panel.port
101-02-01.D24

**Horizontal Link Identifier Voice CAT6**
To be consistent for all new projects the voice horizontal link identifier will follow this format fnn-wbn-vnn
the \( f \) represents the floor level in the building for buildings up to nine floors. The \( nn \) in the format will represent room numbers up to 99. The \( wbn \) in the format will represent a wall mounted block or group of blocks (110 or 66). The \( vnn \) will represent the Voice port number. **Note:** The \( v \) of \( vnn \) portion of the identifier is mandatory to identify a Voice circuit and the \( w \) in the \( wbn \) portion of the identifier is also mandatory to identify the termination device is wall mounted.
fnn-wbn-vnn
room-wallblock-port
101-W01-V24

**Horizontal Link Identifier Voice A B Split**
To be consistent for all new projects the voice horizontal link identifier will follow this format fnn-wbn-vnna/b
the \( f \) represents the floor level in the building for buildings up to nine floors. The \( nn \) in the format will represent room numbers up to 99. The \( wbn \) in the format will represent a wall mounted block or group of blocks (110 or 66). The \( vnn \) will represent the Voice port number. **Note:** The \( v \) of \( vnn \) portion of the identifier is mandatory to identify a Voice circuit and the \( w \) in the \( wbn \) portion of the identifier is also mandatory to identify the termination device is wall mounted. Wall mounted block will always be grouped as one shelf
fnn-wbn-vnn
room-wallblock-port
101-W01-V24A
fnn-wbn-vnn
room-wallblock-port
101-W01-V24B

Horizontal Link Identifier for buildings with underground floors such as basements a B will take the place
of the numeric f identifier portions as follows:

fnn-rbn-pn.dnn
room-rack-panel.port
101-02-01.D24

fnn-wbn-vnn
room-wallblock-port
B01-W01-V24

Copper Riser/Tie (Backbone) Cable
This cable is used to tie two telecommunication rooms (TR) together. This cable is generally used for
voice communication and therefore is termination to wall mounted block or group of blocks (110 or 66).
This cable will be labeled with two labels at each end within six inches of the termination device. Using
the following format the label closet to the termination device within that TR will provide information for
that end of the cable. The second label will indentify the remote termination location.
To be consistent for all new projects the voice riser/tie identifier will follow this format fnn-wbn-nn.nn the f
represents the floor level in the building for buildings up to nine floors. The nn in the format will represent
room numbers up to 99. The wbn in the format will represent a wall mounted block or group of blocks
(110 or 66). The nn.nn will represent a range of port termination numbers. Note: The wbn portion of the
identifier is also mandatory to identify the range of device is wall
fnn-wbn-vnn
room-wallblock-range of termination
101-W01-1.50

Inside Plant Fiber Optic Riser/Tie (Backbone) Cable
This cable is used to tie two telecommunication rooms (TR) together. This cable is specifically used for
data communication and therefore is termination to rack mounted fiber optic patch panel shelves. This
cable will be labeled with two labels at each end within six inches of the termination device. Using
the following format the label closet to the termination device within that TR will provide information for that
end of the cable. The second label will indentify the remote termination location.
To be consistent for all new projects the fiber riser/tie identifier will follow this format fnn-rbn-pn.nn the f
represents the floor level in the building for buildings up to nine floors. The nn in the format will represent
room numbers up to 99. The rbn in the format will represent the equipment rack or bay number. The
pn.nn portion of the format the pn will represent the fiber optic patch panel shelf number and the nn will
represent the total pair count.

fnn-rbn-pn.nn-nn
room-rack-panel.range of termination
101-02-01.01-24

In addition to cable link identifiers equipment racks, data/voice termination
devices and user faceplates are also required to be labeled. Equipment racks are
to be identified numerically starting at 001 and continue consecutively for each
rack added to the TR. Below are examples of how labeling that the NEC/DOIM
requires for termination devices and user faceplates.
Examples of labeling

Panel designator

Port designator

Cable management

Panel designator

Port designator
Patch panels consecutively numbered 1-96

Cable management

Port designator
Panel designator
Wall mounted 66 block or group of blocks
With a group of eight terminations terminating
a 4-pair horizontal cable split to an A and B configuration.
Wall mounted 66 block or group of blocks
With a group of eight terminations terminating
a 4-pair horizontal cable to a CAT6 configuration.
Wall mounted 110 block or group of blocks
With a group of eight terminations terminating
a 4-pair horizontal cable split to a CAT6 configuration.
Wall mounted 110 block or group of blocks
With a group of eight terminations terminating
a 4-pair horizontal cable split to an A and B configuration.
User Outlet Data Jack
with a 4pair horizontal cable to an RJ45 CAT6 configuration
and terminated to one or more RJ45 patch panels numbered consecutively

User Outlet Voice Jack
with a 4pair horizontal cable to an RJ45 CAT6 configuration
User Outlet Data Jack
with a 4pair horizontal cable to an RJ45 CAT6 configuration
and terminated to more than one RJ45 patch panel numbered 1-48
and repeated for each numbered RJ45 patch panel shelf.

User Outlet Voice Jack
with a 4pair horizontal cable spilt to two phone jacks
Required reports
The installation contractor is required to provide reports identifying all components of the telecommunications infrastructure for each project. The installation contractor is also required to provide test reports for all components of the telecommunications infrastructure (Cables and Termination Devices).
There are several forms of software that combine identification information along with the cable test results allowing one record to be submitted to the NEC/DOIM for each type of cable tested. A test report may consist of an individual record, a group of records. Regardless, all test report must be compiled per the I3A, TIA-526-7, TIA-568-B.1 and TIA-568-B.3 and must contain the following for each cable tested.

1. Date of test
2. Project Number/Site Name
3. Description of the test equipment used—Model and S/N
4. Date of latest calibration of test equipment used.
5. Test personnel.
6. Test procedure and method used.
7. Cable type - Description of the elements of the cable plant that are to be measured.
8. Loss measurement results with location (To and Form), path, and wavelength identification.
9. Location of work area outlet -------Room #/RSU/Vault#
10. Outlet connector type----------------ST/SC
11. Cable length-----------------------------Feet
12. Cross-connect hardware type-----Fiber Patch Panel
13. Service record of link-------------------Installed and tested by ABC Cabling, 1/12/01; re-terminated at Splice Case 4/22/01 due to broken fiber and retested, by technician Billy Sykes

Additional information that must be submitted with the test reports:
1. Calibration certificates
2. Qualifications of test personnel
3. Cable Reel test results

**Drawings shall be posted in each TR showing all identified and actual elements of the telecommunications infrastructure.**

Outside Plant Copper Protected Entrance Terminals (PET/BET).
All PETs shall be stenciled with the terminal number and cable count. The telecommunications terminal is composed of a physical interface corresponding to the signal coupling device of the originating switched telephone system.

RSU-Bldg#.CA-4001. 001-100
a-b.CA-UUU.d
Outside Plant Fiber Optic/Copper Backbone Cable
Cable ID/cable tags shall be installed at all termination points (terminals) and splices. In maintenance holes, all new and existing cables that are part of the project shall be tagged/re-tagged between the splice and the wall and on both sides of a splice loop or maintenance loop. When a cable is re-homed to a new node, DCO, cross-connect box, etc., all existing cable tags and terminal labels on the re-homed cable shall be re-tagged and re-labeled to reflect the new information. One tag is required for a copper cable pull-through, and two tags are required for an FOC pull-through. Labels in maintenance holes and hand holes shall be machine-produced on a durable material suitable for the environment. Handwritten labels are not acceptable.

Outside Plant Copper Backbone Cable
HUT 3130
P9-24PF
CA-4001, 1-900
Bldg. 3372

Unique identifiers for each cable will include an indicator of the originating and terminating building locations of the cable.
To identify a copper cable, size + type and cable ID+ count are needed. Cable sizes shall be identified with an abbreviation. For example, a 1,200-pair cable shall be identified as “P12-24PF.” The “24” represents the American Wire Gauge (AWG). All cables with fewer than 25 pairs shall include an “X.” (Refer to the examples.) Note: Only Copper cable is identified with a “CA” prefix.

To identify a 900-pair, 24AWG copper cable:
P9-24PF = size and type
CA-4001, 1-900 = cable number and count

Outside Fiber Optic Backbone Cable
RSU12570
F4001, 1-12
12SM
Bldg. 1293

Unique identifiers for each cable will include an indicator of the originating and terminating building locations of the cable.
To identify fiber optic cable, use the cable ID + count and then size + type.
F4001, 1-12 = cable number and strand count
12 SM = type of cable

When an existing cable is rehomed to a new node, the new node identifier should apply to all of the rehomed cable, to include laterals. Therefore, all the existing cable tags, the labels on the building terminals, and associated cable records shall be changed to reflect the new information. This is to be construed as a requirement to place labels on cables that do not have existing tags. An example of this is when there is only one cable in the maintenance hole, and the identifier and count were verified in the previous maintenance hole.
Outside Plant Fiber Optic/Copper Backbone Cable Containing Copper Clear Capped (CC) Pairs and Fiber optic Dead and Dark (DD) Strands;

Clear Capped (CC)
Additional information shall be provided on all cable tags where a large count cable (Copper) steps up or down by not splicing through all pairs.

For instance an 1800pr copper backbone cable originates at a Comm. Hut and a smaller 100pr cable is spliced into it on pairs 001 to 100 the remainder of the count 101 to 1800 shall be considered Clear Capped or CC.

This also holds true for the reverse. For instance only 50pr of the 100pr cable is spliced into to the same 1800pr copper backbone cable that un-spliced 50pr shall also considered Clear Capped or CC.

There is a difference in how the different segments of cable shall be labeled. The label for copper backbone cable that originates at a Comm. Hut shall identify all the components of an Outside Plant Copper Backbone Cable to include the cable count that is not spliced through to another cable or building. This cable count shall be identified with a CC.
Hut 3130
P18-24PF
CA. 347, 001 – 100 (101-1800, CC)
Bldg. 12888

For a copper backbone cable that has un-spliced pair continuing from a splice case to a building that Outside Plant Copper Backbone shall be identified with a CC and only the amount of un-used pairs.
Hut 3130
P18-24PF
CA. 347, 001 – 050 (50pr, CC)
Bldg. 12888

Dead and Dark (DD)
Additional information shall be provided on all cable tags where a large count cable (Fiber) steps up or down by not splicing through all strands.

For instance a 96 strand fiber backbone cable originates at a Comm. Hut and a smaller 12 strand cable is spliced into it on pairs 01 to 12 the remainder of the count 13 to 96 shall be considered Dead and Dark or DD.

This also holds true for the reverse. For instance only 12 strands of a 24 strand cable is spliced into to the same 96 strand backbone cable that un-spliced 12 strands shall also considered Dead and Dark or DD.

There is a difference in how the different segments of cable shall be labeled. The label for Outside Fiber Optic Backbone Cable that originates at a Comm. Hut shall identify all the components of an Outside Plant Fiber Optic Backbone Cable to include the strand count that is not spliced through to another cable or building. This cable count shall be identified with a DD.
RSU12570
F430, 01-12 (13-96, DD)
96SM
Bldg. 12888

For a fiber backbone cable that has un-spliced strands continuing from a splice case to a building that Outside Plant Fiber Optic Backbone shall be identified with a CC and only the amount of un-used stands.
RSU12570
F430, 01-12 (13-24, DD)
SECTION 27 51 16
PUBLIC ADDRESS AND MASS NOTIFICATION 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 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones,
with separate amplification and switching that permit selection between paths for speaker
alternative program signals.

B. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for
selective switching between different channels.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Power amplifiers.
   2. Telephone paging adapter.
   3. Equipment cabinet and rack.
   4. Loudspeakers.
   5. Battery backup power unit.

B. Shop Drawings: Signed and sealed by a qualified professional engineer.
   1. Design Calculations: Calculate requirements for selecting seismic restraints for central
      control cabinets.
   2. Equipment Details: Detail equipment assemblies and indicate dimensions, weights,
      required clearances, method of field assembly, components, and location of each field
      connection.
   3. Control panels.
   4. Rack arrangements.
   5. Wiring Diagrams: Power, signal, and control wiring. Include the following:
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.
      c. Cabling diagram showing cable routing.

C. Calculations: For sizing backup battery.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items
   are shown and coordinated with each other, based on input from installers of the items
   involved:
1.4 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Rauland-Borg Corporation.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions: Include the following:
   1. Selectively connecting separate zones to different signal channels.
   2. Selectively amplifying sound among various microphone outlets and other inputs.
   3. Communicating simultaneously to all zones regardless of zone or channel switch settings.
   4. Paging, by dialing an extension from any local telephone instrument and speaking into the telephone.
   5. Reproducing high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; and output free of nonuniform coverage of amplified sound.

2.3 EQUIPMENT AND MATERIALS

A. Coordinate features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Modular type using solid-state components, fully rated for continuous duty, unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations.
2.4 POWER AMPLIFIERS

A. Comply with TIA/EIA SE-101-A.

B. Mounting: Rack mounted.

C. Output Power: 70-W balanced line.

D. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.


F. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

G. Output Regulation: Less than 2 dB from full to no load.

H. Controls: On/off, input levels, and low-cut filter.

I. Input Sensitivity: Matched to preamplifier and providing full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.5 COMPONENTS

A. Telephone Paging Adapter: Arranged to accept voice signals from telephone extension dialing access and to automatically provide amplifier input and program override for preselected zones.

1. Minimum Frequency Response: Flat, 200 to 2500 Hz.

2. Impedance Matching: Adapter matches telephone line to public address equipment input.

B. Equipment Cabinet: Comply with TIA/EIA-310-D. House amplifiers and auxiliary equipment at each location.

1. Cabinet Housing: Construct of 0.0478-inch steel, minimum, with front- and rear-locking doors and standard TIA/EIA 19-inch racks. Arrange for floor or wall mounting as indicated. Size to house all equipment indicated plus spare capacity. Include 20 percent minimum spare capacity for future equipment over and above space required for future cassette deck and CD player.

2. Power Provisions: Install a single switch in cabinet to supply cabinet power distribution system and electrical outlets, uniformly spaced, to accommodate ac-power cords for each item of equipment.

3. Ventilation: A low-noise fan for forced-air cabinet ventilation. Equip fan with a filtered input vent and connect to operate from 105- to 130-V ac, 60 Hz; separately fused and switchable; arranged to be powered when main cabinet power switch is on.

C. Equipment Rack: Comply with TIA/EIA-310-D. House amplifiers and auxiliary equipment in standard TIA/EIA 19-inch racks.

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically.


3. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
4. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
5. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
7. Power-Control Panel: On front of equipment housing, with master power on/off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
8. Service Light: At top rear of rack with an adjacent control switch.
9. Vertical Plug Strip: Grounded receptacles, 12 inches o.c. the full height of rack, to supply rack-mounted equipment.
10. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
11. Spare Capacity: 20 percent spare space capacity in rack for future equipment.

D. Cone-Type Loudspeakers: Comply with TIA/EIA SE-103.
1. Minimum Axial Sensitivity: TIA/EIA pressure rating of 45 dB.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
5. Rated Output Level: 10 W.
6. Matching Transformer: Comply with TIA/EIA-160. Full-power rated with four TIA/EIA standard taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.

E. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
1. Wattage Rating: 10 W, unless otherwise indicated.
2. Attenuation per Step: 3 dB, with positive off position.
3. Insertion Loss: 0.4 dB maximum.
4. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-calling, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
5. Label: "PA Volume."

F. Battery Backup Power Unit: Rack-mounted unit consisting of time-delay relay, sealed lead-calcium battery, battery charger, on/off switch and "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
1. Arrange unit to supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
2. Arrange for battery to be on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
3. Automatic retransfer of system to normal supply when normal power has been reestablished for three to five seconds continuously.

G. Conductors and Cables: Jacketed, twisted pair and twisted multipair, untinned solid copper.
1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.

3. Plenum Cable: Listed and labeled for plenum installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in raceways except within consoles, desks, and counters. Conceal cables and raceways except in unfinished spaces.

B. Wiring Method: Install wiring in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum-board partitions where cable wiring method may be used. Use plenum cable in environmental air spaces including plenum ceilings. Conceal cables and raceways except in unfinished spaces.

C. Install exposed cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings so designed and installed to avoid damage to cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Use lacing bars in cabinets.

E. Control-Circuit Wiring: Install number and size of conductors as recommended by system manufacturer for control functions indicated.

F. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

G. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

H. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

I. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

J. Wall-Mounting Outlets: Flush mounted.

K. Floor-Mounting Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

L. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
M. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

N. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

O. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Schedule tests with at least seven days' advance notice of test performance.
   2. After installing public address and music equipment and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
   4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
      a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
      b. Repeat test for each separately controlled zone of loudspeakers.
      c. Minimum acceptance ratio is 50 dB.
   5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
   6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in the same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
   7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Retesting: Correct deficiencies, revising tap settings of speaker-line matching transformers where necessary to optimize volume and uniformity of sound levels, and retest. Prepare a written record of tests.

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.5 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain public address and music equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 27 51 16
SECTION 28 16 00
INTRUSION DETECTION

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 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Protected or Protection Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between sensors and communication link to central-station control unit.

F. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.

G. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

1.3 SUBMITTALS

A. Product Data: Components for sensing, detecting, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type, and size, and type and size of wire and cable fill for each raceway run.

2. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for central-station control-unit console, terminal cabinet, racks, and UPS.

3. Device Address List: Coordinate with final system programming.

4. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.

5. Details of surge-protection devices and their installation.

C. Equipment and System Operation Description: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are not acceptable.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 INTRUSION DETECTION SYSTEMS

A. Provide intrusion detection system per Joint Base Lewis McChord. The system shall have backup batteries capable of operating the system for 24 hours without normal AC power.

2.2 ACCESS CONTROL SYSTEM

A. Provide an access control system per Joint Base Lewis McChord standards. The system shall have backup batteries capable of operating the system for 24 hours without normal AC power.

2.3 DATA TRANSPONDERS

A. Data transponders shall be 8-input unit.

2.4 DOOR KEYPAD

A. Keypad shall be 12 buttons, programmable, and compatible with access control system.

2.5 SENSING DEVICES

A. Furnish and install sensing devices as follows:

1. Magnetic door switches. Switches shall consist of separate flush mounting switch and magnet assemblies in separate nonferrous housings. Units shall be rated for 500,000 operations. Door switches shall recess in door frame.
2. Duress alarms, pushbutton type. Pushbutton shall have SPDT contacts.
3. 180 and 360 Passive Infrared/Microwave type motion detectors shall be compatible with access control system.
4. Foot rail duress switch shall be 18" wide, have indicator flag with key reset and have SPDT contact.
2.6 WIRE AND CABLE
   A. All wiring shall be installed in raceways.
   B. Unless equipment manufacturer recommends another cable type, provide one 4 conductor 189 AWG cable for data communications between servers and transponders.

2.7 SECURE ACCESS PANELS (SAP)
   A. Secure access panels shall be installed for door access control as required. Panel shall be per Joint Base Lewis McChord standard and along with associated power supplies and power distribution modules.

2.8 INTRUSION DETECTION SYSTEM MONITOR
   A. Provide and install a system server terminal with keyboard and mouse, 15” LCD monitor, serial cable, and SmartPAC.

2.9 ENCLOSURES
   A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.
   B. Interior Electronics: NEMA 250, Type 12.
   C. Exterior Electronics: NEMA 250, Type 4X fiberglass.
   D. Corrosion Resistant: NEMA 250, Type 4X PVC.
   E. Screw Covers: Where enclosures are accessible to inmates, secure with security fasteners of type appropriate for enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install equipment in accordance with manufacturer’s instruction.
   B. Interrupt power to electromagnetic door locks via SAP.
   C. Locate motion detectors at least 5 feet horizontally from heating supply registers.
   D. Locate door contacts in head of door frame no more than 6 inches from strike side of door.
   E. Route open cables parallel to building lines. Support cable at 4-1/2 foot intervals using locking cable ties. Do not group with cables of other systems.
   F. Provide dedicated 120V branch circuit for Security System Head-end.
   G. Provide telephone cable from Security System Head-end to telephone equipment.
3.2 Testing

A. IN the presence of representative from Base Security, test entire system for proper operation. Correct all defects.

B. Provide written certification system was installed according to manufacturers instruction and operated properly during final acceptance test. Include certification as part of O&M manual.

3.3 TRAINING

A. Provide services of factory representative for two hour training seminar for Exchange and Base Security Personnel.

END OF SECTION 28 16 00
SECTION 28 31 11
FIRE DETECTION AND ALARM

PART 1 – GENERAL

1.1 DEFINITIONS

A. Addressable: A fire alarm system component with a unique identification that can have its status individually identified or that is used to individually control other functions.
B. AHJ: Authority Having Jurisdiction.
C. CAD: Computer Aided Design.
D. Coded: Audible or visible signal that conveys information about alarm event. Examples are, number of rings of a bell or flashes of a strobe. This could be used to convey location or type of alarm.
E. DB: Decibels.
F. DXF: Drawing Interchange Format.
G. ECP: Environmental Control Panel.
H. FACP: Fire Alarm Control Panel.
I. HVAC: Heating, Ventilating, and Air Conditioning.
J. I/O: Input/Output.
K. LCD: Liquid Crystal Display.
L. LED: Light-Emitting Diode.
M. MOV: Metal Oxide Varistor.
N. RAM: Random Access Memory.
O. SOM: Sequence of Operations Matrix.
P. Zone: A defined area within the protected premises. A zone can define an area from which an alarm signal can be received or an area to which a signal can be sent. The term zone is typically used when describing conventional, nonaddressable systems.

1.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Contract Drawings show location of fire alarm panel(s) annunciator panel(s), duct detectors, emergency alarm components required by IFC 2704, fan monitoring components required by NFPA 820, and fire suppression system switches. Other component locations and quantities shall be determined by fire alarm system installer and shall be included as part of their design. This includes, but is not limited to, smoke detectors, heat detectors, manual pull stations, and notification appliances. Design and installation shall meet requirements of the local AHJ. Any costs incurred from changes to the system as part of the Fire Marshal inspection process shall be the sole responsibility of the fire alarm system supplier.

2. Design, coordinate, and provide system in accordance with building codes indicated in Section 01 61 00, Common Product Requirements.
3. Design conduit layout and wiring interconnection of devices specified herein, and for
interconnection of flow and supervisory switches and alarm bells specified in
Section 21 13 00, Fire-Suppression Sprinkler Systems.
4. Coordinate, and include in design, requirements for interfacing with HVAC system.
5. Equipment suitable for a fully addressable, networked fire alarm system. All
addressable panels shall be networked together utilizing dedicated plant fiber optic
system.

B. Performance Requirements:
1. Actuation of alarm (smoke or heat detector, flow switch, or other normally open
initiating device contact) or trouble (trouble or supervisory switch) shall cause the
following operations:
   a. Audible and visual indications of alarmed devices on fire alarm control panel
display, and on remote annunciator.
   b. For remote buildings with subpanels, transmit common alarm or trouble signal
to light appropriate zone lamp at master fire alarm control panel.
   c. Fire alarm control panels shall transmit common alarm or trouble signal to plant
control panel as shown on P&ID's.
2. Actuation of duct smoke detectors shall, send signal (contact closure) to environmental
control panel (ECP) to shut off HVAC equipment and send a Supervisory Alarm to the
fire control panel. Fan equipment shall shutdown in accordance with Section 23 09 00,
Instrumentation and Control Devices for HVAC. Contact output to ECP shall be rated
for no less than 5A, 250V ac.
3. Actuation of sprinkler flow switch shall alarm at panel.

