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1329-C KINGSLEY AVENUE
ORANGE PARK, FLORIDA  32073
B&H PROJECT NO.: 17072

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ELECTRICAL ENGINEER
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JACKSONVILLE, FLORIDA 32257
# PEGASUS NEW OPERATIONS BUILDING
## FOR BID – 11/20/2019
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PART 1  GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

AMERICAN WATER WORKS ASSOCIATION (AWWA)
AWWA C651  (1999) Disinfecting Water Mains

FM GLOBAL (FM)

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCCHR)
FCCCHR List  List of Approved Backflow Prevention Assemblies (continuously updated)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

UNDERWRITERS LABORATORIES (UL)
UL 262  (2004) Gate Valves for Fire-Protection Service
1.2 SYSTEM DESCRIPTION

A. Hydraulically design and provide new automatic wet pipe fire extinguishing sprinkler systems for complete fire protection coverage throughout all areas of the proposed facility.

1.3 SPRINKLER SYSTEM DESIGN

A. Design automatic wet pipe fire extinguishing sprinkler systems in accordance with the required and advisory provisions of NFPA 13, except as modified herein, by for light or ordinary hazard occupancy and hydraulic calculations for uniform distribution of water over the design area. Discharge from individual heads in the hydraulically most remote area shall be between 100 percent and 120 percent of the specified density. System shall include materials, accessories, and equipment inside and outside the building to provide system complete and ready for use. Design and provide system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed working drawings to be submitted for approval. Locate sprinkler heads in a consistent pattern and center of ceiling panels both ways with ceiling grid, lights, and air supply diffusers. Provide sprinkler heads and piping system layout sprinkler heads and piping system layout. Devices and equipment for fire protection service shall be UL Fire Prot Dir UL Fire Prot Dir listed or FM P7825 FM P7825 approved for use in wet pipe sprinkler systems. Submit all calculations and final signed and sealed drawings to Engineer for review and approval prior to submission for permitting and to start of work. Engineer of Record shall be Contractor's signing and sealing Professional Engineer.

B. Location of Sprinkler Heads: Heads in relation to the ceiling and the spacing of sprinkler heads shall not exceed that permitted by NFPA 13 for light and ordinary hazard occupancy. Uniformly space sprinklers on the branch piping. Locate heads in center of tiles in two directions. Flexible section of piping maybe used to locate sprinkler heads.

C. Water Distribution: Distribution shall be uniform throughout the area in which the sprinkler heads will open. Discharge from individual heads in the hydraulically most remote area shall be 100 to 120 percent of the specified density.

D. Density of Application of Water: Size pipe to provide the specified density when the system is discharging the specified total maximum required flow. Application to horizontal surfaces below the sprinklers shall be 0.10 gpm per sq ft (Light Hazard and Ordinary Group I) and .15 gpm per sq foot for Ordinary Group #1 Hazard.

E. Sprinkler Discharge Area: Area shall be the hydraulically most remote 1500 sq ft area as defined in NFPA 13.

F. Outside Hose Allowances: Hydraulic calculations shall include an allowance of 250 gpm for outside hose streams per riser.

G. Friction Losses: Calculate losses in piping in accordance with the Hazen-Williams formula with ‘C’ value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.

H. Water Supply: Base hydraulic calculations on provided flow test. Refer to site plan for specific site data.
I. Detail Drawings: Prepare 24 by 36 inch detail working drawings of sprinkler heads and piping system layout in accordance with NFPA 13, "Working Drawings (Plans)." Show data essential for proper installation of each system. Show details, plan view, elevations, and sections of the systems supply and piping. Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams. Submit drawings signed by a registered fire protection engineer.

J. As-Built Drawings: After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes. Submit 24 by 36 inch drawings on reproducible bond or vellum with title block similar to full size contract drawings. Furnish the as-built (record) working drawings in addition to as-built contract drawings required by Division 01, "General Requirements."

1.4 SUBMITTALS

A. Engineer’s approval is required for all submittals. All submittals are to be reviewed by Project Mechanical Engineer.

B. SD-02 Shop Drawings
   1. Sprinkler heads and piping system layout
   2. Electrical Wiring Diagrams

C. SD-03 Product Data
   1. Piping;
   2. Alarm Valves
   3. Valves, including gate, check, and globe
   4. Sprinkler heads;
   5. Pipe hangers and supports
   6. Pressure or flow switch
   7. Fire department connections
   8. Mechanical couplings
   9. Backflow preventer
   10. Annotate descriptive data to show the specific model, type, and size of each item.

D. SD-05 Design Data
   1. Sprinkler system design
   2. Submit computer program generated hydraulic calculations to substantiate compliance with hydraulic design requirements. Submit name of software program used.

E. SD-06 Test Reports: Preliminary tests on piping system.

F. SD-07 Certificates: Qualifications of installer

G. SD-10 Operation and Maintenance Data
   1. Alarm Valves
   2. Backflow Preventer
   3. Submit in accordance with Section 01700 Execution Requirements, Operation and Maintenance Data.

H. SD-11 Closeout Submittals: As-built drawings of each system
1.5 QUALITY ASSURANCE

A. Prior to installation, submit data showing that the Contractor has successfully installed systems of the same type and design as specified herein, or that Contractor has a firm contractual agreement with a subcontractor having such required experience. Data shall include names and locations of at least two installations where the Contractor or the subcontractor referred to above, has installed such systems. Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.

B. Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies (NICET) as an engineering technician with minimum Level-III certification in Automatic Sprinkler System program. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

2PART 2 PRODUCTS

2.1 ABOVE GROUND SYSTEMS

A. Provide fittings for changes in direction of piping and for connections. Make changes in piping sizes through tapered reducing pipe fittings; bushings will not be permitted. Perform welding in the shop; field welding will be permitted. Conceal piping in areas with suspended ceiling and all areas where physically possible. Piping above hard ceiling in trusses is permitted.

B. Sprinkler Piping: NFPA 13, except as modified herein. Steel piping shall be Schedule 10 minimum to 40 for sizes less than 8 inches. Fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples shall be threaded, polypropylene piping or grooved-end type piping is acceptable. Plain-end fittings with and fittings which use steel gripping devices to bite into the pipe when pressure is applied will not be permitted. Rubber gasketed grooved-end pipe and fittings with mechanical couplings shall be permitted in pipe sizes 1.5 inches and larger. Fittings shall be UL Fire Prot Dir listed or FM P7825 approved for use in wet pipe sprinkler systems. Fittings, mechanical couplings, and rubber gaskets shall be supplied by the same manufacturer. Steel piping with wall thickness less than Schedule 30 shall not be threaded. Side outlet tees using rubber gasketed fittings will not be permitted. Sprinkler pipe and fittings shall be metal in metal systems. Flex piping may be used to locate sprinkler heads.

C. Sprinkler Heads: Provide nominal 0.50 inch or 0.75 inch orifice quick response sprinkler heads. O-rings will not be permitted in sprinkler heads. Release element of each head shall be of the intermediate temperature rating or higher as suitable for the specific application. Provide polished stainless steel ceiling plates or standard chromium-plated finish ceiling plates, and chromium-plated pendent sprinklers below suspended ceilings. Provide corrosion-resistant brass sprinkler heads and sprinkler head guards in all Storage, Mechanical and Closets or areas subject to damage. Deflector shall not be more than 3 inches below suspended ceilings. Ceiling plates shall not be more than 0.5 inch deep. Ceiling cups shall not be permitted. Provide semi-recessed heads in all meeting, occupied, finished, administrative spaces and in all corridors ceiling. See plans for specifics.

D. Cabinet: Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each riser alarm valve. The number and types of extra sprinkler heads shall be as specified in NFPA 13.
E. Alarm Valves: Provide variable pressure type alarm valve complete with retarding chamber, alarm test valve, alarm shutoff valve, drain valve, pressure gages, accessories, and appurtenances for the proper operation of the system. A riser check assembly may be used.

F. Pressure or Flow Switch: Provide sprinkler zone switch with circuit opener or closer for the automatic transmittal of an alarm over the facility fire alarm system.

G. Pipe Hangers and Supports: Provide in accordance with NFPA 13. Attach to steel trusses with, Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor.

H. Valves: NFPA 13. Provide valves of types approved for fire service. Gate valves shall open by counterclockwise rotation. Provide an OS&Y valve beneath each alarm. Check valves shall be flanged clear opening swing-check type with flanged inspection and access cover plate for sizes 4 inches and larger. Provide double check valve assembly type backflow preventer with OS&Y gate valves on both ends. Each check valve shall have a drain. Each OS&Y gate valve shall be supervised; minimum contact ratings shall be 2.5 amps at 24 volt DC. Provide supervision against valve closure or tampering of valve. Double check valve assembly shall be tested and certified under ASSE 1015.

I. Backflow Preventer: See Civil for type required. Provide assembly backflow preventer with OS&Y gate valve on both ends. Each check valve shall have a drain. Backflow prevention assemblies shall have current "Certificate of Approval from the Foundation for Cross-Connection Control and Hydraulic Research, FCCCHR List. Listing of the specific make, model, design, and size in the FCCCHR List shall be acceptable as the required documentation." Backflow preventer shall be insulated with 3 inch fiberglass with foil backing, 3/4 lb. density, and housed in a full aluminum jacket insulation enclosure on a 4 inch concrete pad. See Civil plans for details. Provide detector assembly on back flow for connection to existing Fire Alarm. Electrical contractor to provide connection to Fire Alarm System. No heat tracer tape required.

J. Identification Signs: NFPA 13. Attach properly lettered and approved metal signs to each valve and alarm device. Permanently affix hydraulic design data nameplates to the riser of each system.

K. Test Connections
   1. Inspector's Test Connection for sprinkler Systems: Provide test connections approximately 6 feet above the floor for each sprinkler system or portion of each sprinkler system equipped with an alarm device; locate at the hydraulically most remote part of each system. Provide test connection piping to a drain location that can accept full flow where the discharge will be readily visible and where water may be discharged without property damage. Discharge to a floor drain shall be permitted only if the drain is sized to accommodate full flow. Discharge to janitor sinks or similar fixtures shall not be permitted. Provide discharge orifice of same size as corresponding sprinkler orifice. The penetration of the exterior wall shall be no greater than 2 feet above finished grade.
2. **Backflow Preventer Test Connection:** Provide downstream of the backflow prevention assembly listed hose valves with 2.5 inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand or fraction thereof. Provide a permanent sign in accordance with paragraph entitled "Identification Signs" which reads, "Test Valve."

L. **Main Drains:** Provide separate drain piping to discharge at safe points outside each riser in building. Provide auxiliary drains as required by NFPA 13. Provide precast concrete splash block under each exterior drain discharge. The penetration of the exterior wall shall be no greater than 2 feet above finished grade. Main drain shall also serve as the backflow preventer test connection. Site main drain pipe and valve to support flow at system demand. Locate in non patient nor common areas. Select mechanical rooms or closets not accessible to public.

M. **Fire Department Connections:** Provide 4 inch connections approximately 3 feet above finish grade, of the approved two-way type with 2.5 inch National Standard female hose threads with plug, chain, and identifying fire department connection escutcheon plate.

N. **Alarm Bells:** Provide gong (water operated) alarm type compatible with Fire Alarm and Sprinkler Controls. Tie to building Fire Alarm system.

### 2.2 BURIED WATER PIPING SYSTEMS

A. **Pipe and Fittings:** Provide outside-coated, cement-mortar lined, ductile-iron pipe, or DR18 PVC and fittings conforming to NFPA 24 for piping and outside of building walls. Anchor joints in accordance with NFPA 24. Provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size shall be 6 inches. Minimum depth of cover shall be 3 feet at finish grade. Turn piping up at building and penetrate through building floor slab. Seal all penetrations water tight.

B. **Valves:** Provide as required by NFPA 24. Gate valves shall conform to UL 262 and shall open by counterclockwise rotation.

C. **Buried Utility Warning and Identification Tape:** Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall read "CAUTION BURIED WATER PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

D. The contractor installing underground fire protection lines shall be licensed under Chapter 633, F.S. and shall obtain separate permit from the District for this work. This contractor shall provide a Material and Test Certificate or Underground Piping as specified in NFPA 13.

### 2.3 PIPE SLEEVES

A. Provide where piping passes entirely through walls, floors, and roofs. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, floors, and roofs. Provide one inch minimum clearance between exterior of piping and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole.
with plastic waterproof cement which will dry to a firm but pliable mass, or provide a
mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal
both ends of pipe sleeves or core-drilled holes with UL listed fill, void, or cavity material.
1. Sleeves in Masonry and Concrete Walls, Floors, and Roofs: Provide hot-dip
galvanized steel, ductile-iron, or cast-iron sleeves. Core drilling of masonry and
cement may be provided in lieu of pipe sleeves when cavities in the core-drilled
hole are completely grouted smooth.
2. Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs: Provide
20 gage galvanized steel sheet.

2.4 ESCUTCHEON PLATES

A. Provide split hinge metal plates for piping entering walls, floors, and ceilings in exposed
spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy
plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

3. PART 3 EXECUTION

3.1 INSTALLATION

A. Installation, workmanship, fabrication, assembly, erection, examination, inspection, and
testing shall be in accordance with, except as modified herein. Install piping straight and
true to bear evenly on hangers and supports. Do not hang piping from plaster or sheet
rock ceilings. Keep the interior and ends of new piping and existing piping affected by
Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping
systems clean during installation by means of plugs or other approved methods. When
work is not in progress, securely close open ends of piping to prevent entry of water and
foreign matter. Inspect piping before placing into position. Provide Teflon pipe thread
paste on male threads.

B. Electrical Work: Electrical work associated with this section shall be under Division 26.

C. Disinfection: Disinfect the new water piping and existing water piping affected by
Contractor's operations in accordance with AWWA C651. Fill piping systems with
solution containing minimum of 50 parts per million (ppm) 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 to 0.5 ppm, or the
residual chlorine content of domestic water supply.

D. Connections to Existing Water Supply Systems: Use tapping or drilling machine valve
and mechanical joint type sleeves for connections to be made under pressure. Bolt
sleeves around the main piping; bolt valve to the branch connection. Open valve, attach
drilling machine, make tap, close valve, and remove drilling machine, all without
interruption of service. Notify the Engineer in writing at least 15 days prior to connection
date; receive approval before any service is interrupted. Furnish materials required to
make connections into existing water supply systems, and perform excavating,
backfilling, and other incidental labor as required. Furnish the labor and the tapping or
drilling machine for making the actual connections to existing systems.

E. Buried Piping System: Bury tape with the printed side up at a depth of 12 inches below
the top surface of earth or the top surface of the subgrade under pavements. Provide #10
copper locator wire on PVC type underground piping.
3.2 FIELD QUALITY CONTROL

A. Perform test to determine compliance with the specified requirements in the presence of the Engineer. Test, inspect, and approve piping before covering or concealing.

B. Preliminary Tests: Hydrostatically test each system at 200 psig for a 2 hour period with no leakage or reduction in pressure. Flush piping with potable water in accordance with NFPA 13. Piping above suspended ceilings shall be tested, inspected, and approved before installation of ceilings. Test the alarms and other devices. Test the water flow alarms by flowing water through the inspector's test connection. When tests have been completed and corrections made, submit a signed and dated certificate, similar to that specified in NFPA 13.