1.3 SUBMITTALS

A. Action Submittals:
1. Descriptive product information for each individual system component.
2. Dimensional drawings of panels and associated equipment.
3. Itemized bill of material.
4. Operating and programming instructions.
5. Control panel configuration and module data.
6. Complete point to point wiring diagrams of system and device interconnection. Identify
spare connection points.
7. Alarm initiating, indicating, and supervisory device electrical data.
8. Annunciator configuration and module data.
9. Plans showing device and panel locations as well as conduit and cable sizes. Prepare
drawings and diagrams on drawing sheets of uniform size without extraneous
information. Marked up electrical, HVAC, lighting or similar drawings or copies of
catalog data sheets are not acceptable in lieu of required drawings or diagrams.
10. Sequence of Operation Matrix.
11. Battery sizing calculations.
12. Supervisory power requirements for equipment.
13. Alarm power requirements for equipment.
14. Power supply rating justification showing power requirements for system power
supplies.
15. Voltage drop calculations for wiring runs, demonstrating worst case condition.
16. Sample warranty.
17. For each system’s control panel, provide written schedule of active and spare
addresses provided on each addressable circuit.
18. Seismic anchorage and bracing drawings and cut sheets, as required by
Section 01 88 15, Seismic Anchorage and Bracing.
19. Refer to Section 017823 Operation and Maintenance Data for additional requirements.
B. Informational Submittals:
   1. Experience and qualifications of firm(s) proposed to design and install system.
   2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
   3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
   4. Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.
   6. Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of NFPA 72, manufacturer’s recommendations, and local authority having jurisdiction.
   7. Written documentation for logic modules as programmed, for system operation, with matrix showing interaction of input signals with output commands.
   8. System program hard copy and CD-ROM showing system functions, controls, and labeling of equipment and devices.
   9. NFPA 72, Record of Completion: Submit to code-enforcement authorities.
  10. NFPA 72, Inspection and Testing Form: Submit to code enforcement authorities.
  11. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. System design, installation and testing shall be performed by licensed firm(s) with established reputation in fire alarm system industry having 5 years’ experience in design, installation, and testing of fire alarm systems.
   2. Technician with minimum of NICET Level II Certification for fire alarm systems or professional engineer registered in State of Washington shall be available onsite.
   3. Service technician shall be formally trained by manufacturer.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:
   1. Fire Alarm – Silent Knight or approved base equivalent

2.2 GENERAL

A. Material and equipment shall be standard products of their respective manufacturers, and shall be of a model that has been in production for not less than 3 years.

2.3 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories, Inc. shall conform to UL Standards and have an applied UL listing mark.

B. Equipment shall be UL listed in accordance with requirements of NFPA.

2.4 FIRE ALARM CONTROL PANEL (EXPANSION PANEL)

A. General:
1. Control panel circuit for 24V dc, power limited, initiating circuits per NFPA 70, Article 760.
2. Assembled panel UL 864 listed Product Category UOJ2, as an integrated control system.
3. Enclosure:
   a. NEMA 250 Type 1.
   b. Color: Red.
4. Internally Mounted Module with:
   a. Transformer with 120 V ac input and 21.5V ac output.
   b. Standby batteries sized for system operating period of 24 hours of standby mode operation.
   c. Battery charger.
   d. Alarm mode of 5 minutes after standby operation.
5. Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.
6. EMI/RF Protection:
   a. Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from affects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.
   b. System shall be designed and installed so as to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 12 inches of system components.

B. Addressable Control Panel:
1. Modular construction with solid state, microprocessor-based components, programmable central processor unit, back lighted display of primary control status and essential alarm operating conditions, and concealed, maintenance, purpose operator's keypad.
2. With signaling line circuit Class B, and Class B, Style Y notification appliance circuits.
3. Main control module consisting of operator's keyboard/keypad, local and remote communications and supervision capabilities, system control memory, and programming interface.
4. TIA 485, NFPA 72, Style 4, Style 6, or Style 7 data circuit capability for remote annunciators.
5. Form C relay contacts rated 2 amperes, 24V dc.
6. Power supply interface module generating digital voltage and current data to LCD with:
   a. dc power conversion and output terminals.
   b. Supervision and control of power supply.
7. Modules with coded input on first alarm, local trouble LED, and in/out capabilities for:
   a. 120 addressable initiating alarm sensors consisting of analog/addressable or traditional detector methods.
   b. Four hardwired I/O points, field selectable in any combination to be either NFPA 72, Style B or Style D, initiating device circuits or NFPA 72, Style Y or Style Z, indicating appliance circuits or auxiliary control circuits.
   c. Auxiliary control circuit contacts shall be single-pole, double-throw, rated 2 amperes at 24V dc and 0.5 amperes at 120V ac.
8. Auxiliary control circuit contacts shall be single-pole, double-throw rated, 2 amperes at 24V dc and 0.5 amperes at 120V ac.
2.5 SERIAL ANNUNCIATORS

A. Modular constructed with modules installed in cabinet having lockable, full hinged door panel, and red baked enamel finish.

2.6 ADDRESSABLE DETECTOR BASE

A. Solid state circuitry with integral LED visual alarm, dip switch or program selectable addressing, and common base receptacle for ionization, photoelectric, and heat detectors. Device address shall be located in base.

B. Constantly monitors detector status and status changes.

C. Suitable for mounting on standard outlet box.

D. Normally open, single-pole contacts.

2.7 INDIVIDUAL ADDRESSABLE MODULE

A. Solid state circuitry with selectable latch/nonlatch operating conditions and mounting plate.

B. Monitors single and multiple devices with dry contacts.

C. Suitable for installing inside 4-inch by 4-inch by 2-1/2-inch electrical box.

2.8 INITIATING DEVICE

A. Pull Station, Fire:
   1. Double-action station for general alarm.
   2. Red housing with white letters stating "FIRE".
   3. Hinged front cover having keyed or allen-wrench reset lock.
   5. Activated station pull handle, latched in protruding position until reset by key.
   6. Stations keyed alike with fire alarm control panel.

B. Pull Station, Emergency Alarm:
   2. Blue housing with white letters stating "EMERGENCY."
   3. Hinged front cover having keyed or allen-wrench reset lock.
   5. Recessed pull handle for single action.
   6. Activated station pull handle, latched in protruding position until reset by key.
   7. Stations keyed alike with fire alarm control panel.

C. Heat Detector:
   1. Fixed temperature elements with [E: 57] [F: 90] degrees C trip setting, complete with addressable mounting base.
   2. Nonrestorable fixed temperature elements.
   3. Dangling disk indicator for activated fix temperature element.
   4. Attach detector bases on octagon boxes.
   5. Conceal surface mounted boxes with surface trim skirt.

D. Smoke Detector:
   1. Ionization type with plug-in, twist-lock addressable base per UL 217 and UL 268.
   2. Solid state circuitry, unipolar, single source, dual sensing chamber, suitable for device releasing service.
3. Concealed, field adjustable, sensitivity test switch.
4. LED; pulsed indication for power availability and steady indication for activated detectors.
5. Self-Compensating Circuitry:
   b. Temperature Range: 0 degrees C to 38 degrees C.
   c. Operating Temperature Range: Minus 10 degrees C to 50 degrees C.
   d. Humidity Range: 0 to 95 percent relative humidity.

E. Air Duct Smoke Detector:
1. Duct mounted housing with prealigned sampling and exhaust tubes, analog sensing, solid state circuitry, and plug-in, twist-lock addressable base for photoelectric detector in accordance with UL 286A, NFPA 72, NFPA 90A, and NFPA 101.
2. Sampling tubes to extend full width of branch air return duct.
3. Self-Compensating Circuitry:
   b. Temperature Range: 0 degrees C to 38 degrees C.
   c. Humidity Range: 10 percent to 90 percent relative humidity.
   d. Velocity Range: 400 feet to 4,000 feet per minute.
4. Front mounted LED with pulsed indication for alarm condition.

2.9 ALARMS

A. Audible Alarm: Fire Alarm System
1. General:
   a. Polarized, 24V dc device with sound power measured dB in accordance with UL 464.
   b. Baked red enamel finish.
   c. Audibility: In accordance with NFPA 72 and local requirements.
   d. Emergency Alarm audible alarms shall have a different and distinct tone from those used for the Fire Alarm System.
2. Modular Horn:
   a. Manufacturer supplied box with flush grille plate and basic surface unit for recessed horns.
   b. Explosion-Proof Horns: Vibrating diode type with sealed wires, and tapped for 3/4-inch conduit in accordance with UL 1604.
3. Modular Bell: Basic unit complete with gong designed for mounting on 4-inch electrical box.
4. Explosion-Proof Bell: Vibrating diode type with gong, sealed wires, and tapped for 3/4-inch conduit in accordance with UL 1604. Rated for environment as shown on Drawings.
5. Chime: Field adjustable volume control, designed for mounting on 4-inch square electrical box.

B. Visual Alarm, Fire:
1. Polarized, 24V dc, multi-candela indicating output per UL 1638.
2. Solid state circuitry for high and low intensity control of xenon flashtube.
3. Tamper-proof, translucent molded, polycarbonate, pyramidal shaped lens with “FIRE” in red lettering visible from 180-degree viewing field; red enclosure.
4. Polarized in/out wiring.
5. Designed for mounting on electrical box, or as part of audible/visible base housing.
6. Synchronized unit.
C. Visual Alarm, Emergency Alarm:
   1. Polarized, 24V dc, 100 candela indicating output per UL 1638.
   2. Solid state circuitry for low intensity control of xenon flashtube.
   3. Tamper-proof, translucent blue, molded polycarbonate, pyramidal shaped lens with “EMERGENCY” in lettering visible from 180-degree viewing field; blue enclosure.
   4. Polarized in/out wiring.
   5. Designed for mounting on electrical box, or as part of audible/visible base housing.
   6. Synchronized unit.

D. Visual Alarm in Outdoor or Hazardous Location:
   1. Cast metal fixture with red glass globe and guard.
   2. Rating: 100 candela.
   3. UL Listed for wet locations when installed outdoors.
   4. UL Listed for classification of hazardous location where alarm is to be installed.

E. Audio Visual Alarm:
   1. Audible/visible base housing with visual alarm and front mounted horn as specified.
   2. Semi-flush mounting on recessed 4-gauge square electrical box or surface mounted on backbox with adapter.
   3. Audibility: In accordance with NFPA 72 and local requirements.
   4. Synchronous audible/visible output.

F. Bi-Color Warning Lights:
   1. Corrosion-resistant metal fixture with green and red globes.
   2. 24V dc, LED lamps; green steady, red flashing.
   3. UL Listed for wet and outdoor installation.
   4. Wall mount design.

2.10 WIRING

A. AC power wiring shall meet requirements of Section 26 05 05, Conductors.

B. Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

C. Network or addressable loop cables shall be as recommended by manufacturer for installation of their system and UL Listed for Fire Alarm Systems.

2.11 RACEWAYS

A. Conduit used for installation of Fire Alarm or Emergency Alarm system shall follow requirements as identified in Section 26 05 33, Raceway and Boxes.

2.12 END-OF-LINE RESISTORS

A. Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.

2.13 SURGE SUPPRESSORS

A. Transient Voltage Surge Suppressors (TVSS): In accordance with Section 26 43 00, Transient Voltage Suppression.
2.14 INTRINSICALLY SAFE MODULE

A. Fused, resistor/zener diode barrier module with output currents limited for NFPA 70, Class I, Division 1, Group D atmosphere.

B. Surface-mounted backbox with secured, full-hinged access door and baked red enamel finish.

PART 3 – EXECUTION

3.1 GENERAL

A. Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein and for interconnection of flow and supervisory switches and alarm bells specified in Section 21 13 00, Fire-Suppression Sprinkler Systems, for complete and operable system.

3.2 INSTALLATION

A. Mount detector LEDs so they are readily visible from floor.

B. Install conductors in accordance with Section 26 05 05, Conductors, and NFPA 70, Article 760.

C. Install initiating alarm, signal, and communication conductors in separate and independent raceway system.

D. Circuit wiring color-code, as established by installer, to be maintained throughout installation.

E. Size conductors in accordance with device manufacturer’s recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.

F. Detectors shall not be installed until after construction clean up of trades is complete, per requirements of NFPA. Exception, where required by AHJ for protection during construction, detectors installed prior to final clean-up by trades shall be cleaned or replaced.

G. Duct Smoke Detector: Furnish, wire, and connect to fire alarm system in accordance with this Specification. Installed in accordance with Section 23 09 13, HVAC Controls, Field Components, and Instruments.

H. HVAC Equipment: Wire and connect fire alarm system to air handling system, smoke exhaust fan and smoke damper control circuits, and fan status contacts. Coordinate work with Section 23 09 00, Instrumentation and Control Devices for HVAC.

I. Suppression Sprinkler System: Wire and connect to fire alarm system to suppression sprinkler system. Coordinate work with Section 21 13 00, Fire-Suppression Sprinkler Systems.

3.3 CONDUIT

A. Conduit systems shall be dedicated to fire alarm system and shall contain no unrelated conductors.

1. Install junction boxes as necessary. Conductors shall be pulled through junction boxes, without splices.

2. Pullboxes shall be installed in each conduit at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.

3. Device backboxes and junction boxes shall be sized to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.
B. Pull boxes, junction boxes, conduit bodies, and terminal cabinets shall be painted “fire engine red” prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.

C. Mount end-of-line resistors on terminal blocks.

D. Detection and alarm wire shall be installed in separate conduits. Outgoing and return conductors for each supervised circuit shall be routed in separately as required by NFPA 72. The minimum separation of outgoing and return conduits shall be 1 foot vertically and 4 feet horizontally.

3.4 IDENTIFICATION

A. Junction, terminal, and pulling box covers shall be painted red and identified with engraved labels as recommended by system provider.

B. Detection and terminal devices shall have engraved alphanumeric identification that shall be keyed to maintenance instructions.

3.5 CONDUCTORS

A. Requirements apply to fire alarm system conductors, including all signaling line, initiating device, indicating appliance, releasing function, remote signaling, ac and dc power and grounding/shield drain circuits.

B. Conductors shall be:
   1. Installed in conduit.
   2. Continuous between devices and between devices and intermediary terminal cabinets.
   3. Low voltage conductors shall be minimum size No. 14 AWG. Smaller conductors shall only be permitted where part of a manufacturer’s specific communications cable, i.e. addressable system.
   4. In accordance with requirements of NEC, Article 760 for nonpower limited service.

C. Splices in conductors are specifically prohibited.

D. Types:
   1. Conductors, except ac power conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper.
   2. Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.

E. Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.
   1. Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on as-built drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.
   2. Wire nuts are prohibited.
   3. Where pigtail devices are factory provided with wires too short to be connected to terminal strips (i.e., solenoids), such connections shall be soldered and taped.

F. Control Panel Wiring:
   1. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between ac power conductors and low voltage conductors wherever possible.
2. Control panels shall not be used as raceways. Conductors that do not terminate within a control panel shall not be routed through that control panel.

G. Conductors shall be separated into the following categories:
   1. Low voltage circuits that serve devices.
   2. AC power circuits.

H. Each category of conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another, except at common associated control equipment. Conductors shall be further segregated as necessary to conform to fire alarm system manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

3.6 OVERVOLTAGE AND SURGE PROTECTION

A. Install TVSS for fire alarm control panel per manufacturer's requirements.

3.7 REPAIR/RESTORATION

A. Keep covers on smoke detectors until areas have been thoroughly cleaned.

3.8 TESTS AND INSPECTION

A. Demonstrate entire system meets performance requirements specified in Article System Description.

B. Perform tests in presence of code-enforcement authorities and CH2M HILL.

C. Test wiring runs for continuity, short circuits, and grounds before system is energized. Resistance, current, and voltage readings shall be made as work progresses.
   1. Systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on logging form for readings, dates, and witnesses.
   2. Notify Fire Marshal and Owner before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.
   3. Deliver test reports to Fire Marshal and Owner as completed.

D. Prepare final as-built Sequence of Operations Matrix referencing each alarm input to every output function affected as a result of an alarm, trouble, or supervisory condition on that. In case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; complete output equation shall be referenced in matrix.

E. Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.
   1. Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:
      a. Open, shorted, and grounded intelligent analog signaling line circuit.
      b. Open, shorted, and grounded network signaling line circuit.
      c. Open, shorted, and grounded conventional initiating device circuits.
      d. Primary power or battery disconnected.
      e. Intelligent device removal.
      f. Incorrect device address.

   2. Demonstrate system evacuation alarm indicating appliances as follows:
      a. Alarm notification appliances actuate as programmed.
      b. Audibility and visibility at required levels.
3. Demonstrate system reporting functions as follows:
   a. Correct alarm custom message display, address, device type, date and time transmitted, for each alarm input.
   b. Correct trouble custom message display, address, device type, date and time transmitted, for each alarm input.
   c. Trouble signals received for disconnect.

4. Secondary power capabilities shall be demonstrated as follows:
   a. Disconnect system primary power for a period of time as specified herein; at end of period, alarm condition shall be created and system shall perform as specified for period as specified.
   b. Restore system primary power for 48 hours and system-charging current shall be normal trickle charge for fully charged battery bank.

F. In the event system fails to perform as specified and programmed during acceptance test, test shall be terminated at discretion of acceptance inspector.
   1. Retest system, correcting deficiencies and providing test documentation to acceptance inspector.

G. Upon completion of tests, complete and provide the following:
   1. NFPA 72, Record of Completion, and Inspection and Testing Form.
   2. Certification that final system meets UL.

3.9 MANUFACTURER’S SERVICES

A. Furnish manufacturer’s representative for the following services at site or classroom as designated by CH2M HILL for minimum person-days listed below, travel time excluded:
   1. 1 person-day for installation assistance and inspection.
   2. 1 person-day for functional and performance testing.
   3. 1 person-day for prestartup classroom or site training.

END OF SECTION 28 31 11
SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 DESCRIPTION
A. Section Includes:
   1. Protecting existing vegetation to remain.
   2. Removing existing vegetation.
   3. Clearing and grubbing.
   4. Stripping, screening and stockpiling topsoil.
   5. Removing above and below-grade site improvements.
   6. Disconnecting, capping or sealing, and abandoning site utilities in place.
   7. Temporary erosion- and sedimentation-control measures.

1.2 RELATED WORK
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections.
B. Related Sections:
   1. Section 01 55 00 “Temporary Facilities and Controls”.
   2. Section 31 20 00 “Earth Moving”.
C. The Storm Water Pollution Prevention Plan (SWPPP) and associated NPDES Permitting prepared for the site by the Contractor and implemented by the Contractor.

1.3 DEFINITIONS
A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil;
D. Reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of subsoil and weeds, roots, toxic materials, or other non soil materials.
E. Vegetation: Trees, shrubs, groundcovers, grass, sod and other plants.
1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from EXCHANGE and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify Call Before You Dig, 8-1-1 for area where Project is located before site clearing.

C. Do not commence site clearing operations until the Contractor has submitted for and obtained an NPDES Permit and temporary erosion- and sedimentation-control, SWPPP Plan and plant-protection measures are in place.

D. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

E. Savable Improvements: carefully remove items indicated to be salvaged and store on EXCHANGE premises where indicated.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

C. NPDES Permit (National Pollution Discharge Elimination Systems) with Associated SWPPP (Stormwater Pollution Prevention Plan) prepared for the site and implemented by the contractor. The Notice of Intent (NOI) must be filed with EPA 48 hrs. prior to commencement of the project. The stormwater plan must also be submitted to the contracting officer for review and concurrence. The Contractor is responsible for all permitting requirements for the NPDES permit.

D. MATERIAL OWNERSHIP Except for stripped topsoil and other soil materials indicated to be stockpiled or otherwise remain on EXCHANGE property, cleared materials shall become Contractor's property and shall be removed from Project site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: Stockpile screened topsoil quantities at a suitable location for future amendment process.

B. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.
PART 3 - EXECUTION

3.1 PREPARATION
   A. Protect and maintain benchmarks and survey control points from disturbance during construction.
   B. Locate and clearly identify trees, shrubs, and other vegetation to remain. Protect existing site improvements to remain from damage during construction. Only remove vegetation identified by the Owner.
   C. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 STORMWATER POLLUTION PREVENTION PLAN (SWPP)
   A. The Contractor shall provide a SWPP for the project site.
   B. Contractor shall review, sign, and implement all elements of the SWPP during construction.

3.3 TREE PROTECTION
   A. Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
      1. Do not store construction materials, debris or excavated material within drip line of remaining trees.
      2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
   B. Do not excavate within drip line of trees, unless otherwise indicated or approved by Contracting Officer.
   C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Contracting Officer.
   D. Replace trees that cannot be repaired and restored to full-growth status, as determined by the qualified arborist.

3.4 TEMPORARY EROSION AND SEDIMENTATION CONTROL
   A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction. Utilize the Best Management Practices for silt fence, rock check dams, bio-filtration swales, temporary construction entrances and others shown on the SWPPP, erosion and sedimentation-control Drawings, Grading & Drainage Drawings, and erosion and sedimentation-control details shown on the Drawings, and as needed to ensure a stable site throughout the duration of the project.
   B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.5 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by EXCHANGE or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Contracting Officer not less than five (5) days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Contracting Officer written permission.

D. Excavate for and remove underground utilities indicated to be removed.

3.6 CLEARING AND GRUBBING

A. Remove obstructions, and other vegetation to permit installation of new construction. Do not remove vegetation indicated to remain or to be relocated.

B. Fill depressions caused by clearing and grubbing operations within future building, pavement and sidewalk areas with Structural Fill material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 6 inches at or near optimum and compact each layer to 95 percent of the modified proctor maximum density per ASTM D 1557.

C. Fill depressions caused by clearing and grubbing operations not in future building, pavement and sidewalk areas with suitable native material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 6 inches at or near optimum moisture and compact each layer to 85 percent of the modified proctor maximum density per ASTM D 1557.

3.7 TOPSOIL STRIPPING, SCREENING AND STOCKPILING

A. Remove sod and grass before stripping.

B. Strip topsoil to whatever depths are encountered as directed by the Contracting Officer in a manner to prevent intermingling with underlying subsoil or other waste materials. Remove subsoil and non soil materials from topsoil, including clay lumps, gravel, and other objects more than 1 inch in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
D. Limit height of topsoil stockpiles to 72 inches (1800 mm).
   1. Do not stockpile topsoil within drip line of remaining trees.
   2. Dispose of excess topsoil as specified for waste material disposal.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, and aggregate base as indicated.

C. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner’s property.

B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 31 10 00
SECTION 31 15 00
SITE DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Related documents:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. Extent of site demolition work and provisions are indicated on Drawings C2.0, C3.0 and C4.0.

C. Demolition work: Demolition requires the removal and subsequent offsite disposal of the following:

1. Complete demolition of below grade building materials, abandoned piping, metal objects, or miscellaneous debris to accommodate new construction.
2. Removal of dark brown silty sand beneath the proposed building footprint.
3. Removal of existing site improvements and salvage as per the Drawings.
4. Removal and protection of existing fixtures and equipment items indicated to be relocated.
5. Concrete and asphalt pavement removal.

1.2 SUBMITTALS

A. Submit schedule indicating proposed methods and sequence of operations for demolition work to Owner’s Representative for review prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for barricades, dust and noise control protection.

1.3 EXISTING CONDITIONS

A. Demolition and removal: Materials indicated to be removed shall be removed in entirety. Materials indicated as “may be encountered” shall be removed in entirety if discovered during earthwork or excavation operations.

B. Utility services:

1. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations. Disconnect and cap utilities that are indicated to be removed.
2. Verify if any utilities that service the remainder of the site or adjacent sites are currently located within the demolition area. Upon discovery, notify the Owner’s Representative immediately. Such utilities may be required to remain or be relocated to provide continuous service.
C. Environmental controls: use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulation pertaining to environmental protection.

D. Codes and regulations: Comply with all governing codes and regulations.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to commencement of demolition work, inspect areas in which work will be performed. Photograph existing conditions and file with Owner’s Representative prior to starting work.

3.2 DEMOLITION

A. Perform demolition work in systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulation.

B. Structural fill shall be placed and compacted in lifts in accordance with specification section where demolition occurs to bring surface to existing condition.

3.3 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from site debris, rubbish, concrete foundations, abandoned piping, metal objects, asphalt, and other materials resulting from demolition operations. Transport and legally dispose of materials offsite. Comply with all Federal, State and Local governing regulations.

1. If hazardous materials are encountered during demolition operations, Contractor shall comply with all applicable governmental regulations, laws, and ordinances concerning removal, handling, dumping and protection against exposure of environmental pollution. Notify Owner’s Representative immediately.

3.4 CLEAN-UP AND REPAIR

A. Return structures and surfaces to remain to condition existing prior to commencement of demolition work. Repair adjacent construction or surfaces soiled or damaged by demolition work.

END OF SECTION 31 15 00
SECTION 31 20 00
EARTH MOVING

PART 1 - 1 - GENERAL

1.1 DESCRIPTION

A. Section Includes:
   1. Preparing subgrades for slabs on grade, sidewalks, pavements, turf, seeding and plants.
   2. Excavating and backfilling for buildings and structures.
   3. Drainage course for concrete slabs-on-grade.
   4. Subbase course for concrete walks, pavements.
   5. Subbase course and base course for asphalt paving.
   6. Subsurface drainage backfill for walls and trenches.
   7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 RELATED WORK

A. Related Sections:
   1. Section 01 55 00 – “Temporary Facilities, and Controls”.
   2. Divisions 22, 23, 26, and 33 for installing underground mechanical and electrical utilities
      and buried mechanical and electrical structures.
   3. Section 31 10 10 "Site Clearing".
   4. Section 32 90 00 "Planting".
   5. Section 31 23 19 – Dewatering.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation

B. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

C. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill
   immediately below crushed gravel base, drainage fill, drainage course, or topsoil materials.

D. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground
   services within buildings.

E. Structures: building, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and
   electrical appurtenances, or other man-made stationary features constructed above or below
   the ground surface.

F. Structural Fill: Soil placed or moved on site that will support any structural elements including
   pavements, concrete, sidewalks, and curbs.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and
   dimensions indicated.
1. Authorized Additional Excavation:  Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

2. Unauthorized Excavation:  Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

H. Trench Zone Backfill: Material used to fill a trench above the Pipe Bedding to subgrade, placed over pipe in a trench to subgrade elevation.

I. Pipe Bedding: Aggregate layer placed over the excavated trench bottom in a trench 4 inches below the pipe to 6 inches above the pipe, including haunches to support sides of pipe. Aggregate layer placed over the excavated trench bottom in a trench 6 inches below the pipe in areas of rock to 6 inches above the pipe, including haunches to support sides of pipe.

J. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or ¾ cu. Yd. for footing, trench, and pit excavation.

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curving force of not less than 28,700 lbf and stick-crowed force of not less than 18,400 lbf, measured according to SAE J-1179.

K. Crushed Gravel base: Aggregate layer placed between the subgrade and hot-mix asphalt paving or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Free Draining Aggregate: Backfill material along the exterior building foundation walls placed to a width of 24 inches for the depth of the wall.

M. Drain Rock cover, backfill material placed to surround the perforated footing drain __ inches in all directions.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from EXCHANGE and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by EXCHANGE or authorities having jurisdiction.

B. Utility Locator Service: Notify "Call Before You Dig" 8-1-1 for area where Project is located before beginning earth moving operations.

C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 01 50 00 - "Temporary Facilities Controls, and Construction Safety" and Section 311000 - "Site Clearing," are in place.

D. Do not commence earth moving operations until plant-protection measures specified in Section 31 10 00 - "Site Clearing," are in place.
E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Do not direct vehicle or equipment exhaust towards protection zones.
9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

F. Earth Moving is unclassified and shall include excavation, backfill and compaction of native material, structural fill and imported material and disposal of unsuitable material for the buildings, access roads, drainage, utility lines and all associated structures. It is the Contractor’s responsibility to protect all existing improvements to remain in place.

G. Surplus excavated material shall be removed from the site and disposed of legally by the Contractor at no additional cost to EXCHANGE, surplus excavated material may be stockpiled on the site in locations and heights as determined by the Contracting Officer.

H. Existing Utilities: Locate existing underground utilities in areas of excavation work. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Government and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
2. Do not interrupt existing utilities serving facilities occupied by Government or others, during occupied hours, except when permitted in writing by contracting Officer and then only after acceptable temporary utility services have been provided.
3. Provide a minimum 72-hours notice to the Contracting Officer and receive written notice to proceed before interrupting any utility.

1.5 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Warning tapes.
3. Tracer Wire

B. Samples for Verification: For the following products, in sizes indicated below:

2. Warning Tape: 12 inches long; of each color.

C. Qualification Data: For qualified testing agency.
D. Material Test Reports: For each on-site and borrow soil material proposed for fill, base, free draining aggregate, drain rock cover and backfill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 1557.

1.6 LEED DOCUMENTATION
B. Product data for LEED-NC Credit MR 5.1 and 5.2: Provide letter from supplier listing sources and quantities of all fill materials imported onto the site.
C. Sustainability Characteristics: Earthwork materials shall be regionally sourced as defined in section 01 60 00 PRODUCT REQUIREMENTS.

1.7 REFERENCES
A. Conform to the recommendations of the site geotechnical study.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS
A. General:
   1. Use native onsite borrow soil materials from Government designated areas and onsite excavations.
   2. Provide import borrow soil materials when sufficient satisfactory soil materials are not available from excavations and designated borrow areas onsite.
B. Satisfactory materials: Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SP-SM.
C. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory.
   1. Unsatisfactory materials include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 6 inches. The contracting Officer shall be notified of any contaminated materials.
D. Unstable Materials: Unstable materials shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.
E. Backfill and fill shall consist of satisfactory soil materials meeting the following requirements.
   1. Passing the 1.5 inches sieve: 100%
   2. Passing the #40 sieve: less than 5 times that passing the #200 sieve.
3. Passing the #200 sieve: 35% or less.
4. Plasticity index: 10 or less.

F. Bedding Material: Bedding shall consist of select native material of which 100% shall pass of 5/8-inch square opening in sieve, and shall be uniformly graded from coarse to fine with not more than 15% passing a No. 200 screen. Bedding material shall be free of topsoil or organic matter.

G. Select bedding Material: Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain no more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 2 inches, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

H. Crushed Surfacing Top Course: Crushed surfacing top course shall meet the requirements of Section 9-03 of 2012 WSDOT Standard Specifications for Aggregate.

I. Drainage Course: Select and washed granular soil within the following gradation limits: 100% passing a 1-1/2" sieve and not more than 5% passing a #4 sieve.

J. Rip Rap: Hard, sound and durable broken stone, ranging in size from 3" to 1/3 cubic foot, and free of rock fines, soil or other extraneous material.

K. Silt fencing: 3'-0" high, self-supporting polypropylene fabric specifically designed for the intended purpose.

L. Posts For Silt Fencing: Steel or minimum 1½" x 1½" wood.

2.2 GEOTEXTILES

A. Foundation Drain Geotextile: Water permeable, nonwoven geotextile filter fabric, manufactured for subsurface drainage applications, placed around Drain Rock Cover.

B. Stabilization / Separation Geotextile Fabric for Paved Areas: Non woven geotextile stabilization /separation fabric placed over subgrade with the properties of US Fabrics, Inc. US 205, or approved equivalent.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a tape specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility.

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer (sanitary and storm) systems.
6. Purple: Irrigation systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXPLOSIVES

A. Explosives: Do not use explosives.

3.3 EXCAVATION, GENERAL

A. All excavation is unclassified except that defined as rock excavation. Rock excavation will be paid for by adjusting the contract sum according to unit prices included in the Contract Documents.

1. Unclassified excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock of unauthorized excavation.
   a. Intermittent drilling; ram hammering; or ripping of material not classified, as rock excavation is unclassified excavation.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended for bearing surface.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Division 01 Section "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated. Provide 6 inches clearance each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

A. Subgrade shall be tested by the EXCHANGE hired Testing Entity.

B. If Testing Entity determines that unsatisfactory soil is present continue excavation and replace with compacted backfill or fill material as directed. Notify the Contracting Officer immediately.

C. Proof-roll subgrade below pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Testing Entity, and replace with compacted Structural Fill, as directed.

D. Authorized additional excavation and replacement material outside of fill areas will be paid for according to Contract provisions for Changes in the Work.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Contracting Officer or Testing Entity without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by
Architect. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 03 30 00 "Cast-in-Place Concrete".

D. Backfill voids with satisfactory soil while removing shoring and bracing.

E. Place and compact Pipe Bedding to a height of 6 inches over the pipe or conduit.

1. Carefully compact under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact Trench Zone Backfill to final subgrade elevation.

G. Provide 4-inch-(100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
H. Install warning tape directly above utilities, 18 inches below finished grade along entire length of utility.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, building slabs, curbs, and pavements, scarify and recompact top 12 inches of existing subgrade and compact each layer of backfill or fill soil material to 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material to 95 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of Trench Backfill under pavements, concrete, curbs and sidewalks at 95 percent and Trench Backfill under turf or unpaved areas at 85 percent.

3.14 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus ½ inch.
3. Pavements: Plus or minus ½ inch.
C. Grading inside building Lines: Finish subgrade to a tolerance of ½ inch when tested with a 10-foot straightedge.

3.15 SUBSURFACE FOUNDATION DRAINAGE

A. Foundation Drainage Pipe: Shall be perforated PVC conforming to ASTM D 2729.

B. Drain Rock Cover: Place Drain Rock Cover inside of filter fabric to a minimum width of 6 inches. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

C. Foundation Wall Backfill: Place and compact Free Draining Aggregate around exterior face of foundation walls to a width of 24 inches for full depth of wall.

3.16 CRUSHED GRAVEL BASE UNDER PAVEMENTS AND WALKS

A. Place Crushed Gravel Base on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place Crushed Gravel Base under pavements and walks as follows:

C. Install separation geotextile at locations where sub grade conditions require. Install geotextiles according to manufacturer's written instructions, overlapping sides and ends.

D. Place Crushed Gravel Base course under hot-mix asphalt pavement.

E. Shape to required crown elevations and cross-slope grades.

F. Place 4 inches or less in compacted thickness in a single layer.

G. Place Crushed Gravel Base that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

H. Compact Crushed Aggregate Base at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

1. Pavement Shoulders: Place shoulders along edges of Crushed Aggregate Base to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each layer to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: EXCHANGE shall hire an independent, qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing
subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Contracting Officer.

D. Testing agency will test compaction of soils in place according to ASTM D 1557. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS SOIL

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it. All surplus material shall be hauled to a designated site on base.

END OF SECTION 31 20 00
PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the requirements for start-up and commissioning of Division 32 installed Irrigation System work.

B. The Contractor shall test and provide written certification that the system installation complies with contract documents, code, and proper system operation. Perform acceptance tests in accordance with Commissioning Authority directives and manufacturer recommendations. Complete the installation and start-up checklists and testing procedures.

C. The Contractor shall provide expert personnel to start-up and test components and systems described in this section and related sections. The Contractor shall have a knowledgeable technician present at all testing and commissioning activities. The technicians shall assist the commissioning authority in the completion of the testing of components and systems.

D. The Contractor shall provide training to the owner on all installed systems and components and assist the Commissioning Authority in the development of training outlines, the training plan, and the training schedule.

E. SYSTEMS TO BE COMMISSIONED: The following systems will be commissioned by this section. The Contractor is required to provide qualified personnel to test these systems.

   1. Irrigation System

1.2 RELATED WORK

A. The following sections contain specific information on the systems to be commissioned. 01 91 00 – General Commissioning Requirements, Drawings and general provisions of the contract, including general and supplementary conditions and Division 32 specifications that apply to the work specified in this section, primarily Section 32 84 00 Irrigation Systems.

B. Sustainability – Conform to LEED requirements for use of regional materials and waste management.

1.3 SUBMITTALS

A. The Contractor shall submit copies of the manufacturer's installation and start-up procedures for all equipment listed to be commissioned to the Commissioning Authority (CA) for use in test preparation. The Contractor shall provide additional information as requested by the CA. This may include operation and maintenance data, factory text reports, training plan, and others.

B. Provide notification to the CA at least two weeks prior to the proposed date to perform commissioning activities.
C. Contractor shall warranty his work, parts and plant material for a period of one (1) year.

D. Any damage occurring on the job shall be the responsibility of the contractor and shall be repaired or replaced at the discretion of the owner and at no additional cost to the owner.

1.4 QUALITY ASSURANCE

A. Use only qualified and skilled technicians in the performance of the work.

B. Inform the CA of any impediments to the proper operation of installed components or systems. Keep all parties informed of problems encountered during the installation and testing process.

C. Use only expert training personnel to provide the owner high quality training on all aspects of the operation and maintenance of installed equipment.

D. Provide job specific operation and maintenance manuals. Cross out any information that does not apply. Use high quality copies. Fax reproductions are not acceptable. Organize the manuals as specified elsewhere.

1.5 SPECIFIC CONTRACTOR RESPONSIBILITIES FOR COMMISSIONING

A. The Contractor responsibility for Commissioning is to be executed as detailed in Section 01 91 00: installation verification, start-up, functional performance testing, and concluded with completion of required training activities.

B. Contractors responsible for the completion of the work within this section shall have specific responsibilities related to demonstrating the equipment and systems provided have been installed and function per the contract specifications. These responsibilities are as follows:

1. Assist the CA in the development of specific functional performance test procedures relative to their scope of work.
2. Provide written confirmation of system readiness for start-up and functional performance testing to the CA.
3. Demonstrate system performance to the CA through completion of the functional performance testing process, per the procedures and acceptance criteria provided by the CA.

C. The Owner shall not accept equipment and systems, and the owner shall not make final payment, until all equipment and systems have been successfully commissioned and all specified requirements have been satisfied.

1.6 INSTALLATION VERIFICATION AND START-UP

A. The CA shall conduct an independent Installation Verification using checklists created to indicate the following test requirements:

1. Installation
   a. Pipe scheduled thickness based on project documents
   b. Pipe and wires routed through scheduled sleeves under pavement
   c. Valves provided and installed per detail drawings and specifications
   d. All valve boxes located near curbs, paved surfaces, or in planting beds
   e. Irrigation controllers with specified features installed per project documents
f. Low voltage wiring to control panels complete, low voltage wiring in trenches secured per specification and expansion loops provided

g. Line voltage wiring completed to controller, disconnect is labeled

h. Hydrostatic testing of piping completed for mains and piping over 2” in diameter

i. Bedding and backfill around piping has been installed per project documents

2. Start-Up

a. System has been cleaned and flushed per project documents

b. Valve operation has been adjusted and verified for each zone

c. Heads have been adjusted and tested for coverage

d. Damaged heads, pipe and accessories have been repaired or replaced

e. All known issues have been corrected or reported to the CA and the system is ready for the Functional Performance phase of testing.

1.7 FUNCTIONAL PERFORMANCE TESTING

A. The Contractor shall be responsible for supporting commissioning activities. This may include pre-testing, inspections, functional performance testing and training activities

B. At a minimum, Commissioning testing will comprise the following tests:

1. Operate each manual and automatic valve and verify complete shutoff and full flow conditions.

2. Verify and document operation of all zone programming functions, scheduling, grouping, and manual over-ride. This test will require programming a short duration schedule for test purposes.

3. Verify and document spray pattern of each head and visually check for conformance to plans.

4. Visually verify complete spray coverage of all areas per plan. Call for adjustments, as needed.

5. Verify and document distribution in inches per hour by utilizing a water capture system with containers located every two feet from spray head to end of pattern Ten (10) percent of each head type shall be tested.

6. Verify and document operation of all quick couplers by inserting quill.

END OF SECTION 32 08 00
SECTION 32 12 00
FLEXIBLE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION
A. Work under this section includes pavement for asphalt paths, service roads and roadways. The lines, grades and respective thicknesses are indicated on the Drawings.

1.2 RELATED WORK
A. Section 31 20 00 – Earth Moving.

1.3 SUBMITTALS
A. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.
B. Test Reports: Prior to placement of any materials, employ and pay independent testing laboratory to test paving mixture for conformance to density and stability requirements.

1.4 SITE CONDITIONS
A. Weather Limitations: Apply prime and tack coats when ambient temperature is not below 50 deg F. Do not apply when base is wet or contains an excess of moisture.
B. Place subsurface and surface courses when temperature is at least 35 deg F and rising. Do not apply when base is wet or contains an excess of moisture.
C. Grade Control: Establish and maintain required lines and elevations.

1.5 QUALITY ASSURANCE
A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.6 SUSTAINABILITY CHARACTERISTICS
A. Aggregate for asphalt paving shall be regionally sourced as defined in SECTION 01 60 00 PRODUCT REQUIREMENTS.

PART 2 – PRODUCTS

2.1 EXPANSION DIVIDER STRIPS
A. Expansion joint filler shall be fiber type, composed of can fibers, uniformly saturated with a bituminous binder, which meets the requirements of ASTM D1751.
2.2 ASPHALT CONCRETE PAVEMENT

A. Asphalt Concrete Pavement shall meet the standards of Section 5-04 of WSDOT 2012 Standard Specifications for Hot Mix Asphalt Class ½ P6 64-28 as shown on the Plans.

B. Current mix design approved by WSDOT shall be submitted to the Owner and the Architect at least 2 weeks prior to pavement placement.

2.3 SOIL STERILANT

A. Soil Sterilization: The sterilant shall be a borate or chlorate sterilant containing not less than 25% sodium chlorate and shall be mixed thoroughly with water at a rate of 1-1/2 lbs. of sterilant per gallon of water.

2.4 TACK COAT

A. Emulsified Asphalt: Emulsified asphalt shall conform to ASTM D 977, Type SS-1 or SS1h. Dilute the emulsified asphalt with equal parts of water. The base asphalt used to manufacture the emulsion shall show a negative spot when tested in accordance with AASHTO T 102 using standard naphtha.

2.5 PRIME COAT

A. Asphalt shall conform to AASHTO M 82.

B. Cutback Asphalt shall conform to ASTM D 2027, Grade MC-70.2.1.2 Emulsified Asphalt.

C. Emulsified asphalt shall conform to ASTM D 977, Type SS-1 or SS1h.

2.6 PAVEMENT MARKINGS

A. Traffic directional control markings shall be thermoplastic, or as called out on Plans.

B. Traffic parking striping shall be water base pavement marking paint complying with Federal Specification TT-P-1952-E. Two coats shall be applied at manufacturer’s recommended rates.

C. Color: White, except where noted as yellow.

2.7 SIGNS:

A. Signs shall meet requirements of the Manual of Uniform Traffic Control Devices. Reflective sheeting shall be high intensity grade for all signs.

1. Traffic sign posts shall be fabricated from schedule 40, hot-dipped galvanized pipe, ASTM A-53. The pipe shall be threaded on both ends.

2. Couplings, where required shall be hot-dipped galvanized. Posts shorter than 10 feet in length shall not contain couplings. One coupling is permitted in posts over 10 feet in length.

3. Pipe caps, where required, shall be hot-dipped galvanized.

4. Sign Mounts: Sign mounts shall be stainless steel brackets with stainless steel strapping and stainless steel buckles.

5. Sign posts and back of signs shall be painted facility standard color to match existing signs.
6. Existing signs in acceptable shape may be relocated but shall be installed on new posts and base.
7. Signage must meet recycled content requirements.

2.8 SLEEVES FOR IRRIGATION AND FUTURE USES:

A. ASTM D 1785, Schedule 40 PVC Pipe, 6" diameter minimum.

PART 3 - EXECUTION

3.1 PAVEMENT CUTTING

A. Existing BST pavement shall be first cut by an appropriate means to facilitate removal. Immediately prior to placement of “patch”, the existing pavement shall be sawcut with a mechanical saw manufactured for such purposes along rectangular lines as shown on the Plans or as indicated by the Architect and the pavement removed so as to provide a firm, neat, straight, vertical edge to join. The Contractor shall be responsible for maintaining the edge. Additional saw-cuts will be required to correct broken or damaged edges.

3.2 ALIGNMENT, GRADES, BASE COURSE

A. Layout areas to be surfaced. Compact base course true to grades indicated, free from ridges or depressions, all sloped for good drainage, until the base course is compacted as specified.
B. The subbase shall be stripped of all deleterious materials prior to construction of base course.
C. General: Remove loose material from compacted base course surface immediately before applying herbicide treatment or prime coat.
D. Proof-roll prepared base course surface to check for unstable areas and areas requiring additional compaction.
E. Notify Contractor of unsatisfactory conditions. Do not begin paving work until deficient base course areas have been corrected and are ready to receive paving.

3.3 CRUSHED SURFACING TOP COURSE AND STERILIZATION

A. The area to receive base course and pavement shall be excavated to proper depth to obtain the finish contours and elevations shown on Drawings. After grading, the entire surface shall be checked for unstable soil areas which are not suitable for subgrades. These areas must be excavated to reach stable soil and then be backfilled with suitable materials. The entire area then shall be rolled to required compaction as per Section 31 20 00 – Earth Moving.
B. Provide crushed surfacing top course to depths shown on road cross-section details. Place material in lifts not to exceed 4 inches. Compact each lift to provide in-place compacted density not less than 95% of ASTM D1557 Maximum density.
C. Maintain final surface until it is paved. If ruts, soft spots, or other types of damage occurs before paving, then repair surface and test compaction.
D. Prior to paving, a soil sterilant shall be applied to the completed surface per manufacturer's recommendation.
3.4 HOT MIX ASPHALT

A. Hot Mix Asphalt shall be compacted in one or more lifts over the crushed surfacing. An approved herbicide (weed kill) shall be applied to the crushed surfacing prior to paving. Tack coat shall be applied to all existing pavement and concrete surfaces prior to the HMA placement.

B. Surface Preparation

1. Proof roll prepared subbase surface to check for unstable areas and areas requiring additional compaction.
2. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

C. Placing Mix

1. General: Place asphalt concrete mixture on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 250°F. Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness.
2. Paver Placing: Place in strips not less than 10' wide, unless otherwise acceptable to Architect. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
3. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construction joints to have same texture, density and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

D. Rolling

1. General: Begin rolling when mixture will bear roller weight without excessive displacement.
2. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
3. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filing, if required, with hot material.
4. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.
5. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

E. Compaction: In place compaction shall be determined using ASTM S-2922. Compaction shall continue until mixture has achieved 92% of Rice Density. The Testing Lab shall test compaction and submit certified reports.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective area. Cut out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.5 TACK COAT
A. Tack coat of .05 to .15 gallons per square yard of an emulsified asphalt shall be applied to vertical surfaces of curbs, gutters, and other structures below the pavement surface including between lifts, prior to laying of asphalt mix.

3.6 SMOOTHNESS
A. The completed pavement surface shall be smooth, dense and of uniform texture and appearance. All areas shall drain with flow lines being free of depressions, which permit water to stand.

3.7 ADJUSTMENTS TO GRADE
A. During paving operation all new and existing manhole covers, valve boxes and any similar type of improvement shall be adjusted to finished grade.

3.8 PLACEMENT OF ASPHALT AGAINST CURB OR COLD JOINT
A. Where the asphalt pavement is to be placed against a concrete or stone curb or gutter, or against a cold pavement joint or any metal surface, a thick paint of cutback asphalt shall be applied in advance of the placing. The application shall be thin and uniform. Avoid accumulation of asphalt in depressions.

3.9 DEFECTIVE WORK, CLEAN-UP
A. Remove and replace defective and irregular (that which is not free from ridges or depressions) pavement, and that which does not drain properly. (Surface patching is not acceptable). Contractor shall sawcut defective portions of work and replace in entirety.

3.10 DEFECTIVE WORK, CLEAN-UP
A. Remove and replace defective and irregular (that which is not free from ridges or depressions) pavement, and that which does not drain properly. (Surface patching is not acceptable). Contractor shall sawcut defective portions of work and replace in entirety.