C. Formal Tests and Inspections: Do not submit a request for formal test and inspection until the preliminary test and corrections are completed and approved. Submit a written request for formal inspection at least 15 days prior to inspection date. An experienced technician regularly employed by the system installer shall be present during the inspection. At this inspection, repeat any or all of the required tests as directed. Correct defects in work provided by the Contractor and make additional tests until the systems comply with contract requirements. Furnish appliances, equipment, electricity, instruments, connecting devices, and personnel for the tests.

3.3 FIELD PAINTING

A. Field painting of exposed fire extinguishing piping sprinkler system shall be machine enamel red - two coats.

END OF SECTION
PART 1 - GENERAL

1.1 DESCRIPTION

A. The work includes the providing of all labor, materials, and services necessary to install the indicated systems, complete with hangers, supports, equipment and connections required to any fixture or equipment indicated or specified.

B. The work includes, but is not limited to the following:
   1. Sanitary waste and vent piping systems.
   2. Domestic hot and cold water piping systems.

1.2 ALL WORK

A. Shall be performed by mechanics skilled in the particular class of work and all equipment shall be installed in strict accordance with the manufacturer's recommendations. The work shall be coordinated with other trades and responsibilities established so that the work shall be completed without delays or interference with schedules.

1.3 CUTTING AND PATCHING

A. Where required, the Contractor shall do the cutting and patching using workmen who are skilled in the trade involved. The completed work shall present a finished workmanlike appearance.

1.4 PIPING AND DRAWINGS

A. The drawings are diagrammatic and not intended to show in detail all features of the work. The location of all piping shall be coordinated to determine that it clears all openings and structural members, that piping indicated as concealed can be properly concealed in walls or partitions of finished rooms, and that it does not interfere with lights, ductwork, or equipment having fixed locations. Conceal all piping except where otherwise indicated.

1.5 OPENINGS IN EXISTING CONCRETE CONSTRUCTION

A. Shall be core drilled or cut with masonry saw. Pneumatic tools will not be permitted. The integrity of the fire rating of walls, ceilings and floors shall be maintained and shall meet Life Safety and local codes.

1.6 ELECTRICAL WORK

A. In accordance with Division 16. Refer to electrical drawings for electrical characteristics of equipment.

1.7 TRAPS

A. Each fixture, equipment drain or floor drain shall be separately trapped, unless otherwise indicated or specified.
1.8 UNIONS
   A. Install on each side of each valve and connection to equipment.

1.9 ESCUTCHEON PLATES
   A. For all piping through walls, floors and ceilings exposed to view. Chromium plated, two piece, hinged, with set screws. To fit around insulation, where present. Deep escutcheon plates shall be provided where pipe sleeves extend above floors.

1.10 SHOP DRAWINGS
   A. Seven (7) copies of Shop Drawings of each item listed in the "Equipment Schedules" or elsewhere on the drawings and in the specifications. (These shop drawings shall be submitted to the Architect and approved by him before the Contractor may purchase the equipment or materials.) Two sets will be retained for the Architect.

   B. Shop drawings shall be submitted with all equipment items complete at one time. Shop drawings shall be presented in book form in a hardbacked binder with heavy paper dividers for each paragraph of the specification delineating an item or items of equipment. Dividers shall be provided with substantial staggered index tabs, with each tab numbered with the specification paragraph number for the included item(s) of equipment. In addition, an index listing each tab division with equipment covered shall be provided at the front of the submittal book. Provide a single tab labeled "DWGS" for items of equipment that might be specified on the Drawings. Items presented singly for approval will not be acceptable. All shop drawings shall be presented as hard copies; no electronic submittals will be accepted.

   C. Coordinate the location of floor drains, piping and other pertinent items with the work of other trades. Installation of these items shall be made after receipt of and in accordance with the approved shop drawings.

1.11 UNIONS AND FLANGES
   A. Unions and flanges may not, in every case, be shown on the Drawings, but are to be provided where necessary and adjacent to all equipment installed or provided for under this contract.

1.12 GUARANTEE
   A. All equipment, material, accessories and installation shall carry a guarantee against defects for a period of one year from the date of acceptance. Each system as a whole, and in all its parts, shall be guaranteed to function correctly up to the specified capacity. Should a system, or any part thereof, fail to meet the performance requirements, necessary replacements, alternations or repairs shall be made to bring performance up to specified requirements. Building construction finishes damaged or marred shall be restored to the satisfaction of the Owner's representative. All of the above described shall be done without cost to the Owner.
PART 2 - PRODUCTS

2.1  GENERAL

A. All materials shall be new and free from all defects. These specifications list all of the acceptable materials for a given service, one of which shall be used unless otherwise specifically noted in the specifications or on the Drawings.

B. The quality and weight of materials furnished and installed shall comply with the requirements and specifications of the appropriate standards of the American Society for Testing and Materials, Life Safety Code and the local plumbing code.

2.2  PIPE AND FITTINGS

A. General: All piping shall be run straight, plumb and properly graded in direction indicated on the Drawings. Cut pipe shall be squarely cut and properly reamed to remove all cuttings and burrs before making up the joints. Fittings and nipples shall be of the same materials as the pipe. In cases where it is necessary to joint copper piping to steel equipment or steel piping, install an insulating fitting equal to EPCO dielectric pipe fittings as manufactured by Epco Sales, Inc. 3204 Sackett Avenue, Cleveland, Ohio.

B. Cast Iron Soil Pipe (If Used): Cast iron soil and waste pipe and fittings shall be standard weight, coated with coal tar varnish, and shall comply with ASTM A 74 and CISPI Trademark.

C. Hubless cast iron pipe and fittings (if used) shall be standard weight, coated with coal tar varnish, and shall comply with ASTM Standard A74 and CISPI Standard 301.

D. Steel Pipe (If Used): Steel pipe shall be Schedule 40 mild steel, ASTM A 120. Fittings shall be 150 psi screwed malleable iron fittings, ANSI B16.3.

E. Copper Watertube (if used) shall be Type L, copper tubing, ASTM B88. Fittings shall be wrought copper, ANSI B16.3, with lead free solder-ASTM approved.

F. Plastic Pipe and Fittings: (If used) Pipe shall be Schedule 40 PVC conforming to ASTM D1785. Fittings shall be PVC conforming to ASTM D2466. Solvent cement shall conform to ASTM D2564.

2.3  VALVES

A. General: Crane valve numbers are specified to establish type and quality. Equivalent valve types by Fairbanks, Hammond or Powell will be considered for approval.

B. Domestic Water Piping:

1. Gate Valves: 2" and smaller - Crane No. 428 or No. 438 as applicable. 2-1/2" or IPS or larger - Crane #465-1/2 or #461 as applicable.

2. Check Valves: 2" IPS or smaller - Crane #37. 2-1/2 IPS or larger - Crane 373.


4. Ball Valves: Full port ball valves with stainless steel stem and ball with teflon seat and rings.

5. Exterior isolation valves 2 inches and larger: Cast-iron resilient wedge valve. Wedge shall be to totally encapsulated with rubber, non-rising stem with bonnet and o-ring plate fusion-bond epoxy coated.

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2.4 CLEANSOUTS

A. Where indicated and at the base of all risers. Additional cleansouts at the Contractors' option for the convenience of testing and erection. Cleansouts installed in floors with waterproof membrane shall be provided with clamping rings. Install cleanout frames and covers to be flush with the adjoining architectural finishing material. Cleansouts located outside of the building shall be two-way type. Josam Model Numbers are indicated below. Comparable Model Numbers by Wade or J. R. Smith will be considered for approval.

B. Cleanout Plugs: Josam 58540-20.

C. Cleanouts in Wall: Josam 58790-22.

D. Cleanouts in Concrete and Terrazzo Floor Finishes: Josam 58410.


F. Carpeted Floor Finishes: Josam 58410-14.

2.5 PIPE HANGERS

A. Hangers shall be of the clevis type, MSS SP-58, type 1.

2.6 WATER HAMMER ARRESTORS

A. In conformance with Plumbing and Drainage Institute No. PDI-WH-201.

2.7 PLUMBING FIXTURES

A. General: All plumbing fixtures shall be "First Quality". All enameled iron fixtures shall have acid resisting white enamel. All fixtures and fittings proposed shall be from one manufacturer and of similar character. Escutcheons, handles, etc., on the different fixtures shall be of the same design. All fixtures and fittings proposed shall be submitted for approval with catalog cuts and full description. All exposed metal and piping not otherwise specified shall be polished chromium on brass or bronze. All hot and cold water supply to fixtures shall be provided with stops of the loose key type.

B. See Drawings for fixture specifications. Where fixture types refer to those manufactured by Kohler, unless otherwise noted, these numbers are used to indicate type and quality of fixtures desired. Fixtures of equal quality manufactured by American Standard, Briggs or Eljer will be considered for approval. Hanger supports and carriers shall be installed in accordance with manufacturers recommendations. All wall-hung fixtures located on a stud wall or chased wall shall be provided with floor carriers. Wall-hung fixtures located on a CMU block wall shall be provided with a heavy-duty anchoring plate.

2.8 EQUIPMENT FURNISHED BY OTHER SECTIONS

A. Certain items of equipment will be furnished as work of other sections and shall be furnished with necessary plumbing services as work of this section, responsibility includes determining the correct roughing location for services and making final connections.
B. Piping and Valves necessary to supplement those items which are furnished by other sections shall be furnished and installed by this section. Provide shut-off valves on all supply branches to equipment. All piping and valves in finished room normally exposed to view shall be brass, chromium plated, and provided with chromium plated escutcheon plates.

2.9 THERMAL INSULATION

A. General: No insulation shall be installed until the piping systems have been checked and found free of all leaks. Surfaces shall be clean and dry before attempting to apply insulation. Insulation shall be installed by a professional insulation contractor with adequate experience and ability to perform the work. The Contractor shall verify that all materials comply with the specifications.

B. Domestic Hot Water Piping:
1. Material: Shall be insulated with one-inch thick “Imcolock” or “Arctictherm” polyethylene pipe insulation.
2. Application: Pipe insulation shall be secured in place by applying pressure to the pressure sensitive closure system. Elbows and tees shall be insulated with miter-cut fittings. Valves and other irregular fittings shall be insulated per manufacturer’s installation guidelines.

C. Domestic Cold Water and Horizontal Storm Water Piping:
1. Material: Shall be the same material and applied in the same manner as specified above for domestic hot water piping, except the insulation thickness shall be 1/2 inch.

D. Waste lines from electric water coolers and waste piping exposed, piping in crawl space or in exterior walls shall be insulated with 3/8 inch thick “Imcolock” or “Arctictherm”.

E. Exposed water piping and P-traps serving handicapped lavatories that receive hot water shall be insulated with Truebro Model # 102W insulation kit.

PART 3 - EXECUTION

3.1 SOIL, WASTE AND VENT PIPING

A. Buried Piping: Soil, waste and storm pipe and fittings below the floor slab and to the building 5 foot line shall be of the Schedule 40 PVC plastic and shall be provided with a locator wire #12 gage installed per manufacturer’s recommendations.

B. Above Grade: Soil, waste and vent piping and fittings shall be Schedule 40 PVC plastic.

C. Waste and vent piping located in a plenum shall be cast-iron.

3.2 DOMESTIC HOT AND COLD WATER PIPING

A. Pipe shall be Schedule 80 CPVC with solvent cement fittings.

3.3 CLEANING AND PROTECTION OF PIPE

A. Before being placed in position, pipe and fittings shall be cleaned carefully. All pipe shall be maintained in a clean condition.
3.4 PIPE IN TRENCHES
A. Sewer and water piping shall be placed in separate trenches.
B. Water piping shall be buried at a depth of 6 inches below the frost line or a minimum of 12 inches, whichever is greater.

3.5 BELL AND SPIGOT CAST IRON SOIL PIPING (IF USED)
A. Bell and spigot cast iron soil piping shall be laid with bell ends pointing up-grade. Pipe shall be graded carefully and shall be supported firmly and uniformly at its proper elevation and grade. Adjacent length of pipe shall be adjusted with reference to each other; blocking or wedging between hub and spigot will not be permitted. Spigots shall be adjusted in bells so as to give a uniform space all around. Open ends of pipes shall be closed by a watertight plug at the end of each day’s work.

3.6 CAULKED AND LEADED JOINTS (IF USED)
A. Bell and spigot pipe shall have braided or twisted hemp or oakum gaskets of the best commercial grade and shall provide not less than one inch depth for leading. Gaskets shall not project into the bore of the finished joints. After gaskets are placed, the joints shall be cleaned and the remaining space filled at one pouring with lead which shall be caulked in a manner that will assure tight joints with straining the iron of the bells. After caulking, the lead shall be practically flush with face of the bells. The lead shall contain not less than 99.7 percent pure lead.

3.7 BAND AND SCREW ASSEMBLIES (IF USED)
A. Band and screw assemblies used in conjunction with hubless type cast iron soil pipe shall be tightened to 60 inch pounds torque on each band screw with a torque wrench specifically designed for the purpose. Each screw shall be retorqued after not less than 24 hours. The use of screwdrivers or various types of wrenches will not be permitted for this purpose.

3.8 INSTALLATION OF SCREW-JOINTED PIPING (IF USED)
A. All piping shall be cut accurately to measurements established by the Contractor and shall be worked into place without springing or forcing. Proper provision shall be made for the expansion and contraction of all pipe lines. Pipe and fittings shall be free from fins and burrs. Screw joints in water piping shall be made with a lubricant applied on the male threads only. Threads shall be full cut and not more than three threads on the pipe shall remain exposed. All ferrous pipe thread, after being installed and tested, shall be given one coat of red lead and oil paint. Unions and union type connections and shut-off valves shall be provided for all fixtures and equipment ready for disconnection. On ferrous pipe 3 inches in diameter and smaller, unions shall be 150 pound steam-working-pressure malleable iron ground joint type. On ferrous pipe 4 inches in diameter and larger, unions shall be 125 pound steam-working-pressure forged steel flange type, with gaskets of 1/16 inch thick best quality rubber or cloth inserted rubber. Pipe hung from ceilings shall be supported by heavy adjustable hangers conforming to MSS SP-59. All hangers and collars shall be of sizes suitable for the weight of the pipe. All changes in sizes of pipe shall be made with reducing fittings.
3.9 WATER HAMMER ARRESTORS
A. Water hammer arrestors shall be provided instead of site-fabricated air chambers, and shall be sized as required and installed in accordance with manufacturer’s recommendations. Arrestors shall be of the maintenance free (sealed) type.

3.10 WATER SYSTEMS
A. Water systems shall be installed with a fall towards the shut-off valve or the lowest fixture. Branches from hot and cold water lines shall be provided to fixtures, water heating units, and outlets as indicated.

3.11 SANITARY SYSTEMS
A. Sanitary and storm systems shall be provided where applicable, with Y fittings and 1/8 or 1/16 bends or combination Y and 1/8 bends. All fixtures not specified to be provided with traps as integral parts of their outfits and all drains shall have separate traps with cleanouts. Waste and storm lines shall not be less than 2 inches in diameter. All fixtures shall be individually vented, or shall be connected to a vented soil or waste line. Unless indicated otherwise, sanitary piping shall form circuit or loop vent with no dead ends or inverted siphons. Circuit or loop vent lines shall be connected at a height of not less than 12 inches above the fixtures served. Horizontal vents shall slope down to waste or soil branch or stack. Horizontal soil, waste and storm piping, generally, shall be graded 1/8 inch per foot. Vertical stacks shall be extended full size as vents to not less than 12 inches above the roof and shall be placed in position before the roofing is applied. Where practicable, two or more vent lines may be connected and extended as one pipe through the roof. Cleanouts shall be installed at the foot of each soil or waste line, at changes in direction in the lines, and where indicated; however, within the buildings, the distance between cleanouts in horizontal runs shall in no case exceed 50 feet. Cleanouts in floors shall be extended full size to the floor level with outlets fitted with trap screws with countersunk caps. Cleanouts shall be pipe size except no cleanout shall exceed 6 inches in diameter. Vent flashing at the roof shall extend not less than 8 inches from the vent pipe in all directions. Lead flashing shall be turned down into the pipes or hubs.

3.12 WATER VALVES
A. Water valves shall be installed in accessible places and shall be located as follows: (1) valve with hose connection on the building side of the main shut-off valve; (2) shut-off valve on each supply to each fixture not provided with compression stop; (3) valves shall be provided on all branches serving more than one fixture. Where valves are located in a non-accessible location, an access panel shall be provided and submitted for approval.

3.13 INSTALLATION OF FIXTURES
A. Connections between water closets and the flanges on soil pipe shall be made gas and water tight with one piece special molded gasket. All bulk material including putty and plastics shall not be used. Floor drains shall be secured to the waterproofing or flashing in a watertight manner. Exact rough-in locations for fixtures and floor drains shall be determined from the Architectural Drawings. Contractor shall replace existing watercloset floor flanges when replacing a watercloset.
3.14 PIPE SLEEVES

A. Pipe sleeves shall be provided where pipes pass through masonry or concrete walls, floors, roofs and partitions. Sleeves shall be placed during construction of the building and at no time shall jack hammers be used. Sleeves in outside walls below and above grade, or in floor slabs, shall be zinc-coated sheet steel. Space between pipe, tubing or insulation and the sleeve shall be not less than 1/4 inch. Sleeves shall be held securely in proper position and location before and during construction. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions or slabs. Sleeves in floor slabs shall extend 2 inches above the finished floor. Space between the pipe and the sleeve shall be firmly packed with oakum and caulked on both ends of the sleeve with insulating cement. Sleeves located in waterproofed construction shall be provided with flange and clamping ring. Sleeves are not required in floor slabs located on grade, except that copper pipe shall not come in contact with concrete. All penetrations through fire rated walls and floors shall be sealed in a manner to maintain the integrity of this fire rating and meet Life Safety Codes.

B. Provide termite protection in accordance with FBC 1816.2 at all pipe penetrations through slab or grade floors. Provide rodent proofing in accordance with FBC 443.3 and Appendix F. All openings in walls and floors for piping shall be covered with wire cloth or sheet metal guards per Code.

3.15 SUPPORTS AND FASTENINGS

A. Plumbing fixtures, trimmings, accessories and appurtenances shall be secured to concrete by 1/4 inch brass expansion bolts not less than 4 inches long, and to gypsum with steel plates 1/8 inch thick, 6 inches wide and not less than 24 inches long at the back of the through bolts. Expansion bolts shall be of a length sufficient to extend at least 3 inches into solid concrete. Through bolts shall be provided with plates or washers at the back and set so that heads, nuts and washers will be concealed by the wall material. Exposed heads of bolts and nuts shall be nickel-chromium-plated hexagons with rounded tops. Where necessary, nickel-chromium-plated brass washers shall be provided.

3.16 ANCHORING, GUIDING AND SUPPORTING OF PIPING

A. All piping shall be anchored and supported in a manner such that expansion and contracting will take place in the direction desired and vibration and undue strains on equipment will be prevented by use of vibration dampeners. Hangers used for the support of piping, 2 inch nominal pipe size pipe and larger, shall be fabricated to permit adequate adjustment after erection while still supporting the load. Wall brackets shall be used where pipes are adjacent to wall or other vertical surfaces which may be used for supports. Supports shall be provided with a type 40 pipe covering protection saddle at each support in accordance with Table 4 of SP-69. Pipe supports shall be spaced to provide adequate support for the pipes, the medium in the pipe, insulation, valves and fittings; spacing of supports shall be such as to prevent the forming of pockets. The maximum horizontal spacing for metal piping between pipe supports shall conform to Table 3 of MSS SP-69, except that cast iron soil pipe shall have a maximum spacing between hangers of 5 feet. Vertical piping shall be supported by bolted steel clamps or type conforming to MSS SP-69.

3.17 STERILIZATION

A. Prior to starting work, verify system is complete, flushed and clean.
B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651. At least two samples, no less than six hours apart shall be performed.

I. A testing firm company specializing in testing potable water systems shall be approved by the State.

J. A Certificate shall be submitted to Owner that cleanliness of water distribution system meets or exceeds State HRS requirements.

K. On renovation work all procedures required above will be required for piping downstream of any shut-off valve turned off in order to do the work.

L. If building is to be occupied, Contractor shall provide bottled water until Certificate has been received.

3.18 SAFETY CODE

A. All piping in accordance with ANSI A13.1981.

3.19 INSTRUCTION MANUALS

A. Furnish four complete copies of instructions explaining operation and maintenance and replacement parts lists of the following equipment:
   1. Domestic Water Heaters
   2. Flush Tank Trim
   3. Ball Valves
   4. Faucet Trim
   5. Shower Trim
   6. Thermostatic Mixing Valves

3.20 AS-BUILT DRAWINGS

A. Provide a complete set of reproducible "As-Built" drawings at job completion. Upon request, the Architect will provide the Contractor with reproducible copies of the contract drawings for the use in making these "As-Built" drawings.
3.21 FIELD TESTS

A. Water supply piping shall be subjected to a hydrostatic pressure test of 100 psi minimum. Pressure shall be maintained on the lines for a period of time sufficient to examine the entire system but not less than one hour.

B. Sanitary Piping: Before the installation of any fixtures, the ends of the system shall be capped and all lines filled with water to the roof and allowed to stand until a thorough inspection has been made. After the fixtures are set, a smoke or equivalent test shall be made using a suitable apparatus.

END OF SECTION
PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS
A. The requirements of the Contract Documents apply to all work in all sections of Division 23.

1.2 SCOPE OF WORK
Provide and install two 100% outside HVAC systems with hot gas reheat and electric duct heaters. System to include sheet metal ductwork and aluminum diffusers in common areas. The resident rooms to have a variable refrigerant flow system consisting of multiple indoor units on a single outdoor condensing unit. These mini split systems shall consist of cassette type units in the ceiling. All areas to be exhausted utilizing multiple inline cabinet style exhaust fans. The exhaust fans are to be installed as close to the exhaust exterior louver as possible. All spaces to have individual thermostats wired and mounted on the walls.

1.3 INTENT
A. It is the intention of these Specifications and Drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use".

1.4 CODES, RULES, REGULATIONS, PERMITS AND FEES
A. All work shall comply with governing codes, ordinances and regulations of City, County, State and Federal authority having jurisdiction. Where local codes are not applicable, the work shall comply with the National Electrical Code, Standard Plumbing Code and Standard Mechanical Code. If two or more codes apply and are at a variance, the more stringent shall apply.

B. Notify the Engineer of any observed conflicts between the Contract Documents and governing code. Engineer will issue instructions as to procedures. If the Contractor performs any work knowing it to be contrary to governing code and without notice to the Owner, he shall assume full responsibility therefore and shall bear all costs attributable thereto.

C. All material and equipment for the electrical portions of the mechanical system shall bear the approval label or shall be listed by the Underwriters' Laboratories, Incorporated.

1.5 COMPLETE PERFORMANCE OF THE WORK
A. Work shall be executed in strict accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen.

1.6 DRAWINGS
A. The drawings are diagrammatic and attempt to give reasonable indications of the locations of apparatus. The drawings are not intended to show each item of material or a complete detail of all work to be done, but are for the purpose of illustrating material sizes, minimum equipment performance and special conditions necessary for the
experienced mechanic to take off his material and, in conjunction with job site measurements, lay out his work. Each location shall be determined by reference to the Contract Drawings and Specifications and by actual measurements at the building, and in all cases shall be subject to the approval of the Engineer. Drawings are in no way to be scaled. The architectural drawings and details shall be examined for location of fixtures and equipment. All ductwork shall be located to miss other equipment, light fixtures, and piping.

1.7 SUBMITTALS

A. General: The Contractor shall make submittals as required by the specifications. The Engineer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same as those used in the contract drawings or larger as required herein. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor, and each item shall be stamped, signed, and dated indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals. Samples remaining upon completion of the work shall be picked up and disposed of in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations. Submit all systems in a single 3-ring binder for each system.

B. Definitions

1. Shop Drawings
   a. Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.
   b. Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.
   c. Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

2. Product Data
   a. Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials or equipment for some portion of the work.
   b. Samples of warranty language when the contract requires extended product warranties.

3. Samples
   a. Physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.
   b. Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.
   c. Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.
4. Design Data
   a. Calculations, mix designs, analyses or other data pertaining to a part of work.
   b. Design Submittals and extensions of design submittals.

5. Test Reports
   a. Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. Testing must have been within three years of date of contract award for the project.
   b. Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.
   c. Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.
   d. Investigation reports.
   e. Daily checklists.
   f. Final acceptance test and operational test procedure.

6. Certificates
   a. Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.
   b. Document required of Contractor, or of a supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.
   c. Confined space entry permits.
   d. Text of posted operating instructions.

7. Manufacturer's Instructions
   a. Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

8. Manufacturer's Field Reports
   a. Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
   b. Factory test reports.

9. Operation and Maintenance Data
   a. Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

10. Closeout Submittals
    a. Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

11. Approving Authority
    a. Office authorized to approve submittal.

12. Work
    a. As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.
C. Submittals
1. Engineers’ approval is required for all submittals prior to ordering.

D. Procedures for Submittals
1. Reviewing, Certifying, Approving Authority
a. Contractor organization shall be responsible for reviewing and certifying that submittals are in compliance with contract requirements. Approving authority on submittals is Engineer of Record unless otherwise specified for specific submittal.

2. Constraints
a. Submittals listed or specified in this contract shall conform to provisions of this section, unless explicitly stated otherwise.

b. Submittals shall be complete for each definable feature of work; components of definable feature interrelated as a system shall be submitted at same time.

c. When acceptability of a submittal is dependent on conditions, items, or materials included in separate subsequent submittals, submittal will be returned without review.

d. Approval of a separate material, product, or component does not imply approval of assembly in which item functions.

3. Scheduling
a. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential requirements to resubmit.

b. Except as specified otherwise, allow review period, beginning with receipt by approving authority, that includes at least 30 working days for submittals for approval and 20 working days for submittals for approval. Period of review for submittals begins when Engineer receives submittal.

c. For submittals requiring review by multiple disciplines or engineers, allow review period, beginning when Engineer receives submittal.

4. Variations
a. Variations from contract requirements require Engineer’s approval.

b. Considering Variations
1) Discussion with Engineer prior to submission will help ensure functional and quality requirements are met and minimize rejections and resubmittals.

b. Proposing Variations
1) When proposing variation, deliver written request to the Engineer, with documentation of the nature and features of the variation and why the variation is desirable and beneficial. If lower cost is a benefit, also include an estimate of the cost saving. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

d. Warranting That Variations Are Compatible
1) When delivering a variation for approval, Contractor warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

e. Review Schedule Is Modified
1) In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the Engineer of submittals with variations.
5. Contractor's Responsibilities
   a. Determine and verify field measurements, materials, field construction criteria; review each submittal; and check and coordinate each submittal with requirements of the work and contract documents.
   b. Advise Engineer of variation, as required by paragraph entitled "Variations."
   c. Correct and resubmit submittal as directed by approving authority. When resubmitting disapproved transmittals or transmittals noted for resubmittal, the Contractor shall provide copy of that previously submitted transmittal including all reviewer comments for use by approving authority. Direct specific attention in writing or on resubmitted submittal, to revisions not requested by approving authority on previous submissions.
   d. Complete work which must be accomplished as basis of a submittal in time to allow submittal to occur as scheduled.
   e. Ensure no work has begun until submittals for that work have been returned as "approved," or "approved as noted," except to the extent that a portion of work must be accomplished as basis of submittal.

6. Actions Possible
   a. Submittals will be returned with one of the following notations:
      1) Submittals marked "not reviewed" will indicate submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.
      2) Submittals marked "approved" or "approved as submitted" authorize Contractor to proceed with work covered.
      3) Submittals marked "approved as noted" or "approval except as noted; resubmission not required" authorize Contractor to proceed with work as noted provided Contractor takes no exception to the notations.
      4) Submittals marked "revise and resubmit", "not approved" or "disapproved" indicate submittal is incomplete or does not comply with design concept or requirements of the contract documents and shall be resubmitted with appropriate changes. No work shall proceed for this item until resubmittal is approved.

E. Format of Submittals
   1. Transmittal Form: Transmit each submittal, except sample installations and sample panels, to office of approving authority. Transmit submittals with transmittal form prescribed by Engineer and standard for project. The transmittal form shall identify Contractor, indicate date of submittal, and include information prescribed by transmittal form and required in paragraph entitled "Identifying Submittals." Process transmittal forms to record actions regarding sample panels and sample installations.
   2. Identifying Submittals: Identify submittals, except sample panel and sample installation, with the following information permanently adhered to or noted on each separate component of each submittal and noted on transmittal form. Mark each copy of each submittal identically, with the following:
      a. Project title and location.
      b. Construction contract number.
c. Section number of the specification section by which submittal is required.
d. Submittal description number of each component of submittal.
e. When a resubmission, add alphabetic suffix on submittal description, for example, “-A”, to indicate resubmission.
f. Name, address, and telephone number of subcontractor, supplier, manufacturer and any other second tier Contractor associated with submittal.
g. Product identification and location in project.

3. Format for Shop Drawings
   a. Shop drawings shall not be less than 8 1/2 by 11 inches nor more than 30 by 42 inches.
   b. Present 8 1/2 by 11 inches sized shop drawings as part of the bound volume for submittals required by section or system as appropriate. Present larger drawings in sets.
   c. Include on each drawing the drawing title, number, date, and revision numbers and dates, in addition to information required in paragraph entitled "Identifying Submittals."
   d. Dimension drawings, except diagrams and schematic drawings; prepare drawings demonstrating interface with other trades to 3/8" -1'-0" scale. Identify materials and products for work shown.
   e. Drawings shall include the nameplate data, size and capacity.