3.11 WEATHER LIMITATIONS
A. Bituminous course shall not be constructed on any wet surface or when inclement weather threatens to interrupt the satisfactory placement of the asphalt concrete.

B. Asphalt concrete placement shall cease when rain commences and shall not recommence without the approval of the Technical Representative of the Contracting Officer. Truck loads of bituminous mixtures which have been wet due to exposure to rain, water or runoff from tarpaulins or canvas covering the truck shall not be placed.

3.12 TRAFFIC SIGNS AND PARKING MARKINGS
A. Cleaning: Sweep and clean surface to eliminate loose material and dust.

B. Signs shall be placed at the locations indicated on the plans.
C. Traffic control markings shall be placed as indicated on Sheet C101.

3.13 TESTING

A. Mix Designs:

1. Mix designs must be current for the calendar year with regard to all factors affecting the mix, and must be submitted for each class of A.C.P. for approval 10 working days before first paving. Tolerances are given for deviation from design mix gradation and asphalt content.

2. Plant Inspection: The Owner's Representative shall have access at all times to all parts of the mixing plant for checking the adequacy of the equipment in use, inspecting the operation of the plant, verifying weight, proportions and character of materials, and checking temperatures being maintained in the preparation of the mixtures.

B. Crushed Surfacing Top Course:

1. Contractor shall provide a sieve analysis of the aggregate once, every day that surfacing is being placed. The sample shall be taken from material being placed that day. Contractor shall furnish a proctor for crushed rock, select fill and paving to Contracting Officer and the Architect.

C. Asphalt

1. Contractor shall provide a test report showing percent of asphalt and sieve analysis of extracted aggregates for each day of paving. The sample shall be taken at the site from a truck containing mix being placed that day.

D. Thickness Test:

1. The thickness of the compacted leveling and surface courses will be measured at intervals such that there shall be a depth measurement for each 1,000 square yards or fraction thereof of each completed course. The depth measurements shall be made by test holes at least three inches in diameter through the compacted material. The thickness shall vary from indicated thickness by not more than 1/4 inch. Where the irregularities of the surface or the deficiency in depth are more than the specified tolerance, the defective work shall be removed and replaced with new material without additional cost to the Owner.

2. Thickness shall be checked by the Contractor during progress of the work either by inserting a measuring stick in the uncompacted surface course for the required compacted thickness of the material or by other profile control devices attached to the paving machine.

3. Each course shall be laid in lifts not to exceed four inches maximum.

E. Test Identification: Asphalt concrete-in-place from different plants shall be identified as to its plant source for test correlation.

F. Quality control testing which is the responsibility of the Contractor shall be completed by a licensed testing lab. All cores taken for testing shall be patched by the Contractor at no expense to the Owner.

G. Soil Sterilization: Provide 5 year warranty from sterilant manufacture
H. Without extra cost to the Owner, remove and repair any areas that settle or break up within a year of project complete or Owner Occupancy, whichever comes first. Repairs to be accomplished with hot mix asphalt.

I. Copies of tests certified by a testing laboratory are required with requests for payment. All test reports shall include the project name, testing lab, contractor, and date.

END OF SECTION 32 12 00
SECTION 32 13 00
CONCRETE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION
A. Furnish and install Portland cement concrete paving complete, in place. Extent of Portland cement concrete paving is indicated on the Drawings and as specified herein.
B. This section includes:
   1. Curbs and gutters
   2. Walkways

1.2 RELATED WORK:
A. Section 03 30 00 – Cast in Place Concrete
B. Section 31 20 00 – Earth Moving
C. Section 32 12 00 – Flexible Paving
D. Section 33 40 00 – Storm Utility Drainage Piping

1.3 SUBMITTALS
A. Provide samples, manufacturer’s product data, test reports, and materials’ certifications as required in referenced sections for concrete and joint fillers and sealers.

1.4 QUALITY ASSURANCE
A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.
B. Accessibility Requirements: ADAAG and local requirements.
C. Construction Tolerance: 1/8-inch in 10 feet for grade and alignment of top of forms; 1/4-inch in 10 feet for vertical face on longitudinal axis.
D. Install concrete and joint patterns as detailed in the Drawings.
E. Testing: Contractor shall hire an independent, Owner approved, testing laboratory or entity.

1.5 PROJECT CONDITIONS
A. Traffic control: Maintain access for vehicular, pedestrian and emergency vehicle traffic as required for other construction activities and existing facilities.
B. Coordinate signage and barriers to direct traffic flow around the work area for operations. Review changes and movement of barriers as the work progresses with Contracting Officer. Allow minimum of 3 days for paving to cure prior to allowing other than foot traffic on surface.
1.6 LEED DOCUMENTATION

A. Product data for LEED-NC Credit MR 5.1 AND 5.2: Provide letter from concrete supplier listing sources and percentages of raw materials, and location of concrete batching plant.

B. Cement, sand and aggregate shall be regionally sourced.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Formwork Materials: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

B. Use flexible spring steel forms to form radius bends as required.

C. Form release agent:
   1. Provide commercial formulation form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   2. Form release agent shall meet biobased requirement. All HM must be authorized by Pollution Prevention.

D. Calcium chloride shall not be used unless approved by the Contracting Officer.

E. Antispalling compound: Boiled linseed oil and mineral spirits, complying with AASHTO M-233.

F. Concrete: ASTM C150, Type 1 Portland cement; ASTM C33, normal weight aggregates; potable water.
   1. Design Mix: ASTM C94, 4000 psi (27.6 Mpa), 28 days minimum compressive strength.
   2. Slump Limits: 8 inches minimum with superplasticizer, 3 inches otherwise.
   3. Air Content: 5% to 8%.
   4. Finish: Broom finish, perpendicular to direction of travel.

G. Bonding Compound: Polyvinyl acetate or acrylic base.

H. Welded Wire Mesh: Welded plain cold-drawn steel wire fabric, ASTM A 185. Furnish in flat sheets, not rolls, unless otherwise acceptable to Contracting Officer.

I. Reinforcing Bars: Deformed steel bars, ASTM A 615, Grade 60.

J. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.


L. Liquid-Membrane Forming and Sealing Curing Compound: Comply with ASTM C 309, Type 1, Class A unless other type acceptable to Contracting Officer. Moisture loss no more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work which conform to TT-C-800.

M. Epoxy Adhesive: ASTM C 881, 2-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements.

N. Available Products: Subject to compliance with requirements, products which may be incorporated in the work which meets FS MMM-G-650.

O. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis. Mix in properties as needed to match architects color control sample with design strength as noted.

2.2 CONCRETE MIX

A. Materials shall conform to WSDOT Standard Specifications (2012) and meet the following material requirements:

1. Portland Cement – WSDOT Spec 9-01
2. Aggregates – WSDOT Spec 9-03
3. Premolded Joint Filler – 9-04.1
4. Concrete Curing Materials and Admixtures – WSDOT Spec – 9-23

PART 3 - EXECUTION

3.1 Examination / Preparation

A. Surface Preparation: Compact sub-base.

B. Forms: Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations.

C. Joints: Locate and install contraction, construction, isolation, and expansion joints as indicated or required.

1. Provide control joints (CJ) as shown on drawings. If no control joints are shown provide at 5 feet on center each way. Coordinate with Contracting Officer for point of beginning and module prior to pouring.
2. Provide expansion joints (EJ) as shown on drawings. If no expansion joints are shown provide at 20 feet on center each way

3.2 BASE COURSE MATERIAL:

A. General: Base course consists of placing base course material, in layers of specified thickness, over prepared subgrade surface to support a pavement course.

B. Placing: Place base course material on prepared subgrade in layers of uniform thickness, conforming to required cross section and thickness. Maintain optimum moisture content for compacting base course material during placement operations.

1. When a compacted base course is shown to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.
3.3 SURFACE PREPARATION:

A. Remove loose material from compacted base course surface immediately before placing concrete.

B. Proof-roll prepared base course surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

3.4 FORM CONSTRUCTION

A. Set forms to required grades and lines, braced and secured. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork for grade and alignment to following tolerances:
   1. Top of forms not more than 1/8 inch in 10 feet.
   2. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

D. Slope step treads at 1/4 inch per foot to drain.

3.5 REINFORCEMENT

A. Locate, place, and support reinforcement as specified in Division 3 sections, unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. General: Comply with requirements of Division 3 sections for mixing and placing concrete, and as herein specified.

B. Do not place concrete until base course and forms have been checked for line and grade, and all free of all deleterious material. Moisten base course if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

C. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints. Use only square-faced shovels for hand spreading and consolidation.

D. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

E. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than 1/2 hour, place a construction joint.
F. Curbs and Gutters: Automatic machine may be used for curb and gutter placement at Contractor's option. If machine placement is to be used, submit revised mix design and laboratory test results that meet or exceed minimums specified. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.7 JOINTS

A. General: Construct construction, isolation, and expansion joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

B. When joining existing pavement place transverse joints to align with previously placed joints, unless otherwise indicated.

C. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation or expansion joints.
   1. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

D. Isolation and Expansion Joints: Form isolation and expansion joints of pre-formed joint-filler strips abutting concrete curbs, catch basins manholes, inlets, structures, walks, other fixed objects, and where indicated.
   1. Locate expansion joints at intervals of 15 feet (15.25m), unless otherwise indicated.
   2. Extend joint fillers full width and depth of joint.
   3. Terminate joint filler 1/2 inch (12mm) below finished surface.
   4. Place top of joint filler below finished concrete surface and fill joint with sealant.
   5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
   6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.8 CONCRETE FINISHING

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture.

B. After floating, test surface for trueness with a 10-ft. straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.

C. Work edges of slabs, gutters, back top edge of cut, and formed joints with an edging tool, and round to 1/2-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.
D. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:

1. Broom finish by drawing a fine-hair broom across concrete surface perpendicular to line of traffic. Repeat operation if required to provide a fine line texture acceptable to Contracting Officer.
   a. On inclined slab surfaces, provide a coarse, non-slip finish by scoring surface with a stiff bristled broom, perpendicular to line of traffic.
   b. See Section 03 30 00 for application of integrally colored concrete and exposed aggregate surfaces.

E. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Contracting Officer.

3.9 CURING

A. Protect and cure finished concrete paving in compliance with applicable requirements of Division 3 sections. Use membrane-forming curing and sealing compound or approved moist curing methods.

3.10 WEATHER PLACEMENT CONDITIONS

A. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40 deg F (4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C), and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt and other materials containing antifreeze agents.

B. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength on concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F (32 deg C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated in total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor’s option.
2. Cover reinforcing steel with water soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
3. Fog spray forms, reinforcing steel and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.11 REPAIRS AND PROTECTIONS

A. Repair or replace broken or defective concrete, as directed by Contracting Officer.
B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When Construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

C. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.
3.12 FIELD QUALITY CONTROL

A. See Section 03 30 00 and 01 40 00 for Field Quality Control testing.

END OF SECTION 32 13 00
SECTION 32 84 00
IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:
   A. Furnish all material, equipment and labor required to perform and complete the installation of an automatic landscape irrigation system, as shown on plans and specified herein and as directed by the Owner’s Representative.

1.2 RELATED WORK UNDER SEPARATE CONTRACT
   A. Electricity to controller (by general contractor). See Landscape Irrigation Plan for controller location.
   B. Water tap.
   C. Installation of stub-out for irrigation system.

1.3 RELATED WORK WITHIN OTHER SECTIONS
   A. 31 10 00 – Site Clearing
   B. 31 20 00 – Earthworks
   C. 32 90 00 – Planting
   D. 32 91 00 – Soil Preparation
   E. 32 92 00 – Turf and Grasses
   F. Division 22 – Plumbing
   G. Division 26 - Electrical

1.4 QUALITY ASSURANCE
   A. Criteria:
      1. All manufacturers regularly and presently manufacture the item submitted as one of their principal products.
      2. The Contractor shall render satisfactory service within twenty-four hours of receipt of notification that service is requested.
      3. Installer, or supplier of a service, has technical qualifications, experience, and trained personnel and facilities to perform the specified work.
   B. Products Criteria:
      1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
      2. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, shall assume complete responsibility for the final assembled product.
a. All components of an assembled unit need not be products of the same manufacturer but component parts which are alike are the product of a single manufacturer.
b. Components shall be compatible with each other and with the total assembly for the intended service.

C. System Requirements:

1. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown. Lines are to be common trenched wherever possible.
2. Locations of remote control valves are schematic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads.
3. Irrigation lines and control wire shall be placed under landscaped areas wherever possible. When absolutely necessary to be located under paved surfaces, pipes and wires shall be placed in SCH 40 PVC sleeves, as specified herein and on plans.

D. Maintenance and Operating Instructions: Prior to final acceptance, provide verbal instructions to the operating personnel. Provide manuals as specified in Section 01 00 00, GENERAL REQUIREMENTS.

E. Completely program controller system according to approved irrigation schedule.

F. Follow manufacturer’s instructions for installation.

G. As-Built Record Drawings: Maintain a complete set of as-built drawings which shall be corrected daily to show changes in locations of all pipe, valves, pumps and related irrigation equipment. Valves shall be shown with dimensions to reference points.

H. Controller Chart:

1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. “As-built” drawings must be reviewed and approved before charts are prepared.
2. Provide one controller chart showing the area covered by the controller system. Chart shall be a reduced drawing of the actual “as-built” system.
3. Chart shall be a blackline copy with a different color used to show area of coverage for each station. Charts must be completed and approved prior to final review of the irrigation system.

1.5 QUALITY ASSURANCE

A. Certificate of Qualification: Prior to bid acceptance, submit certification of installer’s experience identifying a minimum of four (4) previous projects with names of Owner’s and Landscape Architects for each project listed.

B. Codes and Standards: All work and materials shall be in full compliance with all Federal, State and Local codes and design standards. Nothing in these plans or specifications shall be construed to permit work not conforming to these requirements.

C. Any “call-outs” of a product name to be used shall automatically infer that the phrase “or approved equal” shall follow.

D. Change without the Owner’s consent is subject to disapproval and may require replacement at no additional cost to the Owner.
1.6 PERMITS AND FEES

A. The procurement of all licenses and permits, necessary for beginning and completion of work and the payment of all testing, damage repair, inspections and other applicable fees, shall be included under this heading and the responsibility of the contractor unless within an agreement with the General Contractor.

B. Where provisions of pertinent codes and standards conflict with the requirements of this section of these specifications, the more stringent provisions shall govern.

1.7 SUBMITTALS

A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Manufacturers’ Literature and Data:
   1. Piping.
   3. Valves.
   4. Automatic controller and cabinet.
   5. Control wire
   6. Wire connectors
   7. Sprinkler heads.
   8. Quick couplers.
   9. Valve boxes.
   10. Purple metallic locator ribbon

C. Name and address of a permanent service organization maintained or trained by the manufacturers that will render satisfactory service within eight hours of receipt of notification that service is requested.

D. Reproducible “as-built” drawings.

E. After “as-built” drawings have been approved, submit print of controller chart.

1.8 PROTECTION

A. Utilities: Protect existing utilities within construction area; repair to the satisfaction of the owner, any damages to utilities that occur as a result of the work provided for this section, at no additional cost to the owner.

B. Provide protection of persons and property throughout the progress of work. The work shall proceed in such a manner as to minimize the spread of dust or any flying particles and to provide safe working conditions for employees, other construction personnel, site visitors, residents and adjacent property owners.

C. Execute all work in an orderly and careful manner to protect pavement, walks, work of other trades, items to remain, and other improvements. Restore all damage caused during executions of this section to the Owner’s satisfaction at no additional cost to the Owner.

D. If there is a question about potential damage, stop work in the area and call the Owner’s Representative and review problem for acceptable solution. Proceeding with work in that area may preclude the Contractor from gaining additional fees for repair of damaged improvements or existing features.
1.9 CLEAN-UP

A. Contractor shall maintain cleanliness in all areas of this operation and shall remove all debris within the limits of work. Contractor shall remove from the project site in a legal manner, all rubbish and debris resulting from this contract work, leaving site in a safe and clean condition on a day-to-day-basis.

1.10 WARRANTY

A. Contractor shall warranty his work and parts for a period of (1) year beginning on the date of acceptance of irrigation system. Any repairs or replacements, deemed to be the contractor's responsibility, shall be remedied immediately with in-kind material and to the owner's satisfaction and at no additional cost to the owner. The contractor shall replace material within 15 days of written notice from the owners' representative. Replacement material shall be warranted for the time remaining on the original warranty period.

1.11 APPLICABLE PUBLICATIONS

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

B. American Society for Testing and Materials (ASTM):

1. B61-02 ..................... Steam or Valve Bronze Castings
2. B62-02 ..................... Composition Bronze or Ounce Metal Castings
3. D1785-04a ................. Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120
4. D2287-96(2001) ........... Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
5. D2464-99e1 .............. Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
8. F477-02e1 ................ Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C. American Water Works Association (AWWA):

1. C110/A21.10-03 ..... Ductile-Iron and Gray-Iron Fittings, 3-inch Through 48-Inch for Water
2. C111/A21.11-00 ..... Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
5. C500-02 ................. Metal-seated Gate Valves for Water Supply Service C504-00 Rubber Sealed Butterfly Valves
6. C600-99 ................. Installation of Ductile-Iron Water Mains and Their Appurtenances

D. Manufacturers Standardization Society (MSS):

1. SP70-1998 ............... Cast Iron gate Valves, Flanged and Thread Ends

E. National Electrical Manufacturers Association (NEMA):

1. 250-2003 ................. Enclosures for Electrical Equipment (1000 Volts Maximum)
PART 2 - PRODUCTS

2.1 PIPING, FITTINGS, SLEEVES AND CONDUIT

A. Irrigation Mains: Polyvinyl Chloride, Schedule 40 ASTM D 2241, PVC 1120, SDR 21, solvent welded.

B. Irrigation Laterals: Polyvinyl Chloride, Schedule 40 ASTM D 2241, PVC 1120, SDR 21, solvent welded.

C. Sleeves: All OVC ‘sleeve’ pipe under pavements and roadways shall be Polyvinyl Chloride, Schedule 40, ASTM D2241, PVC 1120, SDR 21, solvent welded. SLEEVES SHALL BE A MINIMUM OF TWICE THE SIZE AS THE INSERTED PIPE, unless otherwise noted. LOW VOLTAGE wire sleeves are called out on the irrigation plans. All sleeves shall extend a minimum 12” beyond edge of pavement.

D. IMPORTANT: Exposed control wire to the controller shall only be placed in Electrical Metallic Tubing (EMT) for interior building locations and PVC pipe for exterior building locations.

E. Threaded Pipe: Polyvinyl Chloride, ASTM D1785, PVC 1120, Schedule 80, for threaded connections, risers and swing joints.

F. Fittings:

1. Irrigation Mains: PVC, Schedule 40, solvent welded socket type, ASTM D2466.
2. Irrigation Laterals: PVC, Schedule 40, solvent welded socket type, ASTM D2466.
4. Swing Joints: Threaded fittings with elastomeric seals that allow 360 degree rotation, and designed for minimum 1375 kPa(200 psig) working pressure, may be used in lieu of standard threaded fittings.

2.2 VALVES (EXCEPT REMOTE CONTROL VALVES)

A. Underground Shut-Off/Isolation Valves:

1. Ball valves (for isolation valves 4” and smaller): Full-port ball valves with bronze body, PTFE seats, and 90 degree on/off handle. Ball valves to have NPT female end connections to accommodate the type of pipe installed.

2.3 VALVE BOXES

A. Valve boxes & sizes: Shall be green plastic "Rainbird", "Carson - Brooks". Control valve boxes shall be 15" x 21.5" top access, 12" deep w/bolt down cover. Round valve boxes, 10" diameter top access shall be used for quick coupler or main line isolation valves only. Where applicable, valve boxes shall be placed on level ground in a neat, orderly fashion, no closer than 12" apart.

B. After installation, label boxes with 80 mm (3 inch) size stencils with designated circuit numbers with permanent white epoxy paint. Numbers shall be placed at center of valve cover and shall face nearest main road or service road.

2.4 AUTOMATIC CONTROL EQUIPMENT

A. The automatic controller shall be Rainbird ESP Series. The number of modules shall be as specified on the plans.
2.5 REMOTE CONTROL VALVES:
   A. Remote Control Valves shall be Rainbird PESB-R, size as indicated on the Plans. Install valves with Schedule 80 PVC unions on each side to allow for easy removal. Valves shall have a minimum of (200 psi) working pressure.
   B. Valves shall be completely serviceable from the top without removing valve body from the system. Valves to operate at no more than 50kPa (7 psi) pressure loss at manufacturers maximum recommended flow rate.

2.6 SPRINKLER HEADS
   A. Flood Bubbler:
      1. Rainbird 1800 Bubblers, as specified on plans.

2.7 QUICK COUPLERS
   A. Metal parts shall be brass, size and model number as shown on plans.
   B. Lids shall be lockable, vinyl covered, and have springs for positive closure on key removal.
   C. Furnish three (3) hose swivels and operating keys for each size coupler to the Owner’s Representative.

2.8 LOW VOLTAGE WIRE
   A. All direct burial wire shall be 14 Type UF, 600 Volt PVC insulated, solid copper. Black in color for the control wire, and white to be used as a common wire.

2.9 TRACER WIRE
   A. No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with all non-metallic irrigation main lines.

PART 3 - EXECUTION

3.1 PIPE LAYING – GENERAL
   A. Do not lay pipe on unstable material, in wet trench or when, in the opinion of Owner’s Representative, trench or weather conditions are unsuitable for the work.
   B. Allow a minimum of 80 mm (3 inches) between parallel pipes in the same trench.
   C. Hold pipe securely in place while joint is being made.
   D. Do not work over, or walk on, pipe in trenches until covered by layers of earth well tamped in place to a depth of 300 mm (12 inches) over pipe.
   E. Full length of each section of pipe shall rest upon the pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking.
   F. Install sprinkler lines to avoid heating trenches, electric ducts, storm and sanitary sewer lines, and existing water and gas mains, all of which have right of way.
G. Clean interior of pipe of foreign matter before installation. Keep pipe clean during laying operations by means of plugs or other methods. When work is not in progress, securely close open ends of pipe and fittings to prevent water, earth, or other substances from entering.

H. Each main line section shall drain to manual drain valves placed at lowest points in the system. Drain valves shall discharge to drainage sumps filled with drain rock placed under the lawn areas.

I. Minimum cover over water mains shall be 60 cm (24 inches). Control valves shall never be less than 8 cm (3 inches) below finished grade. Cover laterals to minimum depth of 46 cm (18 inches).

J. Roadways, sidewalks and curbs shall not be cut during trenching and installation of pipe. Install pipe under sidewalks and curbs through sleeves. Repair or replace any concrete that cracks, due to settling, during the warranty period.

K. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all work thoroughly clean fixtures exposed materials and equipment.

L. Warning tape shall be continuously placed 300 mm (12 inches) above sprinkler system water mains and laterals.

M. Bubblers shall be installed so that the bubbler is placed vertically. The bubbler shall protrude above the soil a height one inch above the earth saucer.

3.2 LAYING PLASTIC PIPE

A. Shall be snaked in trench at least 1 meter to 100 meters (1 foot per 100 feet) to allow for thermal construction and expansion and to reduce strain on connections.

B. Joints

2. Threaded Type: Apply liquid Teflon thread lubricant of Teflon thread type. After joint is made hand tight (hard), a strap wrench should be used to make up to two additional full turns.

3.3 INSTALLATION OF CONTROL WIRING

A. Wiring from central controller equipment to control valves and stub-outs for future extension shall be located in trench with new mains or in separate trench at back of pavement. Locate in trench with mains when possible.

B. Wiring bundles located with piping shall be set with top of the bundle below top of the pipe. No two wires in any bundle shall be of the same color. Wires shall be bundled, and tied or taped at 4.5 m (15 foot) intervals. A numbered tag shall be provided at each end of a wire, i.e., at valve, at sensors and at Remote base unit controller. The number at each end of wire to be the same.