4. Format of Product Data and Manufacturer's Instruction’s
   a. Present product data submittals for each section as a complete, bound volume. Include table of contents, listing page and catalog item numbers for product data.
   b. Indicate, by prominent notation, each product which is being submitted; indicate specification section number and paragraph number to which it pertains.
   c. Supplement product data with material prepared for project to satisfy submittal requirements for which product data does not exist. Identify this material as developed specifically for project, with information and format as required for submission of Certificates.
   d. Product data shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified for Certificates.
   e. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), ASTM International (ASTM), National Electrical Manufacturer's Association (NEMA), Underwriters Laboratories (UL), and Association of Edison Illuminating Companies (AEIC), 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 Engineer. 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.
   f. Submit manufacturer's instructions prior to installation.
   g. Electronic submittals are acceptable and shall be per item basis with a submittal number basis for item of like kind. I.e., diffusers, pumps, exhaust fans, or air handlers.
5. Format of Samples
   a. Furnish samples in sizes below, unless otherwise specified or unless the manufacturer has prepackaged samples of approximately same size as specified:
      1) Sample of Equipment or Device: Full size.
      2) Sample of Materials Less Than 2 by 3 inches: Built up to 8 1/2 by 11 inches.
      3) Sample of Materials Exceeding 8 1/2 by 11 inches: Cut down to 8 1/2 by 11 inches and adequate to indicate color, texture, and material variations.
      4) Sample of Linear Devices or Materials: 10 inch length or length to be supplied, if less 10 inches. Examples of linear devices or materials are conduit and handrails.
      5) Sample of Non-Solid Materials: 750 ml or Pint. Examples of non-solid materials are sand and paint.
      6) Color Selection Samples: 2 by 4 inches.
      7) Sample Panel: 4 by 4 feet.
      8) Sample Installation: 100 square feet.
   b. Samples Showing Range of Variation: Where variations are unavoidable due to nature of the materials, submit sets of samples of not less than three units showing extremes and middle of range.
   c. Reusable Samples: Incorporate returned samples into work only if so specified or indicated. Incorporated samples shall be in undamaged condition at time of use.
   d. Recording of Sample Installation: Note and preserve the notation of area constituting sample installation but remove notation at final clean up of project.
   e. When color, texture or pattern is specified by naming a particular manufacturer and style, include one sample of that manufacturer and style, for comparison.

6. Format of Design Data and Certificates
   a. Provide design data and certificates on 8 1/2 by 11 inches paper. Provide a bound volume for submittals containing numerous pages.

7. Format of Test Reports and Manufacturer's Field Reports
   a. Provide reports on 1/2 by 11 inches paper in a complete bound volume.
   b. Indicate by prominent notation, each report in the submittal. Indicate specification number and paragraph number to which it pertains.

8. Format of Preconstruction Submittals and Closeout Submittals
   a. When submittal includes a document which is to be used in project or become part of project record, other than as a submittal, do not apply Contractor's approval stamp to document, but to a separate sheet accompanying document.
   b. Provide all dimensions in administrative submittals in metric. Where data are included in preprinted material with English units only, submit metric dimensions on separate sheet.

F. Quantity of Submittals
1. Number of Copies of Shop Drawings
   a. Submit six copies of submittals of shop drawings requiring review and approval only by Engineer.
2. Number of Copies of Product Data and Manufacturer's Instructions
   a. Submit in compliance with quantity requirements specified for shop drawings.
3. Number of Samples
   a. Submit two samples, or two sets of samples showing range of variation, of each required item. One approved sample or set of samples will be retained by approving authority and one will be returned to Contractor.
   b. Submit one sample panel. Include components listed in technical section or as directed.
   c. Submit one sample installation, where directed.
   d. Submit one sample of non-solid materials.

4. Number of Copies Design Data and Certificates
   a. Submit in compliance with quantity requirements specified for shop drawings.

5. Number of Copies Test Reports and Manufacturer's Field Reports
   a. Submit in compliance with quantity with quality requirements specified for shop drawings.

6. Number of Copies of Operation and Maintenance Data
   a. Submit three copies of O&M Data to the Contracting Officer for review and approval.

7. Number of Copies of Preconstruction Submittals and Closeout Submittals
   a. Unless otherwise specified, submit administrative submittals compliance with quantity requirements specified for shop drawings.

G. Approved Submittals: The Engineer's approval of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory design, general method of construction, materials, detailing and other information appear to meet the Solicitation and Accepted Proposal. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work. After submittals have been approved by the Engineer, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary and there will be a cost associated with the additional review of $175/hour, $500 minimum. The same applies for value engineering and product substitution analysis. Invoice is to be paid prior to release of reviewed submittal.

H. Disapproved Submittals: The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. The Contractor shall make all corrections required by the Engineer, obtain the Designer of Record's approval when applicable, and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal. Any "information only" submittal found to contain errors or unapproved deviations from the Solicitation or Accepted Proposal shall be resubmitted as one requiring "approval" action, requiring Designer of Record approval. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, a notice in accordance with the Contract Clause "Changes" shall be given promptly to the Owner. Resubmittals shall be reviewed at an hourly rate of $175/hour, $500 minimum per required review.

I. Withholding of Payment: Payment for materials incorporated in the work will not be made if required approvals have not been obtained. No payment for materials incorporated in the work will be made if all required Designer of Record approvals have not been obtained. No payment will be made for any materials incorporated into the work for any conformance review submittals or information only submittals found to contain errors or deviations from the Solicitation or Accepted Proposal.
1.8 SPACE LIMITATIONS

A. Equipment shall be chosen which will properly fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements and the requirements of the local inspection department. Physical dimensions and arrangements of equipment to be installed shall be subject to the Engineer review. However, since space requirements and equipment arrangement vary according to manufacturer, the responsibility for initial access and proper fit rests with the Contractor.

B. Piping, domestic pressure piping, control conduit, roof drains or gravity piping shall be routed in the bar joist or trusses where and when possible such as to minimize conflicts with ductwork, light fixtures, ceilings, equipment and other items installed between the bottom of the bar joist and the ceiling.

1.9 COORDINATION AND INTERFERENCES

A. The Contractor shall give full cooperation to other trades. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. Shifting of ductwork to clear light fixtures, piping walls, conduit, equipment, etc. shall be the Contractor’s responsibility and shall be considered cooperation with other trades. If required and/or directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a scale of 1/2" is equal to 1'-0", clearly showing how his work is to be installed in relation to the work of other trades and structures or inserts in poured walls. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades or structures, he shall make the necessary changes in his work to correct the condition without additional cost to the Owner.

1.10 SLEEVES, CUTTING AND PATCHING

A. This Contractor shall be responsible for providing and the timely placing of sleeves for all piping passing through walls, partitions, beams, floors, and roof while same are under construction. A pipe sleeve shall be one size larger than the size of pipe it serves. If a pipe is insulated, its pipe sleeve shall be one size larger than the outside diameter of the insulation around the pipe. Sleeves set in concrete floor construction shall be 18 gauge galvanized steel except at pipe supports. Sleeves supporting pipes shall be Schedule 40 galvanized steel with three 6" long reinforcing rods welded at 120 degree spacing to the sleeve and shall be installed with the rods embedded in the concrete slab. Sleeves in floors shall extend four inches above the finished floor. All pipes passing through concrete or masonry walls shall have 18 gauge galvanized steel sleeves. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no expense to the Owner by parties approved by the Engineer. The Contractor shall undertake no cutting or patching without first securing the Engineer's written approval.

B. Where a pipe passes through a sleeve, no point of the pipe or its insulation shall touch the sleeve. Caulk around such pipe with sufficient quantity of fire safing insulation to equal fire rating of construction and seal off opening between pipe and pipe sleeve with a non-hardening mastic.
1.11 ESCUTCHEONS
A. Provide heavy chrome-plated or nickel-plated plates or approved pattern on piping passing through walls and ceiling in finishing areas. Escutcheons shall be B & G No. 10 or equal chrome-plated steel plates with concealed hinges. Pattern shall be approved by the Engineer.

1.12 EXCAVATION AND BACKFILL
A. This Contractor shall make all necessary excavations, cutting of paving, concrete, etc., and do all backfilling and paving repairs necessary for the proper execution of the Mechanical work. All installations below grade shall have a minimum of 24 inches cover or greater where indicated herein or on Plans.

1.13 PAINTING
A. Machinery furnished by this Contractor shall be factory-finished. If the factory finish is damaged during shipment, installation, etc., it shall be repainted subject to the Engineer’s approval. See individual Specifications for additional painting requirements.

1.14 MATERIALS
A. Materials and equipment shall be new and of first-class quality. The commercially standard items of equipment and the specific names mentioned herein are intended to fix the standards of quality and performance necessary for the proper functioning of the Mechanical Work.

B. All materials and equipment covered in this specification shall be new and shall fit in spaces provided. All equipment, fixtures and accessories shall carry a guarantee against defects for a period of one (1) year from the date of acceptance. Each system, as a whole and in all its parts, shall be guaranteed to function correctly up to the specified capacity for a minimum of one (1) year. Should a system or any part thereof fail to meet performance requirements, necessary replacements, alterations or repairs shall be made to bring performance up to specified requirements. All building construction and finishes damaged or marred shall be restored to the satisfaction of the Owner's Representative. All the above described shall be done without cost to the Owner. Each major component of the equipment shall have the manufacturer's name, address and catalog number on a plate securely affixed in a conspicuous place. The above guarantee shall include the replacement of all refrigerant lost.

C. Since manufacturing methods vary, reasonable minor equipment variations are expected; however, performance and material requirements are minimum. The Engineer retains the right to judge equality of equipment that deviates from the specifications.

1.15 WELDING SPECIFICATIONS
A. All field made pressure vessel welds shall be radiographed (x-rayed) in accordance with the requirements of ASME/ANSI B31.9.

B. All branch, fillet, and socket welds on piping system shall be TP (dye-checked), or MT (magnetic particle) examined in accordance with the requirements of ASME/ANSI B31.9.
C. The Contractor shall submit, as a Shop Drawing submittal, a copy of the Welding Procedure Specifications (WPS) that he plans to use on the project along with the Procedure Qualifications Records (PQR) that qualify these WPS’s. All WPS’s and PQR’s shall be done in accordance with the requirements of ASME Section IX.

D. All Welding Procedures Specifications (WPS) shall be qualified by the Contractor. Welding Procedures Specifications qualified by other Contractors or other Agencies will not be accepted. The Contractor must qualify all his own WPS’s.

E. All welders used on the project shall be qualified for the welds they will be making in accordance with ASME Section IX. The Welder Qualifications Performance (PQR) for each welder shall be current in accordance with the requirements of ASME Section IX.

F. All welders used by the Contractor shall be tested and qualified under his employ and to the requirements of ASME IX. Welders who are qualified by other Contractors or Agencies will not be accepted. The Contractor must qualify his welders.

G. The Welding Performance Qualifications (WPQ) for each welder shall be recorded on an appropriate form (QW-484) that indicates actual test variables and qualification ranges. The WPQ form for each welder shall be signed by the Contractor and certified. Copies of the WPQ records for each welder shall be submitted to the Engineer prior to any production welding on the project by the Contractor.

1.16 IDENTIFICATION OF EQUIPMENT, PIPING, AND VALVES

A. Mechanical equipment and motor controllers shall be identified by means of nameplates permanently attached to the equipment. Nameplates shall be engraved laminated plastic with letters at least 1/4" high.

B. Valves shall have identification markers; either engraved plastic or brass tags, permanently attached.

C. Nameplate designations shall correspond to the identifications on the "Record Drawings" or "As Built Record Drawings".

1.17 EQUIPMENT PADS AND ANCHOR BOLTS

A. Equipment pads shall be provided for all floor-mounted equipment, for all equipment supported off the floor on legs, and for all pipe support stands. An equipment pad shall generally conform to the shape of the piece of equipment it serves with a minimum 6" margin around the equipment and supports. Pads shall be 28-day, 3000 psi concrete reinforced with 6" x 6" 10/10 gauge welded wire mesh minimum or greater as indicated on Plans. Top and sides of pad shall be troweled to smooth finishes, equal to those of the floors, with all external corners bull nosed to a 3/4" radius with a minimum thickness of 3½ inches unless otherwise noted.

B. The Contractor shall furnish templates and anchor bolts for all equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.
1.18 LUBRICATION

A. Where necessary, provide means for lubricating all bearings and other machine parts. If a part requiring lubrication is concealed or inaccessible, extend a lubrication tube with suitable fitting to an accessible location and suitably identify it.

B. After installation, properly lubricate all parts requiring lubrication and keep them adequately lubricated until final acceptance by the Owner.

1.19 ACCESS DOORS

A. Wherever access is required through walls or ceilings to valves, fire dampers, or other concealed equipment installed under this Division, the Contractor shall furnish and install a hinged access door and frame with a flush latch handle. Contractor shall furnish complete information to the Engineer as to the number, size and location of required access doors. All shall be finished to match adjacent surfaces or as approved by Architect/Engineer. All doors shall be 24 x 24 inches minimum in size or sized to all removal of equipment.

1.20 PRECLEANING AND PASSIVATION PROCEDURES FOR OPEN RECIRCULATING AND CLOSED LOOP COOLING SYSTEMS

A. General

1. The precleaning of the system refers to the removal of debris, solid materials, oil, and corrosion products that have accumulated in the system, as it has been idle during construction or during a system shutdown. Precleaning is a combination of mechanical and chemical methods. Precleaning provides a clean, chemically reactive surface, which will react with corrosion passivation treatments.

2. The passivation or pre-filming of the system pertains to the promotion of the formation of protective oxide films, which will help prevent future corrosion. It is important to apply the passivation process immediately after the precleaning procedure to prevent incomplete formation and subsequent rapid corrosion and build up of associated corrosion products.

3. Other considerations include considering discharge limits on various chemical components used during the process. Use of lower pH waters may require neutralization prior to discharge. The dislodging of debris and corrosion product may increase clogging in filters. Backwashing and increased filter maintenance may be required.

B. Precleaning

1. Remove debris: Remove all accumulated debris such as wood, trash, leaves and sediments. Clean the deck, basin and screens by sweeping prior to filling the basin with fresh water. Avoid the use of wire brushes on galvanized surfaces.

2. Tower wood wash down for newly constructed or refurbished cooling towers: Wash tower wood down with fresh water prior to filling the tower basin. Water used for washing of tower wood shall be discharged prior to stating the chemical cleaning procedure. Tower wood structures shall be treated with copper based salts as microbiocides and removal of residual salts from the wood surfaces. 50 parts of active azole shall be present in the system during tower wood washing to complex copper solubilized during the wash down procedure.
3. Flush and fill basin: Fill the tower basin with fresh water, preferably the same as will be used for system makeup. Circulate through supply and return header system and across tower before flushing exchangers if possible.

4. Flush and fill exchangers: Open drains at exchanger low points and back flush, if possible. Check back pressures and pressure drops to ensure there are no blockages. Depending on the size of the system, it is recommended to purge the system and refill with fresh makeup. If large volumes restrict a complete purge, blowdown the system and add fresh makeup to dilute the solids and iron.

C. Precleaning Option #1 - Ferroquest
1. Recommended for non-galvanized open recirculating systems and closed loop systems. Caution: This procedure will remove galvanizing.
2. Products required:
   a. Ferroquest FQ7101 or equal - A 0.5% to 2.0% of system volume charge of the product. For example, you will need between 50 and 200 gallons for a 10,000 gallon system.
   b. Ferroquest FQ7102 neutralizer or equal - 0.1% of system volume of product. For example, you will need approximately 10 gallons for a 10,000 gallon system.
   c. Anti-foam.
   d. Non-oxidizing biocide to achieve 50 to 70 ppm. Do not exceed registered maximum as indicated on product label.
   e. Maintain pH for 12 to 72 hours.
   f. Monitor iron levels and pH.
3. Procedure:
   a. Make sure there is enough excess system volume for the FQ7101 or equal product.
   b. Make sure all automatic and manual valves are open for the entire cleaning.
   c. Add heat load to system, attempting to maintain hot returns in the 120 to 160 degrees F range. Maintain temperatures below the maximum specified for the tower fill.
   d. Charge system with FQ product or equal in an area of high mixing.
   e. Recirculate and control pH in the 6.5 to 7.0 range. Add FQ7102 or equal as needed to keep pH in this range. If FQ7102 is not available you may use any excess FQ7101 for this purpose.
   f. Recirculate the system for 12 to 72 hours. Lower concentrations of product will require longer recirculation times.
   g. During cleaning, flush through drain valves occasionally during the cleaning to remove scales and deposits that have been liberated by the cleaning. Keep open for approximately 15 seconds.
   h. Monitor iron levels and pH during the cleaning. If iron levels exceed 1200 ppm replace one-half the volume of the system with fresh water and add appropriate amount of new product.
   i. When iron levels plateau or you run out of precleaning time, flush the system (for small cooling towers and closed loops) or blowdown heavy to remove product, iron and any scale removed. Flush through all valves and inspect for deadlegs.
   j. Once system water is near make up water conductivity and iron levels, immediately institute recommended water treatment program and avoid keeping pre-clean solution in system for long periods of time.

D. Precleaning Option #2 - Multiple Chemical Approach for Non-Galvanized Systems
1. Products required:
   a. HPS-1 dispersant product or equal to achieve 25 to 100 ppm active polymer.
b. HRA or equal to achieve 8 to 20 ppm active HRA.
c. Non-oxidizing biocide to achieve 50 to 75 ppm as product. Do not exceed registered maximum as indicated on product label.
d. Provide 100 to 200 ppm active pyrophosphate.
e. Surfactant at approximately 20 to 50 ppm as product - should provide oil/grease dispersancy as well as general surfactant properties.
f. Antifoam as needed.
g. If an oxidizing biocide is used at this point, keep levels at or below 1.0 ppm free residual chlorine.
h. Sulfuric acid may be required for pH control.

2. Procedure:
   a. Make sure tower or system is full with fresh make up water. Begin to circulate water through system and bypass tower fill if possible.
   b. Control pH in the 6.0 to 7.0 range.
   c. Add chemicals to tower basin or system near pump screens show wise to achieve desired concentrations. Add products in order as given above or minimally, add HPS-1 or equal dispersant and HRA azole first.
   d. Add heat load to system, attempting to maintain hot returns in the 120 to 160 degrees F range. Make sure to maintain temperatures below the maximum specified for the tower fill.
   e. Circulate for 8 to 24 hours. If there is little heat load, allow to go for the full 24 hours.
   f. After specified time open blowdown(s) to and makeup with fresh water. It is important to remove chemical and ay dispersed solids, oils, etc. at this point.
   g. Immediately institute passivation/pre-filming procedure and avoid keeping precleaning solution in system for long periods of time.

E. Precleaning Option #3 - Galvanized Systems

1. Make sure all chemicals are on-site and that pH control is available. If possible the tower or system should be exposed to atmosphere for 4 to 6 weeks prior to start up.

2. Products required:
   a. HPS-1 dispersant or equal product to achieve 25 to 100 ppm active polymer.
   b. HRA or equal to achieve 8 to 20 ppm active HRA.
   c. Non-oxidizing biocide to achieve 50 to 75 ppm as product. Do not exceed registered maximum as indicated on product label.
   d. Surfactant at approximately 20 to 50 ppm as product - provide oil/grease dispersancy as well as general surfactant properties.
   e. Antifoam as needed.
   f. If an oxidizing biocide is used at this point, keep levels at or below 1.0 ppm free residual chlorine.
   g. Sulfuric acid may be required for pH control.

3. Procedure:
   a. Make sure tower or system is full with fresh make up water. Begin to circulate water through system and bypass tower fill if possible.
   b. Control pH in the 7.0 to 8.0 range.
   c. Add chemicals to tower basin or system near pump screens shot wise to achieve desired concentrations. Add products in order as given above or minimally, add HPS-1 dispersant and HRA azole first.
   d. Add heat load to system, attempting to maintain hot returns in the 120 to 160 degree F range. Make sure to maintain temperatures below the maximum specified for the tower fill.
   e. Circulate for 8 to 24 hours. If there is little heat load, allow to go for the full 24 hours.
f. After specified time open blowdown(s) to and makeup with fresh water. It is important to remove chemical and any dispersed solids, oils, etc. at this point.
g. Immediately institute passivation/pre-filming procedure and avoid keeping precleaning solution in system for long periods of time.

F. Passivation/Pre-Filming Option #1 - Chemical Procedure for Non-Galvanized Open Recirculating Systems
1. Products Required: Utilize product or products to provide the following constituents. Consult water treatment company for appropriate products.
   a. HPS-1 @ 20 to 100 ppm active polymer or equal.
   b. HRA at approximately 5 to 20 ppm active azole or equal.
   c. Orthophosphate levels for the following calcium levels:
      1) 35 to 100 ppm orthophosphate if Ca is <200 ppm.
      2) 35 to 50 ppm orthophosphate if Ca is 200 to 400 ppm.
      3) 35 to 50 ppm orthophosphate if Ca is >400 ppm.
   d. Non-oxidizing biocide to achieve 50 to 75 ppm as product. Do not exceed registered maximum as indicated on product label.
2. Procedure:
   a. Control pH in the 6.0 to 7.0 range.
   b. Ideally temperature should be approximately 102 degrees F.
   c. Add product(s) to achieve residuals as indicated above and add products in order shown above.
   d. Circulate for 8 to 24 hours (24 hours if temperatures are near ambient).
   e. Do not exceed a maximum of 48 hours.
   f. Blowdown the system to achieve target residuals and ion levels prescribed by the standard treatment method. Adjust product feed rates of current product(s) or begin standard treatment program when desired cycles are reached.
   g. Alkaline treatment programs can be started once the alkalinity is 150 ppm or greater and the phosphate level is <7 ppm. Decrease or stop acid feed to allow alkalinity to cycle up.
   h. Continue circulation through all piping and exchangers to minimize corrosion and microbial fouling.
   i. At this point, do not drain and dry the system. If this is done, the passivation program will have to be repeated.
   j. Maintain all treatment programs including deposition, corrosion, and biocide to keep system in good operating order.

G. Passivation/Pre-Filming Option #2 - Chemical Procedure for Passivation/Pre-Filming of Galvanized Open Recirculating Systems
1. For the first 30 to 60 days of system operation, control the system pH in the 7.0 to 8.0 range.
2. If an oxidizing biocide is used (chlorine or bromine based) keep free residual as chlorine below 1.0 ppm.
3. Maintain standard high orthophosphate, low phosphonate cooling water treatment programs during this time. Excessive phosphonate levels are detrimental to zinc coated surfaces.
4. Moderate calcium hardness levels of 100 to 300 ppm as CaCO₃ and alkalinity levels of 50 to 150 ppm as CaCO₃ are ideal during the 30 to 60 day passivation period.
5. Once the 60-day passivation period is complete, desired treatment technology can begin including programs that include higher cycles to achieve higher alkalinity and hardness levels.
H. All systems shall be filled with neutralized (PH7) water then adjusted to meet equipment supplier specifications.

1.21 OPERATING INSTRUCTIONS

A. This Contractor shall provide the services of a competent Operating Engineer to supervise the operation of all equipment specified herein and to instruct the Owner's operators during an 8-hour operating period. The operating instruction period shall be identified as straight time working hours and shall not include nights, weekends, or travel time to and/or from the project.

B. In addition, the manufacturers of the automatic temperature controls shall furnish the services of competent control men to instruct the Owner's operators as set forth in various sections. The operating instruction periods shall be as defined in the immediate preceding paragraph.

C. The Owner shall be notified in writing at least five days before each operating instruction period begins. The Contractor shall commence no instruction period until the Owner has issued its written acceptance of the starting time.

1.22 OPERATING AND MAINTENANCE BOOKS

A. The Contractor shall provide the Owner, through the Engineer, with operating instructions and maintenance data books for all equipment and materials furnished under this Division.

B. Include the following information where applicable.
   1. Identify name and mark number.
   2. Locations (where similar items are used, provide a list).
   3. Complete nameplate data.
   4. Certified Record Drawings and Shop Drawings.
   5. Parts Lists.
   7. Wiring Diagrams.
   8. Lubrication charts.
   9. Manufacturer's operating and maintenance instructions with all non-applicable information deleted.
   10. Supplier's name, address, and phone number.

C. Maintenance instruction manuals shall include complete oiling, cleaning, and servicing data compiled in clearly and easily understandable form. Data shall show all series numbers of each piece of equipment, complete lists of replacement parts, motor ratings, and actual loads.

D. In addition, a clear and concise operation diagram in a laminated cover shall be provided for each system. The location of these diagrams shall be coordinated with the Engineer and the Owner.

E. Complete Test and Balance Report on each item.

1.23 WATERPROOFING

A. Where roofing or waterproof members are pierced with piping and sleeves, provide waterproofing as detailed. Where not detailed, provide lead flashing, oakum and lead caulking, lead sleeves and clamps, or other means approved by the Architect/Engineer to make the membrane watertight.
1.24 MACHINERY GUARDS

A. Provide all belts, couplings, wheels, and other moving parts of machinery with easily removable metal guards. Provide tachometer openings for all belt-driven or variable speed machinery.

1.25 EQUIPMENT PROTECTION

A. The Contractor shall protect all work and material from damage by his work or workmen, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for all work and equipment until finally inspected, tested, and accepted by the Engineer and Owner; he shall carefully store material and equipment received on site and which are not immediately installed from the weather in a manner approved by the Owner.

1.26 MANUFACTURER'S RECOMMENDATIONS

A. With exceptions as specified and/or indicated on the Drawings or in the specifications, apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment per manufacturer’s current printed recommendations. Keep copies of such printed recommendations at Job Site and make them available to the Engineer. The most stringent requirements shall be enforced.

1.27 ELECTRICAL COMPONENTS FOR MECHANICAL EQUIPMENT

A. The electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float, temperature or pressure switches, solenoid valves, heating elements, contractors, transformers and relays and other devices functioning to control and operate mechanical equipment, and control wiring and conduit for circuits rated less than 100 volts are specified in the sections covering the associated mechanical equipment and/or controls. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and greater and associated conduit, and the electrical power circuits are specified in and provided by Division 26.

B. All components, including but not limited to, motors, motor starters, control or push-button stations, float, temperature or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment and the individual component fusible protection for accessory equipment shall be provided under Division 23 in accordance with the National Electrical Code and as specified herein. These components shall be furnished by the Division 23 equipment manufacturer whenever they are available as standard or optional accessories. Components which are not installed within the manufactured equipment shall be furnished as specified in Division 23, and installed as specified in Division 26, NEC and local codes. All components shall be of the highest quality as indicated by Contract Documents.

C. Electrical work specified in this Division shall conform to applicable provisions of Electrical Division and drawings. All control wiring shall be in conduit.

D. Disconnecting means shall be provided as required by the National Electrical Code and shall be fused or non-fused as required by equipment manufacturer’s nameplate data or local code. Disconnecting means when available as a factory integral part of the equipment shall be furnished by the equipment manufacturer. All disconnects shall be as required by the equipment manufacturer, specified herein or indicated by Division 26 and on the Electrical Drawings.
E. At the option of the Contractor or when specified or shown on the drawings external motor starters may be combined with the required disconnecting means as a combination starter. External combination starters and disconnecting means shall be furnished by Division 26 and installed as specified in Division 26. Internal combination motor starters and disconnects shall be furnished by equipment manufacturer in accordance to NEC, Division 26 and Electrical Drawings.

F. It is the intent of these specifications to require complete and finished work, with all systems and equipment tested and ready for operation, in accordance with the sequence of operation. The Contractor shall be solely responsible for all required coordination between construction trades to ensure that all necessary components are furnished and installed in order to comply with the intent, Codes, manufacturer requirements, and Division 23 and 26 herein.

1.28 MOTORS FOR MECHANICAL EQUIPMENT

A. All motors 1/2 horsepower and larger for fans, pumps, compressors, etc., shall be premium high efficiency type, totally enclosed fan cooled in all ambient, vault or damp to wet locations otherwise shall be open drip-proof and certified for VFD duty, squirrel cage induction type for operation at 60 hertz, phase and voltage as indicated on the electrical drawings, quiet ball bearing type, class S insulation, and shall include a motor terminal box meeting applicable codes.

B. Where units are direct driven, the motor type may be as recommended by the equipment manufacturer unless noted otherwise in the Contract Documents. All belt driven motors shall have adjustable rails.

C. Single phase motors 1/6 to 1/3 horsepower inclusive shall be split phase type for operation on 120 volt single phase current unless noted otherwise. Motors less than 1/6 horsepower shall be shaded pole type.

D. Single phase motors over 1/3 horsepower shall be capacitor start, induction run of the voltage indicated on the electrical drawings.

1.29 EQUIPMENT NOISE AND VIBRATION

A. It is the intention to specify and for the Contractor to provide equipment and systems, that as defined herein, will be quiet and free of apparent vibration in operation.

B. It is intended that vibration shall not be apparent to the senses in occupied areas of the building. To this end, both the balancing of rotating machinery and the installation of vibration isolation at various locations are required.

C. It shall be the responsibility of the Contractor to obtain equipment that is quiet in operation as compared to other available equipment of its size, capacity, and type; to install equipment so that a minimum amount of noise and/or vibration is transmitted to the structure; and to fabricate the duct system so that air noises generated in the system are held to an absolute minimum.

D. Any additional precautions deemed necessary to provide a quiet installation shall be done as part of the work of this contract, subject to approval of the Engineer and without additional cost to the Owner. After the system is in operation, it shall be the responsibility of this Contractor to make any changes to equipment or work installed that may be required to provide a system which is quiet in operation as defined herein.
E. Refer to plans for any specific noise level requirements.

1.30 ELECTRICAL INSTALLATION REQUIREMENTS

A. Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein in Division 23 and 26.