C. Splicing shall be held to a minimum. An eight inch round pullbox shall be provided at each splice.

D. Provide 30 cm (12 inch) expansion loops in wiring at each wire connection or change in wire direction. Provide 60 cm (24 inch) loop at remote control valves.
E. Power wiring for the operation of irrigation system shall not be run in same conduit as control wiring.

3.4 TRACER WIRE INSTALLATION

A. Tracer wire shall be installed on top of piping, carefully installed to avoid stress from backfilling, and shall be continuous throughout length of pipe with specified splice materials at connections.

B. Tracer wire shall follow all main line piping and terminate in valve box controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make a loop and attach a plastic label with designation “Tracer Wire”.

C. Record locations of tracer wires and their terminations on project record documents.

3.5 INSTALLATION OF CONTROLLER

A. Install the controller at eye level on the exterior of the building wall, at the location shown on the plans. Coordinate specific location with the Architect and electrical contractor. Install per all applicable codes and requirements.

3.6 SETTING OF VALVES

A. Valves shall be situated within shrub beds whenever possible. No valves shall be placed within drainage swales, under roads, pavement, walks, or edging.

B. Clean interior of valves of foreign matter before installation.

C. Where pressure control valves are installed adjacent to remote control valve, they shall be housed in the same valve box.

D. Set valve box cover flush with finished grade and/or top of top dressing. Place on level ground wherever possible.

3.7 SLEEVING

A. Furnish and install where pipe and control wires pass under walks, paving, walls, and other similar areas.

B. Sleeving to be as specified on Plans, and shall extend 45 cm (18 inches) beyond edges of paving or construction.

C. Bed sleeves with a minimum of 10 cm (4 inches) of sand backfill above top of pipe.

3.8 TEST AND FLUSHING

A. Pressure Test: Pressure test lines before joint areas are backfilled. Backfill a minimum of 30 cm (12 inches) over the pipe to maintain pipe stability during test period. Test piping at hydraulic pressure of 1025 kPa (150 psi) for minimum 30 minutes with maximum 5 psi loss. Locate pump at low point in line and apply pressure gradually. Install pressure gage shut-off-valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks. Line shall be retested until satisfactory.
B. Flushing: After testing, flush system with a minimum of 150 percent of operating flow passing through each pipe beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.

C. Operation Test: Upon completion of the final adjustment of the sprinkler heads to permanent level at ground surface, test each sprinkler section by the pan test and visual test to indicate a uniform distribution within any one sprinkler head area and over the entire area. Operate the entire installation to demonstrate the complete and successful operation of all equipment.

END OF SECTION 32 84 00
SECTION 32 90 00
PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Furnish all material, equipment and labor required to complete all of the landscaping work shown on plans and specified herein. All existing plants and features designated to remain shall be protected from damage. If damage occurs, contractor shall repair, to Owner’s satisfaction, at no additional cost to the Owner.

B. The work shall include, but is not limited to, the following:

1. Finishing and fine grading all soil surfaces of planting areas as indicated on the plans.
2. Preparing soil in all planted areas as specified.
3. Fertilizing as indicated on the plans and specifications.
4. Disposing of excess soil and debris off the site as specified.
5. Constructing and installing landscape edging,
6. Furnishing and spreading rock and bark top dressing.

C. All scaled dimensions are approximate. Before proceeding with work, contractor shall verify all dimensions and quantities and shall immediately inform the Owner’s Representative of any discrepancy between the information on the drawings and the actual conditions. Contractor shall refrain from doing any work until given approval to do so by the Owner’s Representative. Proceeding with work in areas of discrepancy can nullify contractor’s ability to charge additional fees.

D. Planting quantities, and/or planting areas, are shown for the convenience of the contractor only, and are not guaranteed. All planting indicated on the drawings will be required unless indicated otherwise.

1.2 RELATED WORK WITHIN OTHER SECTIONS

A. 31 10 00 – Site Clearing
B. 31 20 00 – Earthworks
C. 32 84 00 – Irrigations Systems
D. 32 91 00 – Soil Preparation
E. 32 92 00 – Turf and Grasses

1.3 EQUIPMENT

A. Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.
1.4 SUBMITTALS

A. Certificates of Conformance or Compliance. Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Owner’s Representative for approval.

1. Plant Materials (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease)
2. Fertilizers
3. pH Adjusters
4. Compost
5. Organic mulch
6. Seed mixes

B. Manufacturer’s Literature and Data:

1. Antidesiccant
2. Erosion control materials
3. Hydro mulch
4. Pre-emergent herbicide
5. Tree stakes
6. Tree ties
7. Top Dressing Material
8. Plant list from source

C. All soils shall also comply with Section 32 91 13 - Soil Preparation.

1.5 DELIVERY AND STORAGE

A. Delivery:

1. Notify the Owner’s Representative of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches.
3. The use of equipment such as “tree spades” is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer and lime to the site in the original, unopened containers bearing the manufacturer’s warranted chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and lime may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.
5. During delivery: Protect seed from drying out and from contamination.

B. Storage:

1. Keep seed, lime, and fertilizer in dry storage away from contaminants.
2. Store plants not installed on the day of arrival at the site as follows:
   a. Shade and protect plants from the wind when stored outside.
   b. Heel in bare root plants.
c. Protect plants stored on the project from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss, or other similar mulching material.

d. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

1.6 PLANTING INSTALLATION SEASONS AND CONDITIONS

A. Perform planting operations during periods normal for optimum growth, as determined by season, weather conditions and forecasts, and accepted practice but not before irrigation system has been installed, tested, and approved.

B. All seeding in climates susceptible to freezing shall be completed so that germination and at least one inch (1") of growth is established before frost, regardless of any time extensions to the contract. All bare soils areas not seeded by said time, shall be covered by two inches (2") depth straw to prevent erosion during the winter months. Straw shall be provided and installed by Contractor at no cost to Government.

C. No planting work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the Owner’s Representative stating the special conditions and proposal variance.

1.7 PLANT ESTABLISHMENT PERIOD

A. The Establishment Period for plants and turf shall begin immediately after acceptance of the plant installation by the Owner’s Representative, and continue until the date that the Owner’s Representative accepts the project or phase for beneficial use and occupancy. During the Plant and Turf Establishment Period the Contractor shall:

1. Water all plants and native grasses to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 30 mm (1 ¼ inch) of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a moderate rate so as not to displace the mulch or flood the plants and turf.

2. Prune plants – remove dead and dying material. Not under any circumstance shall the contractor remove the central leader on any tree without the consent of the Owner’s Representative. Replace mulch as required.

3. Replace and restore tree stakes, tree ties, and eroded plant wells as required.

4. In plant beds and tree wells, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 75 mm (3 inches).

5. Spray with approved insecticides and fungicides to control pests and ensure plant survival in a healthy growing condition, as approved by the Owner’s Representative.

1.8 PLANT WARRANTY

A. All planting and seeding work shall be in accordance with the following:

B. A One Year Plant Warranty shall begin on the date that the Owner’s Representative accepts the project or phase for beneficial use and occupancy. The Contractor shall have completed, located, and installed all plants according to the plans and specifications. All plants are expected to be living and in a healthy condition at the time of final inspection.
C. The Contractor shall replace plant material that dies or is in poor condition as determined by the Owner’s Representative shall be replaced immediately with “in-kind” and same size plants, at no additional cost to the Owner. Material to be replaced shall be replaced by the contractor within 15 days of written notice for the Owner’s Representative. A one year warranty for the plants that were replaced will begin on the day the work is completed and accepted.

D. The Owner’s Representative will re-inspect all plants at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material immediately at no additional cost to the Government regardless of the reason. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:

1. Replace dead, missing or defective plant material prior to final inspection.
2. Mulch and weed plant beds and saucers. Just prior to this inspection, treat these areas to a second application of approved pre- emergent herbicide.
3. For plants having been installed for one year, remove tree stakes, tree ties and any required tree wrappings subject to the approval of the Owner’s Representative.
4. Complete remedial measures directed by the Owner’s Representative to ensure plant and turf survival.
5. Repair damage caused while making plant or turf replacements.

1.9 APPLICABLE PUBLICATIONS

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

B. American National Standards Institute (ANSI) Publications:

   ANSI Z60.1-04 .................Nursery Stock
   ANSI Z133.1-06 .................Tree Care Operations-Pruning, Trimming, Repairing, Maintaining and Removing Trees and Cutting Brush – Safety Requirements.

C. Hortus Third, A Concise Dictionary of Plants Cultivated in the U.S. and Canada.

D. American Society for Testing and Materials (ASTM) Publications:

   C136-06 ..........................Sieve Analysis of Fine and coarse Aggregates
   C516-02 ..........................Vermiculite Loose Fill Thermal Insulation
   C549-06 ..........................Perlite Loose Fill Insulation
   D977-05 ..........................Emulsified Asphalt (AASHTO M140)
   D2028-97 (Rev. 2004) ...............Cutback Asphalt (Rapid-curing Type)
   D2103-05 ..........................Polyethylene Film and Sheeting

   1998 ..............................Rules and Regulations

F. American Wood Protection Association (AWPA):
   C2-02 ..............................Lumber, Timbers, Bridge Ties and Mine Ties, Pressure Treatment
PART 2 - PRODUCTS

2.1 GENERAL

A. All plant and turf material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third Addition.

2.2 PLANTS

A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.

B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken roots systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from objectionable disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Plants that are root-bound, plants with girdling roots, or plants where the root flair is to deep as specified by American Standards for Nursery Stock (ANSI Z60.1-2004), will be rejected. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Spray all plants budding into leaf or having soft growth with an anti-desiccant at the nursery before digging. Contractor shall set a plant check meeting with Owner’s Representative prior to planting. Unapproved plants shall be replaced immediately with approved plants at no additional cost to the Owner.

C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Owner’s Representative, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.

D. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1. Dig and prepare plants for shipment in a manner that will not cause damage to branches, shape, and future development after planting.

E. Balled and burlapped (B&B) plant ball sizes and ratios will conform to ANSI Z60.1, consisting of firm, natural balls of soil wrapped firmly with burlap or strong cloth and tied.

F. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.

G. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the Owner’ Representative authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.
2.3 LABELS
A. Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

2.4 PLANTING SOIL MIXTURE
A. The planting soil mixture shall be composed of the screened native soil amended with fertilizers, pH adjusters and micronutrients in accordance with the approved Soil Test Laboratory recommendations or as listed on landscape drawings and details.

2.5 BIOSTIMULANTS
A. Biostimulants shall contain soil conditioners, VAM fungi, and endomycorrhizal and ectomycorrhizal fungi spores and soil bacteria appropriate for existing soil conditions.

2.6 PLANT FERTILIZER
A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.

B. Granular fertilizer shall contain a minimum percentage by weight of 16 nitrogen (of which 50 percent shall be organic), 16 available phosphoric acid, and 16 potash.

2.7 COMPOST MULCH
A. Compost mulch to be installed at the bottom of the rain gardens shall be ¾” in diameter, dark in color, have a pH value between 5 and 8, and contain 45-65% organic matter.

2.8 LANDSCAPE BOULDERS
A. Boulders shall be type and size specified on the plans. If not specified, all boulders shall be angular, granite rocks, clean and free of debris prior to setting in the landscape.

2.9 TREE STAKES AND TREE TIES
A. Provide 2” min. diameter pressure treated pine wood stakes for tree support. Drive stakes a minimum three feet (3’) into ground. Top of stakes shall be six feet (6’) above finished grade, stand vertically. And be consistent throughout the project.

B. Gro-Strait corded rubber tree tie, or approved equal.

2.10 TOP DRESSING
A. Top dressing within planting beds and where called out on plans shall either be Medium Bark Mulch, with less than 5% bark dust or 1”-1½” washed round river rock, as specified on plans.
2.11 WATER FOR IRRIGATION

A. Water shall not contain elements toxic to plant life. The Contractor shall be responsible for providing all water necessary to irrigate the plant material, clean up paved surfaces, and all other applications. Project that includes an irrigation system may utilize irrigation supply water for all water needs.

PART 3 - EXECUTION

3.1 EXCAVATION FOR PLANTING

A. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor’s expense. Where lawns have been established prior to planting operation, cover the surrounding turf before excavations are made in a manner that will protect turf areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction. The Contractor is responsible for assuring existing vegetation remains healthy during the construction process.

B. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the Owner’s Representative may select other locations for plant material.

C. Dig plant pits by any approved method so that they have flat bottoms. When the sides of the pits become glazed, scarify the glazed surface. Size the plant pits as shown, otherwise, the minimum allowable dimensions of plant pits shall be regardless of width, 150 mm (6 inches) deeper for shrubs and 225 mm (9 inches) deeper for trees than the depth of ball or root spread; for ball or root spread up to 600 mm (2 feet), pit diameters shall be twice the ball or root spread; for ball or root spread from 600 to 1200 mm (2 to 4 feet), pit diameters shall be 600 mm (2 feet) greater; for ball or root spread over 1200 mm (4 feet), pit diameters shall be 1-1/2 times the ball or root spread.

D. Using topsoil, form earth saucers or water troughs for watering around plants. Basins to be 2” high for shrubs and 2” high for trees. For plantings on slopes, create a 4” basin on the downhill side for shrubs and 6” high for trees.

E. Treat plant saucers, shrub, and ground cover bed areas, prior to mulching, with an approved pre-emergent herbicide. Plant ground cover in areas to receive erosion control material through the material after material is in place.

3.2 SETTING PLANTS

A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1” higher than the surrounding grade. Cut, remove and discard all ties, visible burlap and wire only after the tree is in its planting hole, at its proper depth and orientation, taking care not to break apart the root ball. Plant ground cover plants after the mulch is in place. Avoid contaminating the mulch with the planting soil.
B. Backfill balled and burlapped and container-grown plants with planting soil mixture as specified to approximately half the depth of the ball and then tamp and water. Tamp and water remainder of backfill Planting Soil Mixture; then form earth saucers or water basins around isolated plants with topsoil.

3.3 TRUNK WRAPPING

A. Remove shipping protection and pre-wrapping after planting.

3.4 TREE STAKING AND TREE TIES

A. Stake and tie trees as shown on the drawings and as specified.

B. Drive stakes vertically into the ground to a depth of 900 mm (3 feet) in such a manner as not to injure the ball or roots.

C. Remove stakes and ties after one year.

D. Ensure that the final height of the tree stakes and ties are uniform for all trees on the project.

3.5 PRUNING

A. Prune ONLY dead and damaged branches. Discard waste material.

3.6 WATERING

A. The contractor is responsible for providing all water during and after construction. Ensure that areas to receive “Dryland Grass” are sufficiently irrigated to the point where they become self-sufficient. This may include the use of a temporary irrigation system at no additional cost to the Government.

3.7 PROTECTION OF PLANTING AREAS

A. Protect all newly planted areas against foot and vehicle traffic or other use by erecting barricades, as required, and placing approved signs at appropriate intervals until final acceptance.

3.8 RESTORATION AND CLEAN UP

A. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turf work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the station.

END OF SECTION 32 90 00
SECTION 32 91 13
SOIL PREPARATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

A. Provide, install, and fine grade soils, as called out on plans and specifications. The work shall include, but is not limited to, the following:

1. Placing topsoil, as indicated on planting plans and herein.
2. Finishing and fine grading all soil surfaces of planting areas as indicated on the plans.
3. Preparing soil in all planted areas as specified.
4. Fertilizing and amending the topsoil as indicated on the plans and specifications, and recommended by soils laboratory.
5. Disposing of excess soil and debris off the site as specified.

B. All scaled dimensions are approximate. Before proceeding with work, contractor shall verify all dimensions and quantities and shall immediately inform the Owner's Representative of any discrepancy between the information on the drawings and the actual conditions. Contractor shall refrain from doing any work until given approval to do so by the Owner's Representative. Proceeding with work in areas of discrepancy can nullify contractor's ability to charge additional fees.

C. All topsoil quantities indicated on the drawings shall be verified prior to beginning operation. Any discrepancy shall be brought the attention of the Owner's Representative prior to commencing work.

D. All material shall be subject to the inspection and approval of the owner's representative at any time and at any place. The owner's representative may require samples of material prior to approval.

1.2 RELATED WORK WITHIN OTHER SECTIONS

A. 31 10 00 – Site Clearing

B. 31 20 00 – Earthworks

C. 32 84 00 – Irrigations Systems

D. 32 90 00 – Planting

E. 32 92 00 – Turf and Grasses

1.3 SUBMITTAL

A. Three (3) copies shall be supplied. Submit complete list of all plant materials indicating source of supply, order invoice, size and quantity for each species or variety. Cut sheets or reports of all following landscape planting items are required:
1. Source of topsoil
2. Fertilizers
3. Lab results for topsoil and lab recommendations for soil amendments to bring the topsoil into conformance with the specifications

B. Do not commence work until all items are approved.

1.4 WARRANTY

A. Contractor shall warranty his work, parts and plant material for a period of one (1) year.

B. Any damage occurring on the job shall be the responsibility of the contractor and shall be repaired or replaced at the discretion of the owner and at no additional cost to the owner.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil shall be a well-graded soil of good uniform quality. It should be a natural, friable soil representative of productive soils in the vicinity of the project site. Topsoil shall be free of admixture of subsoil, foreign matter, objects larger than 25 mm (one inch) in any dimension, toxic substances, weeds, and any material or substances that may be harmful to plant growth and shall have a pH value of not less than 5.0 nor more than 7.5.

B. If generated onsite, native topsoil meeting the requirements above shall be stripped, screened, and stockpiled in accordance with Section 31 10 00 SITE CLEARING.

C. Amend topsoil according to recommendations of Soils Testing Laboratory for fertilizers and soil amendments, including pH adjusters required for meeting pH range, organic matter, and micronutrients. If amended topsoil requirements call for more than has already called out, the contractor shall be reasonable be compensated for the additional cost generated.

2.2 SOIL MIX WITHIN BIOINFILTRATION SWALES

A. The soil mix within the bioinfiltration swales shall comply with the Western Washington Stormwater Manual, as amended.

B. Soils within the bioinfiltration swales shall be to the depth indicated on plans and comprised of a special soil mix, as required by regional stormwater guidelines and outlined below.
   A. Use sandy loam (USDA Soil Textural Classification).
   B. The final soil mix, including compost and soil, shall have a minimum long-term hydraulic conductivity between 0.5 and 1.5 inches per hour, per ASTM Designation D 2434 at 80% compaction, per ASTM Designation D 1557.
   C. The final soil mixture shall have a minimum organic content of 2% by dry weight, per ASTM Designation D 2974.
   D. Clay content for the final soil mix shall be less than 5%.
   E. The pH for the soil mix shall be between 5.5 and 7.0. Lime or iron sulfate may be added to achieve the required pH. If added, the lime or iron sulfate shall be uniformly mixed.
   F. The final soil mixture shall be tested by an independent laboratory prior to installation to demonstrate compliance with these specifications.
G. The cation exchange capacity (CEC) must be greater than or equal to 5 milliequivalents per 100 milligrams of dry soil.
H. The soil mix shall be uniform and free of stones, stumps, roots, or other similar material greater than 2”.

2.3 SOIL CONDITIONERS

A. Coarse concrete sand, if used to condition the soil, per Sections 2.1 and 2.2 above, shall meet the requirements of ASTM C-33 Fine Aggregate, and shall be clean, sharp, free of limestone, shale, and slate particles and of toxic materials.

B. Organic soil amendment shall be a wood material, Compost Mix or Peat Moss with pH range of 5.5 to 8.0 partially decomposed, as per the following specifications.

C. Compost shall be mature, stable, weed free, and produced by aerobic decomposition of organic matter. Compost feedstock may include, but is not limited to: agricultural, food or industrial residuals; Class A biosolids as defined in the EPA CFR Title 40, Part 503; yard trimmings, or source-separated municipal solid waste. The product must not contain any visible refuse or other physical contaminants, substances toxic to plants, or over 5% sand, silt, clay or rock material by dry weight. The product shall possess no objectionable odors. The product must meet all applicable USEPA CFR, Title 40, Part 503 Standards for Class A biosolids. The moisture level shall be such that no visible water or dust is produced when handling the material. The organic matter content shall be between 35 and 65%, as determined by loss of ignition test method (ASTM D 2974), have a carbon:nitrogen ration between 20:1 and 35:1, maximum electrical conductivity of 3 ohms/cm, moisture content range between 35 and 50%, free from viable weeds.

2.4 FERTILIZER

A. Fertilizer shall be as recommended by Soils Testing Laboratory.

2.5 WEED CONTROL

A. Prior to planting, apply an approved pre-emergent herbicide (except in hydroteed and hand broadcast areas) shall per Manufacturer’s recommendations.

B. Apply "Round-up" shall be applied per manufacturer’s recommendations.

2.6 WATER

A. Water for dust control and clean-up shall be provided by the contractor.

PART 3 - EXECUTION

3.1 GRADING, LEVELING, AND CONTOURING

A. The work covered here is to finish grade and level to correct local conditions.
   1. Top soil, if needed, shall be added to bring landscaping areas up to specified levels, grades and contours.
   2. Till topsoil into top 12 inches of existing soil to break up soil lenses and over-compaction.
B. All shrub and tree planting areas shall be graded to within 2.0" of the top of adjacent curb or paving, except where otherwise noted. All turf areas shall be fine graded to within 1.5" of the top of adjacent curb or paving, except where otherwise noted. If topsoil is required to bring existing grades to these requirements then the contractor shall provide topsoil, either stockpiled or imported to meet these ends.

C. Re-establish all surface drainage grades. Blend slopes into level areas.

D. Do not mix soil if the soil or amendments are saturated.

E. Soil mix will naturally compact by approximately 30%. Allow soil to naturally settle. Use of water by spraying or sprinkling is acceptable. Add additional soil mix until the desired grade is achieved when settled.

3.2 PLANTING PREPARATION

A. All areas to be planted shall be cleaned, weeded and cross-ripped to a minimum depth of 12" (unless otherwise noted), and shall be loosed and friable.

B. If required by the results of the lab testing agency, apply soil amendments at 6 cu. yards/1000 sq. ft. (2" layer) to all non-irrigated “Native Grass” areas. Thoroughly incorporate the soil amendments with top 4" to 6" soil layer.

C. Bring amended soil to finish grades and elevations shown on contract documents and within these specifications. Do not work soil under muddy conditions. No rocks 1" in diameter or larger shall be visible on the finish grades of turf areas and 2" in all shrub and tree beds and compact soil to 80% to 85% modified proctor.

3.3 WEED CONTROL

A. Prior to construction, "Round-up" or an approved equal, may be applied per manufacturer's recommendations to eradicate existing weeds.

B. The project site shall be weed-free prior to acceptance and kept weed-free through the warranty period.

3.4 SITE CLEANUP AND DUST CONTROL (INCLUDING IRRIGATION OPERATIONS)

A. The Contractor shall cause all working forces at the site to maintain the site in a neat, orderly manner throughout the construction operations.

B. The work shall be conducted in a manner that will control the dust. When ordered to provide dust control, the Contractor shall reduce the dusty conditions to the satisfaction of the Owners' Representative.

C. During construction, the Contractor shall remove all rubbish and debris as it is generated. Upon completion of the work, the contractor shall remove all equipment, debris and shall leave the site in a neat, clean condition; all to the satisfaction of the Owner's Representative.

END OF SECTION 32 91 13
SECTION 32 92 00
TURF AND GRASSES

1.1 DESCRIPTION OF WORK:

A. Furnish all material, equipment and labor required to seeding all grass areas, as shown on plans and specified herein. The work shall include, but is not limited to, the following:

1. Finishing and fine grading all soil surfaces of planting areas as indicated on the plans.
2. Preparing soil in all planted areas as specified.
3. Furnishing and planting all seed as indicated on the plans and specifications.
4. Fertilizing as indicated on the plans and specifications.
5. Disposing of excess soil and debris off the site as specified.