B. All Work: Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided and installed under Division 26, except internal wiring for components of package equipment shall be provided as an integral part of the equipment. WHEN MOTORS OR ELECTRICAL EQUIPMENT FURNISHED ARE DIFFERENT THAN SIZES INDICATED ON SCHEDULES, THE MECHANICAL CONTRACTOR SHALL PROVIDE AND COORDINATE ANY AND ALL REQUIRED CHANGES TO THE ELECTRICAL SERVICE WITH THE ELECTRICAL CONTRACTOR AS MAY BE NECESSARY AND RELATED WORK AS A PART OF THE WORK FOR THE SECTION SPECIFYING THAT MOTOR OR EQUIPMENT AT NO ADDITIONAL COST. ALL REQUIRED ELECTRICAL CHANGES AS PART OF THIS COORDINATION SHALL BE ACCOMPLISHED AS PART OF THIS CONTRACT AT NO ADDITIONAL COST.

1.31 DATE OF COMPLETION AND TESTING OF MECHANICAL SYSTEMS

A. The date for the final acceptance test shall be sufficiently in advance of the contract completion date to permit the execution before the expiration of the Contract of any adjustments and/or alterations which the final acceptance tests indicate as necessary for the proper functioning of all equipment. Any such modifications shall be completed within the number of days allotted for completion of the Contract. Retests shall not relieve the Contractor for this Division of Completion date responsibility.

B. After Substantial Completion the Contractor shall visit the site for 5 consecutive work days to ensure the equipment is operating appropriately.

1.32 FINAL REVIEW

A. At a time designated by the Engineer, the entire system shall be reviewed. The Contractor shall be present at this review.

B. The system shall be operating properly with all water and air volumes balanced and all temperature controls adjusted. All labels shall be removed from the plumbing fixtures and the fixtures shall be clean and in operating condition.

C. Certificates and documents required herein shall be in order and presented to the Engineer at least four weeks prior to the review.

D. After the review, any changes or corrections noted by the Engineer as necessary for the work to comply with these Specifications and the Drawings shall be accomplished without delay in order to secure final acceptance of the work.
1.33 GUARANTEE AND SERVICE

A. Refer to General Conditions for guarantee. All Contractors for work under this Division shall have existing, a complete service office within 100 miles of job site.

B. Where extended guarantees are called for herein, furnish three copies to be inserted in Instructions and Maintenance Manuals.

C. The Contractor shall be responsible for labor to troubleshoot systems/equipment furnished by the Owner and all other systems/equipment called for by these Construction Documents for the duration of the minimum one year warranty period.

D. Contractor shall perform preventative maintenance for a minimum period of one (1) year after substantial inspection of project. Contractor shall provide all parts, labor, and fluids for all equipment supplied on this project for a minimum of one (1) year after Substantial Completion unless extended herein by specific Specification Sections.

1.34 PRODUCT APPROVAL

A. All products submitted and used on this Project shall bear the Florida Product Approval Seal or be on the approved lists. Shop Drawings shall be accompanied with a letter indicating or have printed on them the Florida Product Approval Number. Approval shall be per Florida Statute 553.842.

B. All products mounted on the building envelope (roof, walls, canopies, etc.) shall have Wind Load Certification from manufacturer indicating attachment requirements and details showing exactly how to install and attach products to building, roof curb, and/or roof to comply with Project Wind Load Certification.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe Markers.

1.2 REFERENCES

1.3 SUBMITTALS
   A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   B. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   C. Product Data: Provide manufacturers catalog literature for each product required.
   D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.4 PROJECT RECORD DOCUMENTS
   A. Submit record of actual locations of tagged valves.

2 PART PRODUCTS

2.1 NAMEPLATES
   A. Manufacturers:
   B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS
   A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
   B. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 STENCILS
   A. Manufacturers:
      1. Based on Seton Identification Products.
B. Stencils: With clean cut symbols and letters of following size:
1. 3/4 to 1-1/4 Inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
2. 1-1/2 to 2 Inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
3. 2-1/2 to 6 Inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
4. Ductwork and Equipment: 2-1/2 inch high letters.


2.4 PIPE MARKERS

A. Manufacturers:
1. Based on Seton Identification Products.

B. Color: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

3 PART EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

E. Identify air handling units, blower coils, fans, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line circulating pumps, may be identified with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify valves in main and branch piping with tags.

H. Tag automatic controls, instruments, and relays.

I. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
J. Identify ductwork with stencils marking on both sides of ductwork. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction. Indicate direction of flow on ducts and piping systems.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Single phase electric motors.
   B. Three phase electric motors.

1.2 RELATED SECTIONS
   A. Division 26 - Electrical: Electrical characteristics and wiring connections.

1.3 REFERENCES
   A. NEMA MG 1 - Motors and Generators.
   B. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS
   A. Submit Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
   B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 5 horsepower.
   C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

1.5 OPERATION AND MAINTENANCE DATA
   A. Submit Operation Data: Include instructions for safe operating procedures.
   B. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacture of electric motors and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.7 REGULATORY REQUIREMENTS
   A. Conform to applicable electrical code, NFPA 70, local energy code.
   B. Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
   C. Products Requiring Electrical Connection: Listed and classified by Underwriters’ Laboratories, Inc., as suitable for the purpose specified and indicated.
1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site.

B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.9 WARRANTY

A. Provide five year warranty.

B. Warranty: Include coverage for motors larger than 2.0.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer’s standard and need not conform to these specifications.

B. Electrical Service:
   1. Refer to Division 26 for required electrical characteristics.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, efficiency.

D. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Hanger rods.
B. Inserts.
C. Flashing.
D. Sleeves.
E. Mechanical sleeve seals.
F. Formed steel channel.
G. Equipment bases and supports.

1.2 RELATED SECTIONS
A. Section 230548 - Vibration Isolation.
B. Section 230700 – Mechanical Insulation

1.3 REFERENCES
A. American Society for Testing and Materials:

B. American Welding Society:
   1. AWS D1.1 - Structural Welding Code - Steel.

C. Factory Mutual System:

D. Manufacturers Standardization Society of the Valve and Fittings Industry:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

E. Underwriters Laboratories Inc.:

F. Warnock Hersey:
   1. WH - Certification Listings.
1.4 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

C. Product Data:
   1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Manufacturer's Installation Instructions:
   1. Hangers and Supports: Submit special procedures and assembly of components.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
1.9  ENVIRONMENTAL REQUIREMENTS
   A. Division 1 - Product Requirements: Environmental conditions affecting products on site.

1.10  FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.11  WARRANTY
   A. Division 1 - Execution Requirements: Product warranties and product bonds.
   B. Furnish one year manufacturer warranty for pipe hangers and supports.

2.1   PIPE HANGERS AND SUPPORTS
   A. Furnish materials in accordance with State of Florida and SREF standards.
   B. Refrigerant and Condensate Piping:
      1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, MSS SP89.
      2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron or Carbon steel, adjustable swivel, split ring.
      3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
      4. Wall Support for Pipe Sizes 3 inches (76 mm ) and Smaller: Cast iron hooks.
      5. Vertical Support: Steel riser clamp.
      6. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
      7. Floor Support for Hot Pipe Sizes 4 Inches (100 mm) and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
      8. Copper Pipe Support: Copper-plated, carbon steel ring.

2.2   ACCESSORIES
   A. Hanger Rods: Galvanized mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3   INSERTS
   A. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4   FLASHING
   A. Metal Flashing: 24 gage (0.5 mm) thick aluminum.
   B. Metal Counterflashing: 22 gage (0.8 mm) thick aluminum.
   C. Lead Flashing:
      1. Waterproofing: 5 lb./sq. ft (24.5 kg/sq m) sheet lead
2. Soundproofing: 1 lb./sq. ft (5 kg/sq m) sheet lead.

D. Flexible Flashing: 47 mil (1.2 mm) thick sheet butyl; compatible with roofing.

E. Caps: Aluminum, 22 gage (0.8 mm) minimum; 16 gage (1.5 mm) at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage (1.2 mm) thick galvanized steel, through roof: 16 gage thick aluminum.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage (1.2 mm) thick galvanized steel.

C. Sleeves for Round Ductwork: Galvanized steel.

D. Sleeves for Rectangular Ductwork: Galvanized steel.

E. Sealant: Acrylic.

2.6 MECHANICAL SLEEVE SEALS

A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 FORMED STEEL CHANNEL

A. Product Description: Galvanized 12 gage (2.8 mm) thick steel. With holes 1-1/2 inches (38 mm) on center.

3 PART EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

A. Remove incompatible materials affecting bond.

B. Do not drill or cut structural members.

3.3 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches (100 mm) and larger.
D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS
A. Install in accordance with ASTM F708, MSS SP 58, MSS SP 69, MSS SP 89.
B. Support horizontal piping as scheduled.
C. Install hangers with minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
D. Place hangers within 12 inches (300 mm) of each horizontal elbow.
E. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
H. Support riser piping independently of connected horizontal piping.
I. Provide copper plated hangers and supports for copper piping.
J. Design hangers for pipe movement without disengagement of supported pipe.
K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
L. Provide clearance in hangers and from structure and other equipment for installation of insulation.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS
A. Provide housekeeping pads of concrete, minimum 3-1/2 inches (87 mm) thick or otherwise noted on plans and extending 6 inches (150 mm) beyond supported equipment. Refer to Division 3 or provide a minimum of 3000 PSI concrete mixture for all equipment pads.
B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.6 INSTALLATION - FLASHING
A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
B. Flash vent and soil pipes projecting 3 inches (75 mm) minimum above finished roof surface with lead worked 1 inch (25 mm) minimum into hub, 8 inches (200 mm) minimum clear on sides with 24 x 24 inches (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.

D. Provide curbs for mechanical roof installations 14 inches (350 mm) minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflash mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves.

E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install stainless steel escutcheons at finished surfaces.

3.8 FIELD QUALITY CONTROL

A. Section 01700 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.

3.9 CLEANING

A. Section 01700 - Execution Requirements: Requirements for cleaning.

3.10 PROTECTION OF FINISHED WORK

A. Section 01700 - Execution Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.
3.11 SCHEDULES

PIPE HANGER SPACING

<table>
<thead>
<tr>
<th>PIPE SIZE</th>
<th>MAX. HANGER SPACING</th>
<th>HANGER ROD DIAMETER (minimum)</th>
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<tr>
<td>Inches (mm)</td>
<td>Feet (m)</td>
<td>Inches (mm)</td>
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<tr>
<td>1/2 (12)</td>
<td>7 (2.1)</td>
<td>5/16 (9)</td>
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<td>3/4 (20)</td>
<td>7 (2.1)</td>
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<td>3/8 (9)</td>
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<tr>
<td>1-1/4 (32)</td>
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<td>3/8 (9)</td>
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<td>1-1/2 (38)</td>
<td>9 (2.7)</td>
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</tr>
<tr>
<td>2 (50)</td>
<td>10 (3)</td>
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<tr>
<td>PVC (All Sizes)</td>
<td>4 (1.8)</td>
<td>3/8 (9)</td>
</tr>
</tbody>
</table>

END OF SECTION
SECTION 23 05 48
VIBRATION ISOLATION

PART 1 GENERAL

1.1 SUMMARY

A. Scope: The extent of vibration isolation work to be provided under this Contract is covered by the requirements of this Section, Section 15010, "Mechanical Basic Requirements," and the Contract Drawings including structural, architectural, mechanical and electrical which identify equipment and systems requiring vibration isolation treatment.

B. Types: Types of vibration isolation equipment and systems specified in this Section include:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1I</td>
<td>Isolator Ribbed Neoprene Pads</td>
</tr>
<tr>
<td>2I</td>
<td>Isolator Neoprene-In-Shear Type</td>
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<tr>
<td>2H</td>
<td>Hanger Rubber-In-Shear Type</td>
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<tr>
<td>3I</td>
<td>Isolator Open Spring Type</td>
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<td>3H</td>
<td>Hanger Combination Spring and Neoprene Type</td>
</tr>
<tr>
<td>4</td>
<td>Isolator Vertically Restrained Spring Isolators</td>
</tr>
<tr>
<td>5</td>
<td>Thrust Restraints Spring Type Installed in Pairs</td>
</tr>
<tr>
<td>A</td>
<td>Base Directly Bolted Attachment</td>
</tr>
<tr>
<td>B</td>
<td>Base Structural Rails or Bases</td>
</tr>
<tr>
<td>C</td>
<td>Base Concrete Inertia Type</td>
</tr>
</tbody>
</table>

C. Selection of Isolators: Provide isolators selected by a vibration isolator equipment specialist.

1. Conform to isolator types herein specified.
2. Examine the contract drawings for sizes, equipment power ratings, rotational speeds, equipment location, length of span between columns and beams and construction type to determine the isolator selection type and deflection required for each piece of mechanical equipment.

1.2 QUALITY ASSURANCE


B. Manufacturer: Isolators of the same type shall be the product of the same manufacturer. The manufacturer shall publish and maintain a full line of materials, engineering and application data and operating and maintenance instructions.

1.3 SUBMITTALS

A. Contractor's Certification: Vibration isolator submittals shall include a certification, signed by an officer representing the Contractor and stipulating that the submittal prepared by the manufacturer has been reviewed, and checked on an item by item basis against each piece of mechanical equipment, shown or specified in the Contract Documents, which requires vibration isolation.
B. Manufacturer's Certification: The manufacturer shall certify that the selections of vibration isolation equipment are based upon the drawings and specifications, and that each piece of mechanical equipment has been examined for rotational speed, equipment type, mounting location, and supporting span between column centers, and that an appropriate isolator has been selected.

C. Product Data: Furnish manufacturer's product data covering each isolator type for style, characteristic, and finish.

D. Isolator quantities, dimensions, deflections, capacities and types shall remain the responsibility of the manufacturer and the Contractor.

E. Inline fans type ZH, 1” deflection.

1.4 STORAGE AND PROTECTION

A. Storage: Store vibration isolation equipment indoors in the manufacturer's original shipping containers. Preclude the entrance of construction dirt and debris.

B. Vibration isolation equipment and bases, which show signs of rust, cement or concrete fouling, dirt and construction debris shall be disassembled and cleaned, approved or removed from the project site and replaced with new.

2 PART PRODUCTS

2.1 MANUFACTURERS

A. Isolation equipment shall be the products of a single manufacturer.

B. Equipment by Mason Industries, Kinetics Noise Control, or Amber/Booth Company will be considered for approval.

2.2 EQUIPMENT

A. Selection: Exact mounting sizes, dimensions and quantity of isolators and static deflection required shall be determined by the isolator manufacturer based upon equipment that will be furnished and installed by the Contractor under this Contract.

   1. Vibration isolation specialist shall coordinate his work with that of other trades to verify that equipment speeds, in revolutions per minute (rpm), are based upon actual equipment installed at the project site.

   2. Verify that equipment rpm and spring deflection selected are arranged so that resonance is avoided.

   3. All isolators used outdoors shall be hot dipped galvanized.

2.3 ISOLATOR TYPES

A. Type 1 Isolators: Provide pad type vibration isolators consisting of either two layers ¼ inch thick elastomer, molded to contain a pattern with non-slip characteristics in all directions, and bonded to galvanized steel separator plates, or one inch thick precompressed molded fiberglass isolation pads. Minimum overall thickness shall be one inch. Deflection shall be limited to .025 inches or less. Loading shall not exceed 40 psi.