B. All scaled dimensions are approximate. Before proceeding with work, contractor shall verify all dimensions and quantities and shall immediately inform the Owner’s Representative of any discrepancy between the information on the drawings and the actual conditions. Contractor shall refrain from doing any work until given approval to do so by the Owner’s Representative. Proceeding with work in areas of discrepancy can nullify contractor’s ability to charge additional fees.

C. Planting quantities, and/or planting areas, are shown for the convenience of the contractor only, and are not guaranteed. All planting indicated on the drawings will be required unless indicated otherwise.

1.2 RELATED WORK WITHIN OTHER SECTIONS

A. 31 10 00 – Site Clearing
B. 31 20 00 – Earthworks
C. 32 84 00 – Irrigations Systems
D. 32 90 00 – Planting
E. 32 91 13 – Soil Preparation

1.3 SUBMITTAL

A. Three (3) copies shall be supplied. Submit complete list of all seed, indicating source of supply, order invoice, quantity for each seed mixture. Cut sheets or reports of all following landscape planting items are required
   1. Drought Tolerant Seed Mixture
   2. Dryland Grass Seed Mixture

B. Do not commence work until all items are approved

1.4 WARRANTY
A. Grass shall be warranted for a period of one (1) year from the date of acceptance. Grass that dies or is in poor condition for any reason, as determined by the owner representative, shall be replaced immediately with "in-kind" seed, at no additional cost to the Government. Material to be replaced shall be replaced by the contractor within 15 days of written notice from the owners’ representative. Replacement seed material shall be warranted for the time remaining on the original plant warranty period.

1.5 QUALITY ASSURANCE
A. Protect existing landscaping and new landscaping to be installed from damage. Any damage occurring to existing vegetation shall be the responsibility of the contractor and shall be repaired or replaced at the discretion of the owner and at no additional cost to the owner.

1.6 PLANT MATERIALS
A. SEED MIXES shall be AS SPECIFIED on the planting plan.

1. Seed Mixes shall conform to the requirements of the Plant list on the plans and to "Horticultural Standards" of the American Association of Nurserymen, as to kind, age, size, etc.

B. Substitutions
1. Substitution will not be permitted unless submitted in writing and approved by the Owners’ Representative, prior to contractor ordering material. Substitutions shall be requested during the ‘Submittal' process, see 1.3 – Submittal, A.

1.7 GRASS SEED
A. Seed shall be state-certified seed of the latest season’s crop and shall be delivered in original sealed packages bearing the producer’s warranted analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Seed shall be labeled in conformance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable state seed laws. Seed that has become wet, moldy, or otherwise damaged will not be acceptable. Onsite seed mixing shall be done only in the presence of the Owner’s Representative. Seed mixtures shall be proportioned as indicated on plans.

1.8 FERTILIZER
A. Provide turf fertilizer that is commercial grade, free flowing, uniform in composition, and conforms to applicable state and federal regulations.

B. Granular fertilizer shall bear the manufacturer’s warranted statement of analysis. Granular fertilizer shall contain a minimum percentage of 16 nitrogen (of which 50% shall be organic), 16 available phosphoric acid, and 16 potash.

C. Liquid starter fertilizer for use in the hydroseed slurry shall be commercial type and shall contain a minimum percentage of 16 nitrogen (with 50 percent of nitrogen in slow release form), 16 available phosphoric acid, and 16 potash.
1.9 WATER

A. Water for installation, irrigation and clean-up shall be provided by the contractor. A water source for the automatic irrigation system will be provided.

1.10 MATERIAL INSPECTION

B. All material shall be subject to the inspection and approval of the owner’s representative at any time and at any place. The owner’s representative may require samples of material prior to approval.

1.11 GRADING, LEVELING, AND CONTOURING

A. Prior to seeding, verify that the grade of the planting area preparation conforms to the plans and specifications.

1.12 HYDROSEEDING OPERATIONS AND ESTABLISHMENT

A. Prior to applying hydroseed, the soil preparation, finish grade and irrigation system shall be completed, inspected, tested for coverage and approved by the owner’s representative in writing.

B. Mulch: Wood cellulose fiber (100% wood fiber) with purple dye for dryland grasses mixed with water to form a slurry, applied at a rate of 2,000 LBS. Per acre.

C. Oil binding agent (tackifier): Shall be alpha-plantago, applied at a rate of 50 LBS. per acre on flat ground and 80 LBS. per acre on slopes greater than 3:1 at a rate specified by the manufacturer.

D. Seed mixture: See plant legend.

E. Fertilizer: 16-16-16 ‘BEST’, 10 LBS/1000 S.F.

F. The seeding operation shall be halted when high winds, excessive moisture or other conditions occur which may not be conducive to satisfactory results.

G. The seed, fertilizer and tackifier shall be mixed with a specially prepared dyed wood cellulose fiber under continuous agitation so that homogeneous mixture is discharged hydraulically through hoses to the proposed dryland seed areas. Prolong adding seed to slurry mix until just before spraying, but add seed soon enough to allow seed to homogeneously mix with slurry.

H. Landscape contractor shall request approval for his/her hydroseeding installation from the owner’s representative. If inspection indicates that areas have been skipped or seeded at less than the specified rate, the owner’s representative will not approve seeding until the sowing of additional seed on those areas has been accomplished, at no additional cost to the owner.

I. Irrigation: The contractor shall provide temporary irrigation to non-irrigated grass areas, if necessary to establish the grass and provide the required coverage, as specified herein.

J. The contractor shall establish each hydroseeded area until an 80% density coverage rate has been attained. The establishment period shall begin the day after approval of hydroseeding.
upon inspection, after the contractor has notified the Owner’s Representative that the 80% density coverage has been attained and, the grass is found to be in a healthy growing condition with no bare spots, then the Owner’s representative will approve the establishment period as complete. Noncompliance with the above conditions will extend the establishment period until approval is met. Grass maintenance, during the establishment period, shall include (but not limited to): fertilizing, weed control, removal and replacement of dead grass areas as required and monitoring of irrigation schedule.

K. Prior to final acceptance, re-seed any seeding areas greater than 12” where seed did not germinate.

1.13 MAINTENANCE PERIOD

A. Provide landscape maintenance from the completion and acceptance of each new landscape area. The maintenance period shall be for 90 days and include the following: watering of landscape shrubs, trees, gare-fertilization, weeding, mowing, clean-up, edging, repairs of all washouts and gullies, replanting areas void of turf one square foot and larger in area, mowing the new lawn to 50 mm (2 inches) whenever the grass reaches 75 mm (3 inches) in height prior to final inspection and acceptance, and other necessary work of maintenance.

1.14 3.05 WEED CONTROL

A. Prior to construction, "Round-up" or an approved equal, may be applied per manufacturer’s recommendations to eradicate existing weeds.

B. During construction and establishment period, the contractor shall elect to apply the same as above or selective sprays or begin manual techniques to control weed growth and propagation.

A. All seeded areas shall be weed free at the end of the establishment period and kept weed-free through the warranty period.

1.15 SITE CLEANUP AND DUST CONTROL (INCLUDING IRRIGATION OPERATIONS)

A. The Contractor shall cause all working forces at the site to maintain the site in a neat, orderly manner throughout the construction operations.

B. The work shall be conducted in a manner that will control the dust. When ordered to provide dust control, the Contractor shall reduce the dusty conditions to the satisfaction of the Owners’ Representative.

C. During construction, the Contractor shall remove all rubbish and debris as it is generated. Upon completion of the work, the contractor shall remove all equipment, debris and shall leave the site in a neat, clean condition; all to the satisfaction of the Owner’s Representative.

END OF SECTION 32 92 00
SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section covers all water system piping, its associated fittings, valves, and other components.

B. The work commences at a point 5'-0" outside the building and terminates with the connection to the appropriate main.

C. If interior work is not ready for final connection, all lines shall be capped or plugged at the 5'-0" limit for final connection under other sections of these specifications. When interior work is ready, the Contractor shall make final connection.

D. Verify the location, elevation, size, direction of flow and/or operating pressure of all existing services before work is begun. This includes at points of connection and crossings. Notify the Contracting Officer of any discrepancies before beginning any installation.

1.2 RELATED WORK

A. Section 31 10 00 – Site Clearing

B. Section 31 20 00 – Earth Moving

C. Section 33 30 00 – Sanitary Sewerage Utilities

1.3 COORDINATION

A. The Contractor shall coordinate his work with that of the grading contractor to assure adequate cover for piping.

B. In the event that transite-piping connections are required, Contractor shall discontinue work and notify contracting officer.

C. All connections shall be coordinated with the water purveyor.

1.4 PIPING (GENERAL)

A. All piping shall be laid true to line and grade and shall be kept clean at all times during the construction. Open ends of pipe shall be kept plugged or capped off during construction to prevent the entrance of foreign matter.

B. The minimum cover to be maintained over top of water pipe shall be as normal for the region but in no case shall be less than 4.0 feet.
1.5 REFERENCES
   A. All work shall comply with the pertinent standards of the latest editions of the following Codes and Specifications, unless designated otherwise herein.
      3. American Water Works Association (AWWA).

1.6 SUBMITTALS
   A. Product Data: Provide data on pipe materials, pipe fittings, valves, hydrants, and accessories.
   B. Manufacturer's Certificates: Certify that products meet or exceed specified requirements.

1.7 PROJECT RECORD DOCUMENTS
   A. Disinfection report; accurately record:
      1. Date and time of flushing start and completion.
      2. Signed copy of approval by local jurisdiction.
   B. Pressure and leakage test report; accurately record:
      1. Date and time of test.
   C. As – Built Documents: accurately record location of pipe runs, valves, hydrants and water service appurtenances.
      1. Location shall be noted based on identified Project Bench Marks or staked Property Corners.
      2. Identify and describe unexpected variations of subsoil conditions or discovery of uncharted utilities.

1.8 MANUFACTURERS
   A. Provide piping with the manufacturer's name and class, SDR or pressure rating clearly marked on outside.
   B. Source: For each type of product required for the work of this Section, provide products of one manufacturer and source for consistency.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. General: Provide ells, tees, reducing tees, wyes, couplings, and other required piping accessories of same type and class of material as conduit, or of material having equal or superior physical and chemical properties as acceptable to the Contracting Agent.
B. Class-Rated Polyvinyl Chloride (PVC) Pipe:

1. PVC pipe and accessories 4 inches – 14 inches in diameter, AWWA C900 “Polyvinyl Chloride (PVC) Pressure Pipe”, Class 200, DR 14, cast iron outside diameters, unless otherwise shown or specified.

2. PVC pipe and accessories 16 inches or larger, AWWA C905, “Polyvinyl Chloride Water Transmission Pipe”, Class 235, DR 18, cast iron outside diameters unless otherwise shown or specified. Pipe and accessories shall bear the NSF mark indicating pipe size, manufacturer’s name, AWWA and/or ASTM Specification number, working pressure and production code. Pipe and couplings shall be made in accordance with ASTM D1784.

3. PVC Pipe and Accessories Smaller than 4 inches: Schedule 80, meeting the requirements of ASTM D -1785, Type 1, Grade 1. All exposed piping shall be CPVC meeting requirements of ASTM F441.

C. Joints:

1. Pipe 3 inches and Greater in Diameter: Push-on type with factory installed solid cross section elastomeric ring meeting the requirements of ASTM F-477.

2. Pipe Less Than 3 inches in Diameter: Threaded (ASTM D-2464) or solvent welded (ASTM 2467). Use Teflon tape or liquid Teflon thread lubricant approved for use on plastic on all threaded joints.

D. Fittings:

1. Class-Rated Pipe 3 inches in Diameter and Greater: Ductile iron with mechanical joints conforming to the requirements of AWWA C153.

2. For Schedule 80 Pipe less than 3 inches in Diameter: Threaded or solvent weld. Threaded PVC fittings shall conform to ASTM D2464. CPVC fittings shall conform to ASTM F437 for threaded fittings and ASTM F439 for solvent weld fittings.

2.2 COPPER PIPE AND TUBING

A. Copper Piping: ASTM B88, Type K, or Type L with flared fittings in accordance with AWWA C800, with sweat cast brass fittings per ANSI B16.18. Use brazing alloy, AWS A5.8, Classification BCuP.

2.3 VALVES

A. Asbestos packing is not allowed.

B. Gate:

1. 3 inches and Larger: Resilient seated, ductile iron body, bronze mounted, inclined seats, non-rising stem type turning counter-clockwise to open, 200 pound WOG. AWWA C509. The resilient seat shall be fastened to the gate with stainless steel fasteners or vulcanizing methods. The interior and exterior shall be coated with thermo-setting or fusion epoxy coating in accordance with AWWA C550.

2. Operator:
   a. Underground: Except for use with post indicators, furnish valves with 2 inch nut for socket wrench operation. Post indicator shall comply with the requirements of NFPA 24 and shall be fully compatible with the valve provided.
   b. Above Ground and in Pits: Hand wheels.
3. Joints: Ends of valves shall accommodate, or be adapted to, pipe installed.

C. Check: Swing.

1. Smaller than 4 inches: Bronze body and bonnet, ASTM B61 or B62, 200 pound WOG.
2. 4 inches and Larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 200 pound WOG. Check valves for fire lines shall conform to AWWA C508 and shall be epoxy coated and lined per AWWA C550.

D. Corporation stops and saddles shall conform to AWWA C800.

E. Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness of metal shall be 3/16 inch. Box shall be adapted, without full extension, to depth of cover required over pipe at valve location. Cast the word "WATER" in cover. Provide one "T" handle socket wrenches of 5/8 inch round stock long enough to extend 2 feet above top of deepest valve box.

2.4 HYDRANTS

A. Fire hydrants shall conform to AWWA C502 (dry barrel type). The direction of valve opening shall be clearly indicated on hydrant top with a ductile or embossed direction arrow. The hydrant base shall sit on a 12" by 12" by 4" concrete block or pad, Class 5. The hydrant shall be connected with 6" diameter cast iron pipe to a 6" gate valve 2 feet from the main water line. The fire hydrant shall also be furnished with ½ cubic yard of drain rock. Hydrant shall be furnished with Stortz Quick Connect.

B. Fire hydrants and bonnets shall be painted “Chrome Yellow” for potable water, color code 11120.

C. Color code the painted accent band on the bonnet to indicate tested water pressure.

2.5 SLEEVES

A. Ductile iron or zinc coated steel.

2.6 BACKFLOW PREVENTER

A. Potable water Service: Double check valve, AWWA C510.

B. In cold climate areas, backflow assemblies and devices shall be protected from freezing by a method acceptable to local jurisdiction.

C. Backflow preventers shall be approved by the Foundation for Cross-Connection Control and Hydraulic Research per current edition of the Manual of Cross-Connection Control.

D. Backflow preventer shall not be located in any area containing fumes that are toxic, poisonous or corrosive.

E. Direct connections between potable water piping and sewer connected wastes shall not exist under any condition with or without backflow protection.
F. Backflow preventer shall be accessed and have clearance for the required testing, maintenance and repair. Access and clearance shall require a minimum of one (1) foot between the lowest portion of the assembly and grade, floor or platform.

2.7 DISINFECTION CHLORINE

A. Liquid chlorine shall conform to AWWA B301 and AWWA C651.

B. Sodium Hypochlorite shall conform to AWWA B300 with 5 percent to 15 percent available chlorine.

C. Calcium hypochlorite shall conform to AWWA B300 supplied in granular form of 5g tablets, and shall contain 65 percent chlorine by weight.

2.8 MARKER TAPE & TRACER WIRE

A. Metallic detectable marking tape shall be installed over all water lines including service lines. The tape shall be placed approximately two-foot above the top of the line and shall extend its full length. The minimum wire size and material is 12 AWG copper with a minimum 30 mil polyethylene jacket designed specifically for burial.

B. Tracer wire must be fastened with some slack, to the utility at approximately 10-foot intervals, using tape or non-metallic ties. The wire must not be spiraled around the pipe, or be merely dropped into the trench. A spacer between the wire and the pipe may be necessary, if required by other code. If the tracer wire must be joined below ground, the wire must be joined in a permanent bond (braising, cad welding, or equivalent), the joined area insulated and made water-tight.

C. Tracer wire must be accessible the beginning and end and at each valve box or similar utility entry point. Slack wire must be provided and coiled within these entry points. Access is desired at least every 500’. If this is not possible, the ability to carry the signal across the longer distances must be demonstrated by design.

D. Tracer wire terminations shall be clearly tagged or labeled as end points.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Bedding: Preparation of subgrade and the placement of bedding to the pipe invert shall precede the pipe installation as shown on the Plans. Bedding material shall be so graded to uniformly support the pipe throughout its length, except at joints, where bell holes are to be provided. Following the pipe installation, further bedding material shall be placed uniformly under and around the pipe to the centerline. Bedding shall be installed as a minimum from 6” below pipe to 6” above the pipe. In rock areas and below or within 5’ of structures “Select Bedding” shall be used.

B. Trenching, Backfilling, and Compacting shall be completed per Section 31 20 00 of these specifications.
C. Location of Water Mains: In so far as possible, water mains shall be located as shown on the plans. Deflections at pipe joints shall not exceed 75% percent of the manufacturer's written recommendations.

D. Laying of pipe to line and grade in the trench shall be accomplished only after the trench has been dewatered and the foundation and bedding has been prepared in accordance with these Specifications. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surface.

E. All pipe placed in the trench shall be retained in position by mechanical means or otherwise so as to maintain alignment and joint closure until sufficient backfill has been completed to adequately support the pipe. All pipe shall be installed to conform to the line and grade shown on the Plans.

F. Where the location of water pipe is not clearly defined by dimension on the drawings, water pipe shall not be laid closer horizontally that 10' from the sewer. Where water lines cross under sewer lines, the sewer pipe for a horizontal and perpendicular distance of 10' each side of the crossing shall be fully encased in concrete or sewer line shall be made of pressure pipe with no joint located within 3’ horizontally of the crossing.

G. Water lines shall not be laid in the same trench with sewer lines, gas lines, or electric wiring.

H. Contact Base utilities prior to backfill for inspection and acceptance of piping.

3.2 PIPE SEPARATION

A. Horizontal Separation-Water Mains and Sewers:

1. Water mains shall be located at least 10 feet horizontally from any proposed drain, storm sewer, sanitary or sewer service connection.
2. Water mains may be located closer than 10 feet to a sewer line when:
   a. Local conditions prevent a lateral separation of 10 feet; and
   b. The water main invert is at least 18 inches above the crown of the sewer; and
   c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located one side of the sewer.
3. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of mechanical joint ductile iron pipe. Ductile iron pipe shall comply with the requirements listed in this specification section. The drain or sewer shall be pressure tested to the maximum expected surcharge head before back filling.

B. Vertical Separation-Water Mains and Sewers:

1. A water main shall be separated from a sewer so that its invert is a minimum of 18 inches above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the water main located within 10 feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
2. Both the water main and sewer shall be constructed of slip-on or mechanical joint ductile iron pipe or PVC pipe equivalent to water main standards of construction when:
   a. It is impossible to obtain the proper vertical separations described in (1) above; or
   b. The water main passes under a sewer or drain.
3. A vertical separation of 18 inches between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main.

4. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least 10 feet.

3.3 SETTING OF VALVES AND BOXES

A. Provide a surface concrete pad 18 by 18 by 6 inches to protect valve box when valve is not located below pavement.

B. Clean valve and curb stops interior before installation.

C. Set valve and curb stop box cover flush with finished grade.

D. Valves shall be installed plumb and level and in accordance with manufacturer’s recommendations.

3.4 SETTING OF FIRE HYDRANTS

A. Set center of each hydrant not less than 2 feet nor more than 6 feet back of edge of road or face of curb. Fire apparatus connection shall face road with center of nozzle 18 inches above finished grade. Set barrel flange not more than 2 inches above finished grade.

B. Set each hydrant on a slab of stone or concrete not less than 4 inches thick and 15 inches square. The service line to the hydrant, between the tee and the shoe of the hydrant, shall be fully restrained.

C. Set bases in not less than 1/2 cubic yard of crushed rock or gravel placed entirely below hydrant drainage device.

D. Clean interiors of hydrants of all foreign matter before installation.

3.5 FLUSHING AND DISINFECTING

A. Flush and disinfect new water lines in accordance with AWWA C651.

B. Initial flushing shall obtain a minimum velocity in the main of 0.75 m/sec (2.5 feet per second) at 40 PSI residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

<table>
<thead>
<tr>
<th>Flow Required to Produce 2.5 ft/sec(approx.) Velocity in Main</th>
<th>Number of Hydrant Outlets</th>
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C. The backflow preventers shall not be in place during the flushing.

D. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used, and the Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing, and disinfection operations.

E. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.

F. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the State Health Department. The cost of sampling, transportation, and testing shall be the responsibility of the Contractor.

G. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.

H. Before backflow preventers are installed, all upstream piping shall be thoroughly flushed.

3.6 HYDROSTATIC TESTING

A. Hydrostatic testing of the system shall occur prior to disinfecting the system.

B. After new system is installed, except for connections to existing system and building, backfill at least 12 inches above pipe barrel, leaving joints exposed. The depth of the backfill shall be adequate to prevent the horizontal and vertical movement of the pipe during testing.

C. Prior to pressurizing the line, all joint restraints shall be completely installed and inspected.

D. If the system is tested in sections, and at the temporary caps at connections to the existing system and buildings, the Contractor shall provide and install all required temporary thrust restraints required to safely conduct the test.

E. The Contractor shall install corporation stops in the line as required to purge the air out of the system. At the completion of the test, all corporation stops shall be capped.

F. Piping Tests: Conduct piping test before joints are covered. Fill pipeline 24 hours prior to testing and apply test pressure to stabilize system. Use only potable water.

   1. Hydrostatic Tests: Test at 200 psi for 15 minutes for domestic line and 2 hours for fire lines.
   2. Perform operational testing of valves by opening and closing under water pressure to insure proper operation.
   3. Copper tubing shall have no allowable leakage.
3.7 BACKFLOW PREVENTOR TESTING

A. All backflow preventers shall be tested and certified for proper operation prior to being placed in operation.

B. Original copies of the certification shall be submitted to the Contracting Officer.

3.8 FIELD QUALITY CONTROL

A. Locations and Arrangements: 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 except where deviations to layout are approved on coordination drawings.

B. Install piping without high-points with fittings and valves installed at the required locations.

C. Install components having pressure rating equal to or greater than system operating pressure.

D. Install piping free of sags and bends.

E. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

G. Piping Connections: Except as otherwise indicated, make piping connections as specified below.
   a. Install dielectric fittings to connect piping of dissimilar metals.

H. Sterilization: At completion of water service line installation, flush and sterilize in conformance with AWWA C 601, to the satisfaction of the State Health Department.

3.9 CLEANING

A. Cleaning Piping: Clear interior of conduit of dirt and other superfluous material as work progresses.

END OF SECTION 33 10 00
SECTION 33 30 00
SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section covers all gravity sanitary sewer pipe of classes, sizes, and dimensions and components including cleanouts as required by the Drawings, furnished and installed as shown on the Drawings and in accordance with these Specifications.

B. The work commences at a point 5'-0" outside the building terminated with the connection to the appropriate side service line.

1.2 RELATED WORK

A. Section 31 20 00 – Earth Moving

B. Section 03 30 00 – Cast-In-Place Concrete

1.3 QUALITY ASSURANCE

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: At least equal to system test pressure.

1.4 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations elevations.

B. Locate existing structures and piping to be removed and/or abandoned.

C. Existing Utilities: Do not interrupt existing utilities serving adjacent facilities except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

D. Notify Contracting Officer 48 hours in advance of proposed utility interruptions.

E. Do not proceed with utility interruptions until coordinating with the appropriate agency to determine exact timing of the interruption.

1.5 SUBMITTALS

A. Product Data: Provide data on pipe materials, pipe fittings, valves, hydrants and accessories.

B. As-built Drawings: Note invert elevations of all pipes at buildings or with utility structures. Show location and reference of pipe locations using building construction Bench Marks or staked
property corners. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Coordinate and/or perform all required field tests and inspections required by this Section and submit reports and test results.

D. Manufacturer’s Certificates: Certify that products meet or exceed specified requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic structures, pipe or fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete septic tanks and other structures according to manufacturer's rigging instructions.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 35, for gasketed joints.
   2. Pressure-Type Pipe Couplings: Iron-body sleeve assembly, matching outside diameters of pipes to be joined, for pressure joints.
   4. Followers: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010), or ASTM A 536 ductile iron.
   5. Gaskets, Bolts and Nuts: AWWA C111.

2.2 FENCING

A. Fencing shall be required at the end of each day’s work around open trench. Fence shall be 48” high “Plastic Safety Systems” SF48E. Color shall be fluorescent orange.

2.3 PRECAST CONCRETE COMPONENTS

A. Precast base sections, risers, cones and top slabs shall be dimensioned as shown on the plans and exhibits herein and shall conform to ASTM C478-80.

2.4 STEPS

A. Component steps shall be steel reinforced copolymer polypropylene plastic. Component steps shall have integral restraints to prevent side slippage of feet. Steps shall be installed only in components greater than 4 feet in depth measured from the top of the component cover to the invert. Steps shall be in accordance with ASTM, A615, C478, and D4101.
2.5 JOINT SEAL

A. Joints between precast component elements shall be rubber gasketed conforming to ASTM C443-79.

2.6 CAST IRON FRAMES AND COVERS

A. Cast Iron Frames and Covers:

1. Cast iron frames and covers shall provide a minimum 24-inch diameter round opening. Castings shall be free of porosity, shrink cavities, cold shots or cracks, or any surface defects which impair service ability. Frames and covers shall be machine finished or ground on seating surfaces so as to assure non-rocking fit in any position and interchangeability. In vehicle traffic areas heavy duty traffic type frames and covers shall be provided.

2.7 MORTAR

A. Mortar shall meet the requirements of ASTM C270 for Type S, provided that the amount of water shall be the least amount necessary to provide a workable mix.

2.8 PIPE CONNECTIONS TO MANHOLES AND INLETS

A. Connections for PVC pipe shall be made with approved manhole adapters to form a watertight seal. Manhole adapters shall be Kor-N-Seal 1 Flexible connection conforming to ASTM C923.

2.9 ADJUSTMENT RINGS

A. Adjustment rings shall be secured in place with mortar to form a watertight seal throughout.

2.10 MARKER TAPE

A. Pipeline Marking Tape: As part of the sewer and drainage pipe installation, the Contractor shall install a synthetic tape with a metal face at top of bedding, 2 feet above the pipe, in order to mark the pipe location. Tape shall be detectable from the surface with a metallic locator. Such tape shall be a green pigmented inert polyethylene film specifically intended by the manufacturer for this purpose, and shall have a minimum thickness of four (4) mils and a minimum width of three (3) inches. The words, "CAUTION SEWER/DRAIN LINE BURIED BELOW", or similar warning shall be indelibly printed in large bold letters on at least one side of the tape, with a repeat pattern of no more than thirty (30) inches.

B. Tape shall be the brand name Lintec, Thor, or equal.
PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Trenching, Backfilling and Compacting shall be completed per Section 31 20 00 - Earth Moving of these specifications.

B. Laying of sewer and drainage pipe to line and grade in the trench shall be accomplished only after the trench has been dewatered and the foundation and bedding have been prepared in accordance with these Specifications. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surfaces.

C. All pipe placed in the trench shall be restrained in position by mechanical means or otherwise so as to maintain alignment and joint closure until sufficient backfill has been completed to adequately support the pipe. All pipe shall be installed to conform to the line and grade shown on the Plans.

D. The sewer and drainage pipe shall be installed with the bell end forward or upgrade. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an acceptable temporary plug.

E. Foreign material shall be prevented from entering the pipe. During laying operations, no debris, tools, clothing or materials shall be placed in the pipe.

F. Manhole covers and valve boxes shall be adjusted, when located in drainage facility areas, so that stormwater runoff cannot flow into said appurtenances.

G. Where the location of water pipe is not clearly defined by dimension on the drawings, water pipe shall not be laid closer than 10’ horizontally from the sewer. Where water lines cross under sewer lines, the sewer pipe for a horizontal and performance distance of 10’ each side of the crossing shall be fully encased with PVC pressure pipe with no joint located within 3’ horizontally of the crossing.

H. Contractor shall utilize laser equipment to establish and maintain pipe grades and alignments during construction.

3.2 OBSERVATIONS

A. All pipe or structures shall be accepted by the Contracting Officer during construction.

3.3 STUB INSTALLATION

A. Stubs shall be installed at locations shown on the Plans.

3.4 PRECAST CONCRETE

A. Precast base sections shall be uniformly and fully supported on the prepared bedding such that all entering pipes can be laid to grade.

B. In precast manhole sections where steel loops have been provided in lieu of lift holes, the loops shall be removed flush with the inside wall surface after the manhole has been completed. No
sharp cutoff protrusions will be permitted. If concrete spalling occurs as a result of the loop removal, the spalled area shall be restored in a workmanlike manner to a uniform surface with mortar.

3.5 CONTROL AND COORDINATION

A. Contractor shall obtain all necessary street obstruction permits, and construction permits prior to commencement of construction. Contractor shall coordinate with the governing agency prior to commencement of any work associated with connection to a live sewer main.

3.6 TESTING

A. All lines shall be leak, deflection, and mandrel tested by the Contractor as required by the governing agency and the Owner. The Contractor shall arrange to have appropriate inspectors present to observe the tests. Tests shall meet the following requirements as a minimum

B. Air Pressure Test for Sewers:

1. Pipelines shall be tested with low-pressure air by the pressure drop method, in lieu of water infiltration of exfiltration. The pressure drop shall be from 3.5 to 3 Pound Per Square Inch (Gauge) (psig) greater than the average back pressure of groundwater above the centerline of the pipe.
2. The allowable rate of air loss shall be .003 Cubic Feet Per Minute (cfm) per square foot of internal pipe surface, but the total calculated air loss shall be not less than 2 cfm nor more than 3.50 cfm.
3. The test equipment to be used shall be furnished by the Contractor. The Architect may at any time require a calibration test of gauges or other instrumentation that is incorporated in the test equipment.
4. Safety Provisions: Plugs used to close the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug which can become a high velocity projectile. Gauges, air piping manifolds and valves shall be located at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. (Four psi air pressure develops a force against the plug in a 12-inch diameter pipe of approximately 450 pounds) Air testing apparatus shall be equipped with a pressure release device such as a rupture disk or a pressure relief valve designed to relieve pressure in the pipe under test at 6 psi.

C. Deflection Test for Flexible Pipe:

1. All sewers and drains constructed of flexible pipe shall be tested for deflection not less than 30 days after the trench backfill and compaction has been completed. Any diameter of the installed pipe shall not be decreased by more than 5 percent. The test shall be conducted by pulling a mandrel through the completed pipeline. Testing shall be conducted on a manhole-to-manhole basis and shall be done after the line has been completely flushed out with water. The Contractor shall be required, at no expense to the Owner, to locate and repair any sections failing to pass the test and to retest the section.

3.7 INSPECTION OF COMPONENTS

A. Completed components shall be carefully checked to insure that they are properly set to grade and shall be checked to insure that they have not been damaged during construction.
B. Repairs required shall be accomplished to return components to their original condition.

C. If damages cannot be repaired to the original condition, the component shall be replaced at no additional cost to the Owner.

D. Joint gaskets shall be inspected to insure a continuous seal between manhole sections.

E. A manhole or catch basin shall be considered watertight if the joint seals have been properly installed and all large cracks and holes have been repaired such that there is no visible means of leakage when filled with water.

3.8 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01400.

B. Request inspection prior to and immediately after placing bedding.

C. Compaction testing will be performed in accordance with ANSI/ASTM D1557, ASTM D1556, or ASTM D3017, and ASTM D2922.

D. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

E. Freq. of Tests: Perform tests of each lift, one test for every 50 L.F. of trench.

END OF SECTION 33 30 00
SECTION 33 40 00
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION
A. This Section includes:
   1. All gravity storm sewer pipe of classes, sizes, and dimensions and components including
      cleanouts, catch basins, trench drains and drywells as required by the Drawings,
      furnished and installed as shown on the Drawings and in accordance with these
      Specifications.
   2. The work commences at a point 5'-0" outside the building and terminated with the
      connection to the appropriate drainage structure.

1.2 RELATED WORK
A. Section 31 20 00 - Earth Moving
B. Section 03 30 00 - Cast-in-Place Concrete

1.3 DEFINITIONS
A. Drainage Piping: System of pipe, fittings and appurtenances for gravity flow of storm drainage.

1.4 QUALITY ASSURANCE
A. Environmental Agency Compliance: Comply with regulations pertaining to storm drainage
   systems.
B. Utility Compliance: Comply with regulations pertaining to storm drainage systems. Include
   standards of water and other utilities where appropriate.
C. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements
   of system components and are based on specific manufacturer types indicated. Other
   manufacturers’ products with equal performance characteristics may be considered.
D. Gravity-Flow, Non-pressure-Piping Pressure Ratings: At least equal to system test pressure.

1.5 PROJECT CONDITIONS
A. Site Information: Perform site survey, research public utility records, and verify existing utility
   locations.
B. Existing Utilities: Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted under the following conditions and then only after arranging to provide acceptable temporary utility services.

1.6 SUBMITTALS

A. Submit Product Data.

B. As-built Drawings: Note system piping in elevation. Note invert elevations off building finished floor along pipe run to utility connections. Show location and reference of pipe locations using building construction Bench Marks or staked property corners. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

C. Field test and inspection reports.

D. Shop drawings for precast concrete structures. Include frames, covers, and grates.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe, structures or fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle precast concrete manholes and other structures according to manufacturer's rigging instructions.

1.8 SEQUENCING

A. Coordinate with building roof drainage systems.

B. Coordinate with other utility work.

1.9 GENERAL

A. Furnish ells, tees, cleanouts, reducing tees, wyes, couplings, increasers, crosses, transitions and end caps of same type and class of material as pipe, or of material having equal or superior physical and chemical properties as acceptable to the Architect/Engineer.

PART 2 - PRODUCTS

2.1 STORM PIPE

A. Storm sewer pipe shall be Polyvinyl Chloride (PVC) pipe, ASTM D 3034, SDR 35 and Ductile Iron, Class 50, in accordance AWWA (C151) as shown on the Drawings.

2.2 MARKER TAPE

A. Marker tape shall be the brand name Lintec or Thor.
2.3 CLEANOUTS
   A. Description: Round, cast-iron housing with clamping device and round secured, scoriated, cast-iron cover as shown on the Drawings.
   B. Cleanouts shall conform to the details shown on the Drawings.

2.4 CATCH BASINS
   A. Precast Concrete Catch Basins: ASTM C 858, precast, reinforced concrete, designed according to ASTM C 857 for structural loading. Include depth, shape, and dimensions indicated, with provision for rubber gasket joints.
   B. Cast-in-Place Concrete Catch Basins: Construct of reinforced concrete, designed according to ASTM C 857 for structural loading. Include depth, shape, dimensions, and appurtenances indicated.
   C. Bottom, Walls, and Top: Reinforced concrete.
   D. Frames and Grates: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron. Include 24-by-24 inch minimum flat grate meeting the requirements of Spokane County standards.

2.5 CONCRETE
   A. Portland cement concrete, 4000 psi.
   C. Reinforcement Bars: ASTM A 615, Grade 60, deformed steel.

2.6 DRAIN ROCK
   A. Drain Rock shall be 1.5 inches minus washed drain rock conforming to WSDOT Standard Specification section 9-03.12(5).

2.7 BIOINFILTRATION SWALE SOIL MIX
   A. See Soil Preparation Specification section 32-91-13, paragraph 2.2.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
   A. General: Include watertight joints, except where soiltight or silttight joints are indicated.
B. Refer to Part 2 - Products of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.

C. Polyvinyl Chloride Pipe

1. Pipe Sizes 4 to 15 Inches: When specified, ASTM D3034, SDR 35 polyvinyl chloride (PVC) sewer pipe and fittings with gaskets and gasketed joints.
2. Pipe Sizes 18 to 36 Inches: When specified, AASHTO M 304M, polyvinyl chloride (PVC), ribbed drain pipe; AASHTO M 304M or ASTM F794, PVC ribbed fittings; elastomeric seals; and soil tight, gasketed joints.
3. Pipe Sizes 18 to 36 Inches: When specified, ASTM F 794, polyvinyl chloride (PVC) profile sewer pipe; ASTM F794, PVC profile fittings; elastomeric seals; and watertight, gasketed joints.

3.2 INSTALLATION

A. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

B. Use structures for changes in direction and changes in pipe diameters.

C. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

D. Extend drainage piping as indicated, of sizes and in locations indicated. Terminate piping as indicated.

3.3 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:

B. Join pipe and gasketed fittings with elastomeric seals according to ASTM D 2321.

C. Join profile ribbed drain pipe and gasketed fittings with elastomeric seals according to ASTM D 2321 and manufacturer's written instruction.

3.4 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.5 CONCRETE PLACEMENT

A. Concrete materials shall be in accordance with Section 03 30 00, Cast-in-Place Concrete.
3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in a cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

C. Set cleanout frames and covers in concrete paving with tops flush with surface of paving.

3.7 TRENCH DRAIN INSTALLATION

A. Install trench drains per manufacturer recommendations.

3.8 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

B. In large, accessible piping, brushes and brooms may be used for cleaning.

C. Place plug in end of incomplete piping at end of day and whenever work stops.

1. Flush piping between drywells and other structures, if required by authorities having jurisdiction, to remove collected debris.

D. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of the Project.

E. Submit separate reports for each system inspection.

F. Defects requiring correction include the following:

1. Alignment: Less than full diameter of inside of pipe is visual between structures.
2. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 95 percent of piping diameter.
3. Crushed, broken, cracked, or otherwise damaged piping.
4. Infiltration: Water leakage into piping.
5. Exfiltration: Water leakage from or around piping.

G. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.

H. Reinspect and repeat procedure until results are satisfactory.

I. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

J. Do not enclose, cover, or put into service before inspection and approval.

1. Allowable leakage is a maximum of 200 gallons per inch nominal pipe size, for every mile of pipe, during a 24-hour period.
2. Close openings in system and fill with water.
3. Purge air and refill with water.
4. Disconnect water supply.
5. Test and Inspect joints for leaks.

L. Leaks, loss in test pressure, or inability to pass the deflection test constitute defects that must be repaired.

M. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

END OF SECTION 33 40 00
SECTION 33 51 00

NATURAL GAS DISTRIBUTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Provide trenching, bedding, backfill, and compaction for natural gas distribution systems outside of the building, up to the gas meter.

1.2 RELATED SECTIONS

A. SECTION 31 20 00 - Earth moving.

1.3 DEFINITIONS

A. Gas Main or Distribution Main: A distribution line that serves as a common source of supply for more than one service line.

B. Gas Service Line: A distribution line that transports gas from a common source of supply to the meter set assembly.

1.4 SUMITTALS

A. Submit As-Built Drawings. See SECTION 01 78 39 Project Record Documents.

1.5 PROJECT/SITE CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

C. Interruption of Existing Natural Gas Service: Do not interrupt natural service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of gas supply according to requirements indicated:

D. Notify Owner a minimum of 2 weeks in advance of proposed interruption of natural gas service.

E. Do not proceed with interruption of natural gas service without Owner’s permission.

1.6 COORDINATION

A. The Contractor shall coordinate all work with Puget Sound Energy, including providing application and payment of service fee.
B. Puget Sound Energy will install and connect all piping.

C. trenching (general)

D. The minimum cover to be maintained over top of gas pipe shall be 2.0 feet.

PART 2 - PRODUCTS

2.1 GENERAL

A. All piping components shall be provided and installed by Puget Sound Energy.

B. bedding materials

C. Bedding shall meet the requirements of Section 31 20 00 EARTH MOVING.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Bedding: Preparation of subgrade and the placement of bedding to the pipe invert shall precede the pipe installation as shown on the Plans. Bedding material shall be so graded to uniformly support the pipe throughout its length, except at joints, where bell holes are to be provided. Following the pipe installation, further bedding material shall be placed uniformly under and around the pipe to the centerline. Bedding shall be installed as a minimum from 6” below pipe to 6” above the pipe. In rock areas and below or within 5’ of structures “Select Bedding” shall be used.

B. Trenching, Backfilling, and Compacting shall be completed per Section 31 20 00 EARTH MOVING specifications.

C. Laying of pipe to line and grade in the trench shall be accomplished only after the trench has been dewatered and the foundation and bedding has been prepared in accordance with these Specifications. Mud, silt, gravel, and other foreign material shall be kept out of the pipe and off the jointing surface.

D. Where the location of gas trench is not clearly defined by dimension on the Drawings, trench shall not be laid closer horizontally than 10’ from the sewer.

E. Gas lines shall not be laid in the same trench with sewer lines, water lines, or electric wiring.

3.2 QUALITY CONTROL

A. Compaction testing will be performed in accordance with ANSI/ASTM D1557, ASTM D1556, or D2922 and ASTM D3017 and Section 02300, Earthwork.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

C. Frequency of Tests: Perform tests for each lift, one test for every 50 feet of trench.

END OF SECTION 33 51 00
PART 1 – GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)


ASTM D 1557 (2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2700 kN-m/m³)

ASTM D 709 (2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)


INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)


NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)


NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)
TIA J-STD-607 (2002a) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

TIA-455-107 (1999a) FOTP-107 Determination of Component Reflectance or Link/System Return Loss using a Loss Test Set


TIA-472DOOO (2007b) Fiber Optic Communications Cable for Outside Plant Use


TIA-568-C.3 (2008; Corrections 2008) Optical Fiber Cabling Components Standard

TIA-569 (2004b; Add 1 2009) Commercial Building Standard for Telecommunications Pathways and Spaces

TIA-590 (1997a) Standard for Physical Location and Protection of Below Ground Fiber Optic Cable Plant


TIA/EIA-455 (1998b) Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

TIA/EIA-598 (2005c) Optical Fiber Cable Color Coding

TIA/EIA-606-A (2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS 1755 Telecommunications Standards and Specifications for Materials, Equipment and Construction


RUS Bull 1751F-815 (1979) Electrical Protection of Outside Plant

RUS Bull 1753F-201 (1997) Acceptance Tests of Telecommunications Plant (PC-4)
1.2 RELATED REQUIREMENTS

A. Section 27 15 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM applies to this section with additions and modifications specified herein. Also refer to 271500-A December 22, 2011 Joint Base Lewis-McChord Telecommunications Labeling System document included with the specifications for direction on telecommunications system labeling requirements.

1.3 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA/EIA-606-A, TIA-758, IEEE 100 and herein.

B. Campus Distributor (CD)

1. A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect - (MC).)

C. Entrance Facility (EF) (Telecommunications)

1. An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

D. Entrance Room (ER) (Telecommunications)

1. A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

E. Building Distributor (BD)
A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect - (IC).)

F. Pathway
1. A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

A. The telecommunications outside plant consists of cable, conduit, maintenance holes, etc. required to provide signal paths from the closest point of presence to the new facility, including free standing frames or backboards, interconnecting hardware, terminating cables, lightning and surge protection modules at the entrance facility. The work consists of providing, testing and making operational cabling, interconnecting hardware and lightning and surge protection necessary to form a complete outside plant telecommunications system for continuous use.

1.5 SUBMITTALS

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

1. SD-02 Shop Drawings
   a. Telecommunications Outside Plant; G Telecommunications Entrance Facility Drawings; G
   b. In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.
   c. Telecommunications shop drawings shall be performed and stamped by an RCDD in accordance with I3A Technical Criteria.

2. SD-03 Product Data
   a. Wire and cable; G
   b. Cable splices, and connectors; G Closures; G
   c. Building protector assemblies; G Protector modules; G
   d. Spare Parts; G

3. Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Submittals shall also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required for certificates in Section 01 33 00 SUBMITTAL PROCEDURES.

4. SD-06 Test Reports
   a. Pre-installation tests; G Acceptance tests; G
   b. Outside Plant Test Plan; G

5. SD-07 Certificates
   a. Telecommunications Contractor Qualifications; G Key
   b. Personnel Qualifications; G

6. Minimum Manufacturer's Qualifications; G
7. SD-08 Manufacturer's Instructions
   a. Building protector assembly installation; G Cable
   b. Tensions; G
   c. Fiber Optic Splices; G
8. Submit instructions prior to installation.
9. SD-09 Manufacturer's Field Reports
   a. Factory Reel Test Data; G
10. SD-10 Operation and Maintenance Data
    a. Telecommunications outside plant (OSP), Data Package 5; G Commercial off-the-shelf manuals shall be provided for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications outside plant (OSP). Submit operations and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to requirements of Data package 5, include the requirements of paragraphs TELECOMMUNICATIONS OUTSIDE PLANT SHOP DRAWINGS and TELECOMMUNICATIONS ENTRANCE FACILITY DRAWINGS.
11. SD-11 Closeout Submittals Record Documentation; G
    a. In addition to other requirements, provide in accordance with paragraph RECORD DOCUMENTATION.

1.6 QUALITY ASSURANCE

A. Shop Drawings
   1. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.
   2. Telecommunications Outside Plant Shop Drawings
      a. Provide Outside Plant Design in accordance with TIA-758, RUS Bull 1751F-630 for aerial system design, and RUS Bull 1751F-643 for underground system design and the I3A TC.
      b. TO - Shop drawings that show the physical and logical connections from the perspective of an entire campus, such as actual building locations, exterior pathways and campus backbone cabling on plan view drawings, major system nodes, and related connections on the logical system drawings in accordance with TIA/EIA-606-A.
      c. Drawings shall include wiring and schematic diagrams for fiber optic and copper cabling and splices, copper conductor gauge and pair count, fiber pair count and type, pathway duct and innerduct arrangement, associated construction materials, and any details required to demonstrate that cable system has been coordinated and will properly support the switching and transmission system identified in specification and drawings. The Telecommunications Outside Plant (OSP) shop drawings shall be included in the operation and maintenance manuals.
      d. Telecommunications Entrance Facility Drawings
1) Provide T3 drawings for EF Telecommunications in accordance with TIA/EIA-606-A and I3A Technical Criteria that include telecommunications entrance facility plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, backboard and wall elevations. Drawings shall show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings shall include a complete list of equipment and material, equipment rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of TI or T2 drawings. Provide T3 drawings for EF Telecommunications as specified in the paragraph TELECOMMUNICATIONS SPACE DRAWINGS of Section 27 15 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEMS. The telecommunications entrance facility shop drawings shall be included in the operation and maintenance manuals.

B. Telecommunications Qualifications

1. Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for the telecommunications system contractor, the telecommunications system installer, the supervisor (if different from the installer), and the cable splicing and terminating personnel. A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

2. Telecommunications Contractor Qualifications

a. The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems that include outside plant and broadband cabling within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years and the I3A TC.

3. Key Personnel Qualifications

a. Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems in accordance with TIA-758 within the past 3 years.

b. Cable splicing and terminating personnel assigned to the installation of this system or any of its components shall have training in the proper techniques and have a minimum of 3 years experience in splicing and terminating the specified cables. Modular splices shall be performed by factory certified personnel or under direct supervision of factory trained personnel for products used.

c. Supervisors and installers assigned to the installation of this system or any of its components shall have factory or factory approved certification from each
equipment manufacturer indicating that they are qualified to install and test the provided products.

d. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications outside plant systems, including broadband cabling, and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

e. Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

f. Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

4. Minimum Manufacturer's Qualifications

a. Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with, TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. In addition, cabling manufacturers shall have a minimum of 3 years experience in the manufacturing and factory testing of cabling which comply with ICEA S-87-640, ICEA S-98-688, and ICEA S-99-689.