B. Type 2 Isolators: Provide double rubber-in-shear or elastomer-in-shear with molded-in steel reinforcement in the top and bottom portions.
1. Deflections shall be limited to $\frac{1}{2}$ inch or less.
2. Steel bases shall be drilled with mounting holes and equipment mounting points shall be threaded male or female connections.
3. Treat resilient material with antiozone and antioxidant additives.

C. Type 2H Hangers: Provide rubber-in-compression suspension hangers, consisting of a formed steel frame and elastomer isolation element and provided with attachments for top and bottom suspension rods.
1. Design for a minimum 200 percent overload without noticeable deformation or failure.
2. Design for minimum 30 degrees misalignment without binding or reducing the efficiency of the hanger.
3. Metal components shall be galvanized and factory painted.

D. Type 3 Isolators: Provide adjustable, freestanding, open spring isolators with combination leveling and equipment fastening bases.
1. Spring elements shall be contained in upper and lower housing assemblies and shall have a minimum $K_x-K_y$ of 0.75.
2. Design springs for a minimum travel of 50 percent beyond the rated load.
3. When fully compressed and "bottomed-out", isolators shall be capable of supporting a 200 percent overload without deformation and spring failure.
4. A minimum $\frac{1}{4}$ inch thick non-skid isolation pad shall be bonded to the underside of the base plate.
5. Size base plates to limit floor loading to 100 psi.
7. Provide means for anchoring the top element of the isolator to rails and equipment.

E. Type 3H Hangers: Provide combination spring and elastomer hangers consisting of a formed steel frame with coil spring and elastomer insert in compression.
1. Design hangers to be capable of supporting a 200 percent overload without noticeable deformation or failure.
2. Design hangers to allow 30 degrees misalignment without binding or a reduction in hanger efficiency.
3. Design hangers for connection to equipment and supporting rods.

F. Type 4 Isolators: Provide vertically restrained, freestanding, laterally stable, open spring type isolators.
1. Design for deflection exceeding $\frac{1}{2}$ inch.
2. Provide built-in bearing and leveling provisions.
3. Provide a non-slip elastomer vibration absorbing pad bonded to the underside of the isolator base.
4. Outside diameter of each spring shall be equal to or greater than 0.9 times the operating height of the spring under rated load.
5. Provide vertical limit stops to prevent hyperextension due to wind loads or upward movement when the load is removed. Limit stops shall not bind or inhibit spring movement during normal operating ranges.

G. Type 5 Thrust Restraints: Provide spring isolators of an adjustable, freestanding type enclosed within tubular mountings and arranged to be installed in pairs across the discharge of fan flexible connectors.
1. Design restraints to resist the thrust caused by duct internal air pressure.
2. Install restraints on duct systems with an internal static pressure exceeding 3 inches H$_2$O.
3. Restraints shall have the same deflection as isolators installed under the fans.
2.4 PIPING AND DUCTWORK

A. General: All piping 1 inch diameter and larger in mechanical equipment rooms and to points ten feet away from the extremity of mechanical equipment rooms, shall be isolated from the building structure with flexible vibration isolators.
   1. Suspend piping on Type 3H hangers.
   2. Floor-mounted piping shall be supported with Type 3 spring isolators with deflections the same as the equipment to which the piping is attached.

B. Reciprocating Equipment: Provide spring type hangers with deflections equal to that of reciprocating equipment, with piping arranged with offset elbows to absorb vibration.

C. Risers: Pipe and duct risers within 10 feet of mechanical equipment rooms shall be resiliently anchored to the building structure with Type 1 vibration isolators, near the midpoint of the risers.
   1. Risers shall be isolated and supported at each second floor with pairs of Type 3H hangers, having deflections a minimum of 5 times the anticipated thermal movement at the support point.
   2. Risers shall be guided as required with four sets of Type 3I vibration isolators.
   3. Provide flexible neoprene or canvas connectors as specified in sheet metal ductwork at the connection point to all air moving equipment.
   4. Support ductwork with an internal pressure exceeding 3 inches H₂O with Type 3H hangers on maximum 10 feet centers with deflections equal to the equipment isolators.

2.5 VIBRATION ISOLATION SYSTEM SELECTION

A. General: The following selections of vibration isolation equipment systems shall be considered as a minimum. For the equipment below, the following code applies:
   Letter (i.e. A, B, C) = Base type
   Number (i.e. 1, 2, 3, 4) = Isolator type
   Decimal number (i.e. 0.005, 0.01, etc.) = Minimum deflection (in inches)

B. Low-Pressure AHU Locations (to 3 inches H₂O)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>EQUIPMENT</th>
<th>ON</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through 10HP</td>
<td>A 2</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>10 HP and Over</td>
<td>A 2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>250 to 500 RPM</td>
<td>A 2</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>over 500 RPM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Medium and High-Pressure AHU Location (Above 3 inches H₂O total pressure)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>EQUIPMENT</th>
<th>ON</th>
<th>GRADE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Through 20 HP</td>
<td>A 3</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

D. Air-Cooled Condensing Units:
3 PART EXECUTION

3.1 INSTALLATION

A. Manufacturer: All vibration isolation equipment shall be installed in accordance with the manufacturer's recommendations.

B. Manufacturer's Representative: The vibration isolation installation and deflection testing after equipment start-up shall be conducted by a representative of the manufacturer.

3.2 TESTS AND REPORTS

A. Testing: Each vibration isolation device shall be deflection tested. Two copies of a bound report shall be submitted prior to final acceptance. The certification shall include the following:
   1. Certify that equipment has been isolated in accordance with Contract Drawings, specifications and submittals.
   2. Certify that all minimum specified deflections have been equaled or exceeded.

3.3 ANCHORING

A. Installation: Installation shall comply with manufacturer's published recommendations and shall be installed so that isolators are plumb and are operating at a manner for which they were designed.
   1. Unless otherwise specified, all equipment shall be securely bolted to isolators, steel bases or concrete inertia bases.
   2. Indoor vibration isolators need not be attached to the structure unless required by local codes.
   3. Isolators installed outdoors shall be attached to building structure.

3.4 CLEANING

A. Debris: Remove all debris from under equipment, and thoroughly clean steel bases, inertia bases and check for free movement.

B. Adjustment: Adjust isolators as required for proper operation prior to starting equipment. Testing of vibration isolators shall be performed by a certified representative of the manufacturer as specified.

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Testing adjusting and balancing of air systems.
   2. Testing adjusting, and balancing of refrigerating systems.
   3. Measurement of final operating condition of HVAC systems.

1.2 REFERENCES
A. Associated Air Balance Council:

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. Natural Environmental Balancing Bureau:
   1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS
A. Division 1 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on forms containing information indicated in Schedules.

D. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms.

F. Submit draft copies of report for review prior to final acceptance of Project.

G. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS
A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE


B. Maintain one copy of each document on site.

C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

1.6 QUALIFICATIONS

A. Test and Balance services for HVAC shall be provided by third party employed by the Mechanical Contractor and shall meet all requirements of the Florida Building Code.

B. Perform work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 PRE-INSTALLATION MEETINGS

A. Division 1 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

A. Division 1 - Summary: Work sequence.

B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

A. Division 1 - Administrative Requirements: Coordination and project conditions.

B. Schedule and provide assistance in final adjustment and test of smoke control system with Fire Authority.

2PART PRODUCTS

Not Used.

3PART EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.
B. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized and sealed.
12. Service and balancing valves are open.

3.2 PREPARATION

A. Furnish instruments required for testing, adjusting, and balancing operations.
B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.4 ADJUSTING

A. Division 1 - Execution Requirements: Testing, adjusting, and balancing.
B. Verify recorded data represents actual measured or observed conditions.
C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
E. Report defects and deficiencies noted during performance of services, preventing system balance.
F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
H. Check and adjust systems approximately six months after final acceptance and submit report.
3.5 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.

E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.

F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.08 inches positive static pressure near building entries.

3.6 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Cooled Refrigerant Condensers.
2. Air Handling Units.
3. Fans.
4. Air Filters.
5. Air Inlets and Outlets.

B. Report Forms

1. Title Page:
   a. Name of Testing, Adjusting, and Balancing Agency
   b. Address of Testing, Adjusting, and Balancing Agency
   c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
1. General Information:
   a. Project name
   b. Project location
   c. Project Architect
   d. Project Engineer
   e. Project Contractor
   f. Project altitude
   g. Report date

2. Summary Comments:
   a. Design versus final performance
   b. Notable characteristics of system
   c. Description of systems operation sequence
   d. Summary of outdoor and exhaust flows to indicate building pressurization
   e. Nomenclature used throughout report
   f. Test conditions

3. Instrument List:
   a. Instrument
   b. Manufacturer
   c. Model number
   d. Serial number
   e. Range
   f. Calibration date

4. Electric Motors:
   a. Manufacturer
   b. Model/Frame
   c. HP/BHP and kW
   d. Phase, voltage, amperage; nameplate, actual, no load
   e. RPM
   f. Service factor
   g. Starter size, rating, heater elements
   h. Sheave Make/Size/Bore

5. V-Belt Drive:
   a. Identification/location
   b. Required driven RPM
   c. Driven sheave, diameter and RPM
   d. Belt, size and quantity
   e. Motor sheave diameter and RPM
   f. Center to center distance, maximum, minimum, and actual

6. Air Cooled Condenser:
   a. Identification/number
   b. Location
   c. Manufacturer
   d. Model number
   e. Serial number
   f. Entering DB air temperature, design and actual
   g. Leaving DB air temperature, design and actual
   h. Number of compressors

7. Cooling or Heating Coil Data:
   a. Identification/number
   b. Location
   c. Service
   d. Manufacturer
   e. Air flow, design and actual
   f. Entering air DB temperature, design and actual
   g. Entering air WB temperature, design and actual
   h. Leaving air DB temperature, design and actual
   i. Leaving air WB temperature, design and actual
j. Water flow, design and actual
k. Water pressure drop, design and actual
l. Entering water temperature, design and actual
m. Leaving water temperature, design and actual
n. Saturated suction temperature, design and actual
o. Air pressure drop, design and actual

8. Air Moving Equipment:
a. Location
b. Manufacturer
c. Model number
d. Serial number
e. Arrangement/Class/Discharge
f. Air flow, specified and actual
g. Return air flow, specified and actual
h. Outside air flow, specified and actual
i. Total static pressure (total external), specified and actual
j. Inlet pressure
k. Discharge pressure
l. Sheave Make/Size/Bore
m. Number of Belts/Make/Size
n. Fan RPM

9. Return Air/Outside Air Data:
a. Identification/location
b. Design air flow
c. Actual air flow
d. Design return air flow
e. Actual return air flow
f. Design outside air flow
g. Actual outside air flow
h. Return air temperature
i. Outside air temperature
j. Required mixed air temperature
k. Actual mixed air temperature
l. Design outside/return air ratio
m. Actual outside/return air ratio

10. Exhaust Fan Data:
a. Location
b. Manufacturer
c. Model number
d. Serial number
e. Air flow, specified and actual
f. Total static pressure (total external), specified and actual
g. Inlet pressure
h. Discharge pressure
i. Sheave Make/Size/Bore
j. Number of Belts/Make/Size
k. Fan RPM

11. Duct Traverse:
a. System zone/branch
b. Duct size
c. Area
d. Design velocity
e. Design air flow
f. Test velocity
g. Test air flow
h. Duct static pressure
i. Air temperature  
 j. Air correction factor

12. Air Distribution Test Sheet:
 a. Air terminal number  
 b. Room number/location  
 c. Terminal type  
 d. Terminal size  
 e. Area factor  
 f. Design velocity  
 g. Design air flow  
 h. Test (final) velocity  
 i. Test (final) air flow  
 j. Percent of design air flow

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductwork insulation.
   2. Insulation jackets.
   3. Equipment insulation
   4. Insulation accessories including vapor retarders, jackets, and accessories.

B. Related Sections:
   1. Section 099000 - Paints and Coatings: Execution requirements for painting insulation jackets and covering specified by this section.
   2. Section 230529 - Hangers and Supports: Product and Execution requirements for inserts at hanger locations.

1.2 REFERENCES

A. ASTM International:

B. Sheet Metal and Air Conditioning Contractors':
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS
A. Section 013300 - Submittal Procedures: Submittal procedures.
B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Applicator: Company specializing in performing Work of this section with minimum three years experience.

1.5 PRE-INSTALLATION MEETINGS
A. Section 013000 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.
1.6 DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
   B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS
   A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
   B. Maintain temperature during and after installation for minimum period of 24 hours.

1.8 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.9 WARRANTY
   A. Furnish five year manufacturer warranty for all mechanical insulation on project.

2 PART 2 PRODUCTS

2.1 MAN MADE MINERAL FIBER
   A. Insulation: ASTM C547 Mineral Fiber Pre-molded Pipe Insulation, Type I, 850 degrees F (454 degrees C).
   B. Insulation: ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
      1. 'K' ('ksi') factor: ASTM C177, 0.24 at 75 degrees F.
      2. Maximum service temperature: 650 degrees F.
      3. Maximum moisture absorption: 0.2 percent by volume.
   C. Vapor Retarder Jacket:
      1. ASTM C921, White Kraft paper with glass fiber yarn, bonded to aluminized film.
      2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
   D. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

2.2 GLASS FIBER, FLEXIBLE
   A. Insulation: ASTM C553; flexible, noncombustible blanket.
      1. 'K' ('Ksi') value: ASTM C518, 0.31 at 75 degrees F.
      2. Maximum service temperature: 250 degrees F.
      3. Maximum moisture absorption: 0.20 percent by volume.
      4. 2 inch thick 3/4 lb. density minimum.
   B. Vapor Barrier Jacket:
      1. Kraft paper with glass fiber yarn and bonded to aluminized film.
      2. Moisture vapor transmission: ASTM E96; 0.02 perm.
      3. Secure with pressure sensitive tape.
C. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive. To be sealed with fabric weave embedded with mastic sealant.

D. Vapor Barrier Mastic (in Mechanical Rooms open to ambient):
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, white color.

E. Tie Wire: Annealed stainless steel, 18 gage.

2.3 MAN MADE MINERAL FIBER, FLEXIBLE BLANKET OR BATTS

A. Insulation: ASTM C1290; Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
   1. Operating Temperatures: 250 degrees F (121 degrees C).
   2. Density: 0.75 lb/cu ft (12 kg/cu m), 2 inch thickness minimum.
   3. 'K' ('ksi') factor: ASTM C518, 0.30 at 75 degrees F.

B. Vapor Retarder Jacket: ASTM 1136, Type II Flexible and Low Permeance Vapor Retarders for Thermal Insulation.
   1. For systems operating at temperatures below ambient, close and secure seams and joints. When outward clinching staples are used, seal penetrations.

C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

D. Vapor Retarder Lap Adhesive:
   1. Compatible with insulation.

E. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

2.4 MINERAL FIBER, FLEXIBLE

A. Insulation: ASTM C553 Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications, Type II.

B. Vapor Retarder Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm.
   3. Secure with pressure sensitive tape, fiber mesh embedded with mastic on all seams and joints over taping.