C. Outside Plant Test Plan

1. Prepare and provide a complete and detailed test plan for field tests of the outside plant including a complete list of test equipment for the copper conductor and optical fiber cables, components, and accessories for approval by the Contracting Officer. Include a cut-over plan with procedures and schedules for relocation of facility station numbers without interrupting service to any active location.

2. Submit the plan at least 30 days prior to tests for Contracting Officer approval. Provide outside plant testing and performance measurement criteria in accordance with TIA-568-C.1 and RUS Bull 1753F-201. Include procedures for certification, validation, and testing that includes fiber optic link performance criteria. A Registered Communications Distribution Designer (RCDD) shall stamp and approve both the test plan and test report.

D. Standard Products

1. Provide materials and equipment that are standard products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and shall be the manufacturer's latest standard design that has been in

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satisfactory commercial or industrial use for at least 1 year prior to bid opening. The 1-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 1-year period. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

2. Alternative Qualifications
   a. Products having less than a 1-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 3000 hours, exclusive of the manufacturers' factory or laboratory tests, is provided.

3. Material and Equipment Manufacturing Date
   a. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

E. Regulatory Requirements
   1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

   2. Independent Testing Organization Certificate

   3. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

1.7 DELIVERY, STORAGE, AND HANDLING

   A. Ship cable on reels in 500 or 1000 feet length with a minimum overage of 10 percent. Radius of the reel drum shall not be smaller than the minimum bend radius of the cable. Wind cable on the reel so that unwinding can be done without kinking the cable. Two meters of cable at both ends of the cable shall be accessible for testing. Attach permanent label on each reel showing length, cable identification number, cable size, cable type, and date of manufacture. Provide water resistant label and the indelible writing on the labels. Apply end seals to each end of the cables to prevent moisture from entering the cable. Reels with cable shall be suitable for outside storage conditions when temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 100 percent. Equipment, other than cable, delivered and placed in storage shall be stored with protection from weather, humidity and temperature variation, dirt and dust, or other contaminants in accordance with manufacturer's requirements.

1.8 MAINTENANCE

   1. Record Documentation

      a. Provide the activity responsible for telecommunications system maintenance and administration a single complete and accurate set of record documentation for the entire telecommunications system with respect to this project.
b. Provide TS drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606-A. TS drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts, cross-connect information and connecting terminal layout as a minimum. TS drawings shall be provided on electronic media using Windows based computer cable management software. A licensed copy of the cable management software including documentation, shall be provided. Update existing record documentation to reflect campus distribution TO drawings and T3 drawing schedule information modified, deleted or added as a result of this installation. Provide the following TS drawing documentation as a minimum:

c. Cables - A record of installed cable shall be provided in accordance with TIA/EIA-606-A. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA/EIA-606-A. Include manufacture date of cable with submittal.

d. Termination Hardware - Provide a record of installed patch panels, cross-connect points, campus distributor and terminating block arrangements and type in accordance with TIA/EIA-606-A. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606-A.

e. Provide record documentation as specified in Section 27 15 00, BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

B. Spare Parts

1. In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking. Spare parts shall be provided no later than the start of field testing.

1.9 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Products supplied shall be specifically designed and manufactured for use with outside plant telecommunications systems.

2.2 TELECOMMUNICATIONS ENTRANCE FACILITY

A. Building Protector Assemblies

1. Provide self-contained 5 pin unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules for 25 pairs of outside cable. Building protector assembly shall have interconnecting hardware for connection to interior cabling at full capacity. Provide manufacturer’s instructions for building protector assembly installation. Provide copper cable interconnecting hardware as specified in Section 27 15 00 BUILDING TELECOMMUNICATIONS CABLEING SYSTEM.

B. Protector Modules
1. Provide in accordance with UL 497 gas tube 5 pin rated for the application. Provide gas tube protection modules in accordance with RUS Bull 345-83 and shall be heavy duty, A>10kA, B>400, C>65A where A is the maximum single impulse discharge current, B is the impulse life and C is the AC discharge current in accordance with ANSI C62.61. The gas modules shall shunt high voltage to ground, fail short, and be equipped with an external spark gap and heat coils in accordance with UL 497. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

C. Fiber Optic Terminations
1. Provide fiber optic cable terminations as specified in 27 15 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM.

2.3 CLOSURES
A. Copper Conductor Closures
1. Underground Cable Closures
2. In vault or maintenance hole: Provide underground closure suitable to house a straight, butt, and branch splice in a protective housing. Closure shall be of stainless steel material supplying structural strength necessary to pass the mechanical and electrical requirements in a vault or maintenance hole environment. Stretch cases are not allowed. Encapsulating compound shall not be used.

B. Fiber Optic Closures
1. In Vault or Maintenance Hole
   a. Provide Tyco or approved equal splice cases. Encapsulating compound shall not be used.

2.4 CABLE SPLICES AND CONNECTORS
A. Copper Cable Splices
1. Provide multi-pair, foldback splices of a moisture resistant, insulation displacement connector held rigidly in place to assure maximum continuity in accordance with RUS Bull 1753F-401. Cables greater than 25 pairs shall be spliced using multipair splicing connectors, which accommodate 25 pairs of conductors at a time. Provide correct connector size to accommodate the cable gauge of the supplied cable.

B. Copper Cable Splice Connector
1. Provide splice connectors with a polycarbonate body and cap and a tin-plated brass contact element. Connector shall accommodate 22 to 26 AWG solid wire with a maximum insulation diameter of 0.065 inch. Fill connector with sealant grease to make a moisture resistant connection, in accordance with RUS Bull 1753F-401.

C. Fiber Optic Cable Splices
1. Provide fiber optic cable splices and splicing materials for fusion methods at locations shown on the construction drawings. The splice insertion loss shall be 0.3 dB maximum when measured in accordance with TIA-455-78-B using an Optical Time Domain Reflectometer (OTDR). Splices shall be designed for a return loss of 40.0 db max for single mode fiber when tested in accordance with TIA-455-107. Physically protect each fiber optic splice by a splice kit specially designed for the splice.

D. Fiber Optic Splice Organizer
1. Provide splice organizer suitable for housing fiber optic splices in a neat and orderly fashion. Splice organizer shall allow for a minimum of 3 feet of fiber for each fiber within the cable to be neatly stored without kinks or twists. Splice organizer shall accommodate individual strain relief for each splice and allow for future maintenance or modification, without damage to the cable or splices. Provide splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors in a splice organizer kit.

E. Shield Connectors
1. Provide connectors with a stable, low-impedance electrical connection between the cable shield and the bonding conductor in accordance with RUS Bull 345-65.

2.5 CONDUIT
A. Provide Schedule 40 PVC and Galvanized Rigid Steel conduit to comply with I3A Technical Criteria.

2.6 PLASTIC INSULATING TAPE UL 510.

2.7 WIRE AND CABLE
A. Copper Conductor Cable
1. Solid copper conductors, covered with an extruded solid insulating compound. Insulated conductors shall be twisted into pairs which are then stranded or oscillated to form a cylindrical core. For special high frequency applications, the cable core shall be separated into compartments. Cable shall be completed by the application of a suitable core wrapping material, a corrugated copper or plastic coated aluminum shield, and an overall extruded jacket. Telecommunications contractor shall verify distances between splice points prior to ordering cable in specific cut lengths. Gauge of conductor shall determine the range of numbers of pairs specified; 19 gauge (6 to 400 pairs), 22 gauge (6 to 1200 pairs), 24 gauge (6 to 2100 pairs), and 26 gauge (6 to 3000 pairs). Copper conductor shall conform to the following:
  a. Underground
     1) Provide filled cable meeting the requirements of ICEA S-99-689 and RUS 1755.390.

B. Fiber Optic Cable
1. Provide single-mode, 8/125-um, 0.10 aperture 1310 nm fiber optic cable in accordance with TIA-492CAAA, TIA-472DOOO, and ICEAS-87-640 including any special requirements made necessary by a specialized design. Provide 12 optical fibers as indicated. Fiber optic cable shall be specifically designed for outside use with loose buffer construction. Provide fiber optic color code in accordance with TIA/EIA-598
2. Strength Members
   a. Provide central, non-metallic strength members with sufficient tensile strength for installation and residual rated loads to meet the applicable performance requirements in accordance with ICEAS-87-640. The strength member is included to serve as a cable core foundation to reduce strain on the fibers, and shall not serve as a pulling strength member.
3. Shielding or Other Metallic Covering
   a. Provide bare aluminum or coated aluminum, single tape covering or shield in accordance with ICEAS-87-640.
4. Performance Requirements
   a. Provide fiber optic cable with optical and mechanical performance requirements in accordance with ICEA S-87-640.

C. Grounding and Bonding Conductors
   1. Provide grounding and bonding conductors in accordance with RUS 1755.200, TIA J-STD-607, IEEE C2, I3A Technical Criteria and NFPA 70. Solid bare copper wire meeting the requirements of ASTM B 1 for sizes No. 8 AWG and smaller and stranded bare copper wire meeting the requirements of ASTM B 8, for sizes No. 6 AWG and larger. Insulated conductors shall have 600-volt, Type TW insulation meeting the requirements of UL 83.

2.8 CABLE TAGS IN MAINTENANCE HOLES, HANDHOLES, AND VAULTS
   A. Provide tags for each telecommunications cable or wire located in maintenance holes, handholes, and vaults. Cable tags shall be polyethylene and labeled in accordance with TIA/EIA-606-A and 271500-A JBLM NEC Labeling Scheme. Handwritten labeling is unacceptable.
   1. Polyethylene Cable Tags
      a. Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive, non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F.
      b. Provide 0.05 inch (minimum) thick black polyethylene tag holder. Provide a one-piece nylon, self-locking tie at each end of the cable tag. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.

2.9 BURIED WARNING AND IDENTIFICATION TAPE AND TRACER WIRE
   A. Provide fiber optic media marking and protection in accordance with TIA-590. Provide polyethylene warning tape with a minimum width of 6-inches and imprinted with the words "WARNING - TELECOMMUNICATION CABLE BELOW" at intervals not more than 48-inch. Warning tape shall comply with APWA Uniform Color Code. Tape shall have a minimum thickness of 0.004 inch, and a minimum strength of 1750 pounds per square inch (PSI) lengthwise and 1500 PSI crosswise. Warning tape shall be manufactured with an integral wire, foil backing or other means of enabling detection by a metal detector or underground cable detector. The warning tape shall be chemically inert and resistant to degradation caused by acids, alkalis, and other destructive substances found in soil.
   B. Tracer wire shall be #12 AWG insulated solid copper with a minimum 30-mm PE jacket designed specifically for buried use. Splices in the tracer wire shall be a compression type connector to ensure continuity. Wire nuts shall not be used.

2.10 GROUNDING BRAID
   A. Provide grounding braid that provides low electrical impedance connections for dependable shield bonding in accordance with RUS 1755.200. Braid shall be made from flat tin-plated copper.
2.11 MANUFACTURER'S NAMEPLATE

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

2.12 FIELD FABRICATED NAMEPLATES

A. Provide laminated plastic nameplates in accordance with ASTM D 709 for each patch panel, protector assembly, rack, cabinet and other equipment or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.13 TESTS, INSPECTIONS, AND VERIFICATIONS

1. Factory Reel Test Data
   a. Test 100 percent OTDR test of FO media at the factory in accordance with TIA-568-C.1 and TIA-568-C.3. Use TIA-526-7 for single mode fiber measurements. Calibrate OTDR to show anomalies of 0.2 dB minimum. Enhanced performance filled OSP copper cables, referred to as Broadband Outside Plant (BBOSP), shall meet the requirements of ICEA S-99-689.
   b. Enhanced performance air core OSP copper cables shall meet the requirements of ICEA S-98-688. Submit test reports, including manufacture date for each cable reel and receive approval before delivery of cable to the project site.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Building telecommunications infrastructure and cabling shall be installed in accordance with NECA/BICSI 568-2006, Standard for Installing Commercial Building Telecommunications Cabling. Workmanship shall conform to the practices described in the BICSI Information Transport Systems Installation Methods Manual (ITSIMM).

B. Install all system components and appurtenances in accordance with manufacturer's instructions, IEEE C2, NFPA 70, I3A Technical Criteria, and as indicated. Provide all necessary interconnections, services, and adjustments required for a complete and operable telecommunications system.

C. Contractor Damage

1. Promptly repair indicated utility lines or systems damaged during site preparation and construction. Damages to lines or systems not indicated, which are caused by Contractor operations, shall be treated as "Changes" under the terms of the Contract Clauses. When Contractor is advised in writing of the location of a nonindicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In every event, immediately notify the Contracting Officer of damage.

D. Cable Inspection and Repair
1. Handle cable and wire provided in the construction of this project with care. Inspect cable reels for cuts, nicks or other damage. Damaged cable shall be replaced or repaired to the satisfaction of the Contracting Officer. Reel wraps shall remain intact on the reel until the cable is ready for placement.

E. Underground Duct

1. Provide underground duct and connections to existing maintenance holes, and existing ducts in accordance with I3A Technical Criteria. PVC ducts shall be installed with a minimum of 24 inches of cover over the encasement. Ducts shall enter maintenance holes at the bottom-most holes, deep enough to allow all maintenance hole entrance ports (used now or in the future) to have ducts installed to maintain minimum cover over the uppermost duct. Locate metallic warning tape above ducts at 12 to 18 inches above the encasement but at least 12 inches below grade and continuous above maintenance holes. All new and existing ducts utilized in the project shall be thoroughly cleaned prior to installing cables. A mandrel not less than 12 inches long with a diameter 1/2 inch less than the inside diameter of the duct shall be pulled through each duct. Pneumatic rodding may be used to draw in the lead wire/cord.

2. Install tracer wire in all new ductbanks. The tracer wire shall be placed exterior to the conduit in the center of the top conduit formation. Tracer wire shall be placed prior to the concrete pour. Splices in the tracer wire shall compression type to ensure continuity. Wire nuts are not allowed. After installation, provide continuity test of tracer wire and submit a report to the Quality Control Representative as part of the construction record documents.

3. Plug all ducts, sub-ducts, and innerducts, whether main or subsidiary runs, using universal screw type duct plugs in telecommunications maintenance holes and handholes and at building entrances. Foam sealant is not acceptable.

F. Penetrations

1. Caulk and seal cable access penetrations in walls, ceilings and other parts of the building. Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings in accordance with Section 07 84 13, FIRESTOPPING.

G. Cable Pulling

1. Test duct lines with a mandrel and swab out to remove foreign material before the pulling of cables. Avoid damage to cables in setting up pulling apparatus or in placing tools or hardware. Do not step on cables when entering or leaving the maintenance hole. Do not place cables in ducts other than those shown without prior written approval of the Contracting Officer. Roll cable reels in the direction indicated by the arrows painted on the reel flanges. Set up cable reels on the same side of the maintenance hole as the conduit section in which the cable is to be placed. Level the reel and bring into proper alignment with the conduit section so that the cable pays off from the top of the reel in a long smooth bend into the duct without twisting. Under no circumstances shall the cable be paid off from the bottom of a reel. Check the equipment set up prior to beginning the cable pulling to avoid an interruption once pulling has started. Use a cable feeder guide of suitable dimensions between cable reel and face of duct to protect cable and guide cable into the duct as it is paid off the reel. As cable is paid off the reel, lubricate and inspect cable for sheath defects. When defects are noticed, stop pulling operations and notify the Contracting Officer to determine required corrective action. Cable pulling shall also be stopped when reel binds or does not pay off freely. Rectify cause of binding before resuming pulling operations. Provide cable lubricants recommended by the cable manufacturer. Avoid bends in cables of small radii and twists that might cause damage. Do not bend cable and wire in a radius less than 10 times the outside diameter of the cable or wire.
2. Cable Tensions
   a. Obtain from the cable manufacturer and provide to the Contracting Officer, the maximum allowable pulling tension. This tension shall not be exceeded.

3. Pulling Eyes
   a. Equip cables 1.25 inches in diameter and larger with cable manufacturer's factory installed pulling-in eyes. Provide cables with diameter smaller than 1.25 inches with heat shrinkable type end caps or seals on cable ends when using cable pulling grips. Rings to prevent grip from slipping shall not be beaten into the cable sheath. Use a swivel of 3/4 inch links between pulling-in eyes or grips and pulling strand.

4. Installation of Cables in Maintenance Holes, Handholes, and Vaults Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls, not to interfere with duct entrances, and support cables on brackets and cable insulators at a maximum of 4 feet. In existing maintenance holes, handholes, and vaults where new ducts are to be terminated, or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required with cables arranged and supported as specified for new cables. Identify each cable with corrosion-resistant embossed tags. Coordinate cable labeling with JBLM NEC through the Contracting Officer's Representative. Cable labeling shall comply with the JBLM NEC Labeling Scheme.

H. Cable Splicing

1. Copper Conductor Splices
   a. Perform splicing in accordance with requirements of the I3A and RUS Bull 1753F-401 except that direct buried splices and twisted and soldered splices are not allowed. Exception does not apply for pairs assigned for carrier application. Do not use encapsulating compounds. Flash test using dry nitrogen gas to ensure dry and airtight seals.

2. Fiber Optic Splices
   a. Fiber optic splicing shall be in accordance with manufacturer's recommendation and shall exhibit an insertion loss not greater than 0.2 dB for fusion splices. Do not use encapsulating compounds. Flash test using dry nitrogen gas to ensure dry and airtight seals.

3. Surge Protection
   a. All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of RUS Bull 1751F-815.

4. Grounding

5. Telecommunications Master Ground Bar (TMGB)
   a. The TMGB is the hub of the basic telecommunications grounding system providing a common point of connection for ground from outside cable, CD, and equipment. Establish a TMGB for connection point for cable stub shields to connector blocks and CD protector assemblies as specified in Section 26 05 33 RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
6. Incoming Cable Shields  
a. Shields shall not be bonded across the splice to the cable stubs. Ground shields of incoming cables in the EF Telecommunications to the TMGB.

7. Campus Distributor Grounding  
a. Protection assemblies: Mount CD protector assemblies directly on the telecommunications backboard. Connect assemblies mounted on each vertical frame with No. 6 AWG copper conductor to provide a low resistance path to TMGB.  
b. TMGB connection: Connect TMGB to TGB with copper conductor with a total resistance of less than 0.01 ohms.

I. Cut-Over  
1. All necessary transfers and cut-overs, shall be accomplished by the telecommunications contractor. The RCDD shall render, stamp and approve the Cut-Over Plan in accordance with I3A Technical Criteria and TIA/EIA-606-A.

3.2 LABELING  
1. Labels  
a. Provide labeling for new cabling and termination hardware located within the facility in accordance with TIA/EIA-606-A and JBLM NEC Labeling Scheme.  
b. Handwritten labeling is unacceptable. Stenciled lettering for cable and termination hardware shall be provided using thermal ink transfer process.

B. Cable Tag Installation  
1. Install cable tags for each telecommunications cable or wire located in maintenance holes, handholes, and vaults including each splice. Tag new wire and cable provided under this contract and existing wire and cable which are indicated to have splices and terminations provided by this contract. The labeling of telecommunications cable tag identifiers shall be in accordance with TIA/EIA-606-A and JBLM NEC Labeling Scheme. Do not provide handwritten letters. Install cable tags so that they are clearly visible without disturbing any cabling or wiring in the maintenance holes, handholes, and vaults.

C. Termination Hardware  
1. Label patch panels, distribution panels, connector blocks and protection modules using color coded labels with identifiers in accordance with TIA/EIA-606-A.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING  
A. Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 FIELD QUALITY CONTROL  
A. Provide the Contracting Officer 10 working days notice prior to each test. Provide labor, equipment, and incidentals required for testing. Correct defective material and workmanship disclosed as the results of the tests. Furnish a signed copy of the test results to the Contracting Officer within 3 working days after the tests for each segment of construction are completed. Perform testing as construction progresses and do not wait until all construction is complete before starting field tests.

B. Pre-Installation Tests
1. Perform the following tests on cable at the job site before it is removed from the cable reel. For cables with factory installed pulling eyes, these tests shall be performed at the factory and certified test results shall accompany the cable.

2. Cable Capacitance
   a. Perform capacitance tests on at least 10 percent of the pairs within a cable to determine if cable capacitance is within the limits specified.

3. Loop Resistance
   a. Perform DC-loop resistance on at least 10 percent of the pairs within a cable to determine if DC-loop resistance is within the manufacturer's calculated resistance.

4. Pre-Installation Test Results
   a. Provide results of pre-installation tests to the Contracting Officer at least 5 working days before installation is to start. Results shall indicate reel number of the cable, manufacturer, size of cable, pairs tested, and recorded readings. When pre-installation tests indicate that cable does not meet specifications, remove cable from the job site.

C. Acceptance Tests

1. Perform acceptance testing in accordance with I3A paragraph 3.19 and RUS Bull 1753F-201 and as further specified in this section. Provide personnel, equipment, instrumentation, and supplies necessary to perform required testing. Notification of any planned testing shall be given to the Contracting Officer at least 14 days prior to any test unless specified otherwise. Testing shall not proceed until after the Contractor has received written Contracting Officer's approval of the test plans as specified. Test plans shall define the tests required to ensure that the system meets technical, operational, and performance specifications. The test plans shall define milestones for the tests, equipment, personnel, facilities, and supplies required. The test plans shall identify the capabilities and functions to be tested. Provide test reports in booklet form showing all field tests performed, upon completion and testing of the installed system. Measurements shall be tabulated on a pair by pair or strand by strand basis.

2. Copper Conductor Cable
   a. Perform the following acceptance tests in accordance with TIA-758:
      1) Insulation Resistance
      2) Shorts/Crosses
      3) Grounds
      4) Opens
      5) Reversals
      6) Splits
      7) Transpositions
      8) Shield Continuity
      9) Loop Resistance
     10) Insertion Loss
     11) Capacitance

3. Fiber Optic Cable
   a. Test fiber optic cable in accordance with I3A paragraph 3.19.2 and TIA/EIA-455 and as further specified in this section. Two optical tests shall be performed on all optical fibers: Optical Time Domain Reflectometry (OTDR) Test, and Attenuation Test. In addition, a Bandwidth Test shall be performed on all multimode optical fibers. These tests shall be performed on the completed end-to-end spans which
include the near-end pre-connectorized single fiber cable assembly, outside plant as specified, and the far-end pre-connectorized single fiber cable assembly.

b. OTDR Test: The OTDR test shall be used to determine the adequacy of the cable installations by showing any irregularities, such as discontinuities, micro-bendings or improper splices for the cable span under test. Hard copy fiber signature records shall be obtained from the OTDR for each fiber in each span and shall be included in the test results. The OTDR test shall be measured in both directions. A reference length of fiber, 66 feet minimum, used as the delay line shall be placed before the new end connector and after the far end patch panel connectors for inspection of connector signature. Conduct OTDR test and provide calculation or interpretation of results in accordance with TIA-526-7 for single-mode fiber. Splice losses shall not exceed 0.3 db.

c. Attenuation Test: End-to-end attenuation measurements shall be made on all fibers, in both directions, using a 1310 and 1550 nanometer light source at one end and the optical power meter on the other end to verify that the cable system attenuation requirements are met in accordance with TIA-526-7 for single-mode fiber optic cables. The measurement method shall be in accordance with TIA-455-78-B. Attenuation losses shall not exceed 0.5 db/km at 1310 nm and 1550 nm for single-mode fiber.

d. Power Source/Power Meter: This test shall consist of bi-directional, dual-window (1300/1550nm) testing of every fiber strand installed.

D. Soil Density Tests

1. Determine soil-density relationships for compaction of backfill material in accordance with ASTM D 1557, Method D.

END OF SECTION 33 82 00