C. Vapor Retarder Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

D. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.5 GLASS FIBER, RIGID

A. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
   1. 'K' ('ksi') factor: ASTM C177 or ASTM C518, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 450 degrees F.
3. Maximum Moisture Absorption: 0.1 percent by volume.
4. Density: 3.0 ft.

B. Vapor Retarder Jacket: ASTM C1136 Flexible, Low Permeance Vapor Retarders for Thermal Insulation, Type II.

C. Facing: 1 inch (25 mm) stainless steel hexagonal wire mesh stitched on one face of insulation.

D. Vapor Retarder Lap Adhesive:
   1. Compatible with insulation.

E. Insulating Cement/Mastic:
   1. ASTM C195; hydraulic setting on mineral wool.

2.6 ELASTOMERIC CELLULAR FOAM PRE-MOLDED ON CONDENSATE AND RIFRIGERANT PIPING

A. Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular form: ASTM C534; Type I, Tubular form

B. Elastomeric Foam Adhesive:
   1. Air dried, contact adhesive, compatible with insulation. 100% coverage required.


2.7 REFRIGERANT PIPE INSULATION AND JACKETS

A. Aluminum Pipe Jacket: (Ambient Condition Exposure)
   1. ASTM B209 and/or ASTM B209M.
   2. Thickness: 0.025 inch thick sheet.
   3. Finish: Embossed.
   4. Joining: Longitudinal slip joints and 2 inch (50 mm) laps minimum.
   5. Fittings: .025 inch thick die shaped fitting covers with factory attached protective liner.
   6. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch thick stainless steel.

2.8 GLASS FIBER

A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' ('Ksi') value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.

B. Insulation: ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' ('Ksi') value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   3. Maximum moisture absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket:
   1. ASTM C921, White kraft paper with glass fiber yarn, bonded to aluminized film.
   2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

D. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
E. Vapor Barrier Lap Adhesive:
1. Compatible with insulation.

F. Fibrous Glass Fabric:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
2. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
3. Weave: 5x5.

G. Indoor Vapor Barrier Finish:
1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

3 PART 3 EXECUTION

3.1 EXAMINATION

A. Verify piping, equipment and ductwork has been tested before applying insulation materials.

B. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Exposed Piping: Locate insulation and cover seams in least visible locations.

B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints. Provide premanufactured removable insulation assemblies on pumps, strainers and other equipment needing periodic maintenance.

C. Man made mineral fiber insulated pipes conveying fluids below ambient temperature:
1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. For hot piping conveying fluids over 100 degrees F, insulate flanges and unions at equipment.

E. Man made mineral fiber insulated pipes conveying fluids above ambient temperature:
1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers in all exposed areas.

F. Inserts and Shields:
1. Application: Piping or Equipment 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under finish jacket.
4. Insert configuration: Minimum 6 inches (150 mm) long, of thickness and contour matching adjoining insulation; may be factory fabricated.
5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.

G. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07840 for penetrations of assemblies with fire resistance rating greater than one hour.

H. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.

I. Factory Insulated Equipment: Do not insulate.

J. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

K. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

L. Insulated equipment containing fluids below ambient temperature: Insulate entire system.

M. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.

N. Finish insulation at supports, protrusions, and interruptions.

O. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

P. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage. Provide premanufactured assemblies specifically manufactured for such device and purpose.

Q. Insulated ductwork conveying air below ambient temperature:
   1. Provide insulation with vapor retarder jackets.
   2. Finish with tape and vapor retarder jacket and sealed with fiber mesh and sealer.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints. Mastic all joints, seams and terminations with fiber mesh and sealant.

R. Insulated ductwork conveying air above ambient temperature:
   1. Provide with standard vapor retarder jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

S. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or aluminum jacket.
T. Exterior Applications: Provide insulation with vapor retarder jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

U. External Duct Insulation Application:
   1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
   2. Secure insulation without vapor retarder with staples, tape, or wires.
   3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
   4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
   5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
   6. Provide outer covering of aluminum jacket that is mastic sealed at all joints.

3.3 SCHEDULES
A. Cooling Systems:
   a. Ductwork in Mechanical Rooms - 2" rigid fiberglass, foil faced.
   b. Exposed ductwork 2" rigid fiberglass, foil faced.

B. Exhaust Ducts within 10 feet (3 m) of Exterior Openings: 2 inches.

C. Outside Air Intake Ducts: 2 inch.

D. Plenums: 2 inch.

E. Plenums (Cooling System): 2 inch.

F. Supply Ducts: 2 inch.

G. Return and Relief Ducts in Mechanical Rooms: 2 inch.

H. Ducts Exposed to Outdoors: 2 inch cellular foam with aluminum jacket.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY

A. Scope: Provide condensate drain piping from cooling coil drain pans. Drain piping shall be routed to the nearest floor drain or dry well except as otherwise indicated on the drawings.

B. Related Sections: Refer to other Division 23 sections for the following:
1. Section 230503 - Mechanical Identification.

C. Other Divisions: Refer to other Divisions of the specification for the following:
1. Field Painting: Division 9.
2. Piping systems requiring fixed locations and slopes shall have priority over those which do not have both requirements.

1.2 QUALITY ASSURANCE

A. Codes and Standards: Provide piping and fittings conforming to the requirements of the following:
   d. B88 Standard Specification for Seamless Copper Water Tube
   e. B306 Standard Specification for Seamless Copper Waste and Vent Pipe

1.3 SUBMITTALS

A. Division 1: Refer to "Submittals" for basic information relating to submittal requirements.

B. Product Data: Submit manufacturer's standard technical product data indicating conformance to the stipulated reference specifications, construction materials, construction details, and test and operating pressures. Submit manufacturer's product data on the following:
1. Pipe materials.

1.4 STORAGE AND PROTECTION

A. Storage: Store piping on the project site so as to preclude the entrance of construction dirt and debris into the open ends of piping. Do not install piping fouled with construction dirt.

B. Storage of Fittings: Store fittings under cover, protected from construction dirt and rain.

2 PART PRODUCTS
2.1 PIPING MATERIALS
   A. Piping shall be copper type ‘L’ or Sch 40 PVC as specified.

3. PART EXECUTION
   3.1 GENERAL
      A. Piping shall be sloped uniformly toward floor drain and provided with trap seal having a depth, in inches, equivalent to the total static pressure of the respective fan system plus two inches.
      B. Piping shall be installed in a neat and workmanlike manner and shall not be smaller than full size of the equipment drain connection or one-half inch (1/2”) whichever is larger.
      C. Unless otherwise noted on Drawings, use copper type “L” for condensate line material in Mechanical rooms.

   3.2 INSTALLATION
      A. Sizes: Provide piping systems of sizes indicated on the drawings. Systems shall be installed complete.
      B. Codes: Install piping systems in conformance with all applicable codes.
      C. Pitch: Install condensate drain piping with a pitch or slope of not less than 1/8 inch per foot in the direction of flow.

   3.3 ROUTING
      A. Unless otherwise indicated, route pipe discharge to the nearest floor drain or dry well.

END OF SECTION
SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Refrigerant piping.
   2. Unions, flanges, and couplings.
   3. Pipe hangers and supports.
   4. Refrigerant moisture and liquid indicators.
   5. Valves.
   6. Refrigerant strainers.
   7. Refrigerant filter-driers.

B. Related Sections:
   1. Section - Aggregate: Aggregate for backfill in trenches.
   2. Section - Backfill: Execution requirements for backfilling required by this section.
   3. Section - Trenching: Execution requirements for trenching required by this section.
   4. Section - Firestopping: Product requirements for firestopping for placement by this section.
   6. Section - Paints and Coatings: Product requirements for painting for placement by this section.
   7. Section 230529 - Supports and Anchors: Product requirements for pipe hangers and supports and sleeves, for placement by this section.
   8. Section 230548 - Vibration Isolation: Product requirements for Vibration Isolation for placement by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 495 - Refrigerant Liquid Receivers.
   2. ARI 710 - Liquid-Line Driers.
   4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
   5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. American Society of Mechanical Engineers:
   1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
   3. ASME B31.5 - Refrigeration Piping.
   4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
D. American Society for Testing and Materials:

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

G. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.3 SYSTEM DESCRIPTION
A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.

B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.

C. Provide pipe hangers and supports in accordance with ASME B31.5, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.

D. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.4 SUBMITTALS
A. Division 1 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.

C. Product Data:
1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
   a. Refrigerant strainers.
   b. Refrigerant pressure regulators.
   c. Refrigerant pressure relief valves.
   d. Refrigerant filter-driers.
   e. Refrigerant solenoid valves.
   f. Refrigerant capillary tubes.
   g. Electronic expansion valves.

D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

E. Test Reports: Indicate results of refrigerant leak test and piping system pressure test.

F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.

G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

H. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.5 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.

C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

C. Perform Work in accordance with State of Florida standards.

D. Maintain one copy of document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience.

C. Design piping system and hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Florida.
1.8 PRE-INSTALLATION MEETINGS
A. Division 1 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Division 1 - Product Requirements: Product storage and handling requirements.
B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS
A. Division 1 - Product Requirements.

1.11 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.12 COORDINATION
A. Division 1 - Administrative Requirements: Requirements for coordination.

1.13 WARRANTY
A. Division 1 - Execution Requirements: Product warranties and product bonds.
B. Furnish five year manufacturer warranty for valves excluding packing.

1.14 MAINTENANCE MATERIALS
A. Division 1 - Execution Requirements: Spare parts and maintenance products.
B. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.15 EXTRA MATERIALS
A. Division 1 - Execution Requirements: Spare parts and maintenance products.
B. Furnish two packing kits for each size and valve type.
C. Furnish two refrigerant filter-dryer cartridges of each type.
2PART PRODUCTS

2.1 REFRIGERANT PIPING

A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed, type “K” is required.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F (640 to 805 degrees C).

2.2 UNIONS, FLANGES, AND COUPLINGS

A. 2 inches (50 mm) and Smaller:
   1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

2.3 PIPE HANGERS AND SUPPORTS

A. See Section 230529 for pipe supports.

2.4 VALVES

A. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, flared or solder ends.

B. Refrigerant Check Valves:
   1. Furnish materials in accordance with State of Florida standards.
   2. Globe Type:
      a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.
      b. Maximum working pressure: 425 psig (2930 kPa).
      c. Maximum working temperature: 300 degrees F (149 degrees C).
   3. Straight Through Type:
      a. Spring, neoprene seat.
      b. Maximum working pressure: 500 psig (3450 kPa).
      c. Maximum working temperature: 250 degrees F (121 degrees C).

2.5 REFRIGERANT STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass.

B. Straight Line, Non-Cleanable Type:
   1. Steel shell, copper plated fittings, stainless steel wire screen.

2.6 REFRIGERANT FILTER-DRIERS

A. Replaceable Cartridge Angle Type:
   1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 500 psig (3450 kPa).
2. Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for 20 tons (76,430 W).
3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina, ARI 730 rating for 20 tons (76,430 W).

B. Permanent Straight Through Type:
1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig (3450 kPa).
2. Rating: ARI 710 flow capacity of 20 tons (76,430 W) and ARI 730 flow capacity of 20 tons (76,430 W).

3 PART EXECUTION

3.1 EXAMINATION
A. Division 1 - Administrative Requirements: Coordination and project conditions.

3.2 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS
A. Install hangers and supports in accordance with ASME B31.5, ASTM F708, and MSS SP 89.
B. Support horizontal piping hangers as scheduled.
C. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
D. Place hangers within 12 inches (300 mm) of each horizontal elbow.
E. Install hangers to allow 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
H. Provide sheet lead packing between hanger or support and piping.
I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.4 INSTALLATION - PIPING SYSTEMS
A. Install piping to conserve building space, and not interfere with use of space.
B. Group piping whenever practical at common elevations.
C. Sleeve pipe passing through partitions, walls and floors.
D. Install pipe identification in accordance with Section 230503.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Provide access where valves and fittings are not exposed.
G. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
H. Flood refrigerant piping system with nitrogen when brazing.
I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
K. Install valves with stems upright or horizontal, not inverted.
L. Insulate suction and liquid refrigerant piping with 2 inch elastomeric pipe insulation.
M. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
Q. Provide electrical connection to solenoid valves. Refer to Division 26 for requirements.
R. Fully charge completed system with refrigerant after testing.
S. Follow ASHRAE 15 and 147 procedures for charging and purging of systems and for disposal of refrigerant.
T. Install refrigerant piping in accordance with ASME B31.5.

3.5 INSTALLATION - REFRIGERANT SPECIALTIES

A. Refrigerant Liquid Indicators:
   1. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
   2. Install line size liquid indicators downstream of liquid solenoid valves.
3. Dehydrate lines to $10^{-6}$ microns vacuum and hold for 4 hours prior to charging with Freon.

B. Refrigerant Valves:
1. Install service valves on compressor suction and discharge.
2. Install gage taps at compressor inlet and outlet.
3. Install gage taps at hot gas bypass regulators, inlet and outlet.
4. Install check valves on compressor discharge.
5. Install check valves on condenser liquid lines on multiple condenser systems.
6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

C. Strainers:
1. Install line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
3. On steel piping systems, install strainer in suction line.
4. Install shut-off valves on each side of strainer.

D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

E. Filter-Dryers:
1. Install permanent filter-dryers in low temperature systems.
2. Install permanent filter-dryer in systems containing hermetic compressors.
3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

3.6 FIELD QUALITY CONTROL
A. Division 1 - Quality Requirements: Testing and Inspection Services.
B. Test refrigeration system in accordance with ASME B31.5.
C. Repair leaks.
D. Retest until no leaks are detected.

END OF SECTION
SECTION 23 31 00

DUCTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Duct Materials.
   2. Insulated flexible ducts.
   4. Ductwork fabrication.

B. Related Sections:
   1. Section 230529 - Supports and Anchors: Product requirements for hangers, supports and sleeves for placement by this section.
   2. Section 233300 - Ductwork Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

A. ASTM International:
   2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
   5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

B. National Fire Protection Association:

**C. Sheet Metal and Air Conditioning Contractors:**

1. SMACNA - Fibrous Glass Duct Construction Standards.
3. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

**D. Underwriters Laboratories Inc.:**

1. UL 181 - Factory-Made Air Ducts and Connectors.

### 1.3 PERFORMANCE REQUIREMENTS

**A.** Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

### 1.4 SUBMITTALS

**A.** Division 1 - Submittal Procedures: Submittal procedures.

**B.** Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/8 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
3. Fittings.
4. Reinforcing details and spacing.
5. Seam and joint construction details.
6. Penetrations through fire rated and other walls.
7. Terminal unit, coil, and humidifier installations.
8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

**C.** Product Data: Submit data for duct materials, duct liner, and duct connectors.

**D.** Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

### 1.5 CLOSEOUT SUBMITTALS

**A.** Division 1 - Execution Requirements: Closeout procedures.

**B.** Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

### 1.6 QUALITY ASSURANCE
A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

B. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

A. Division 1 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Division 1 - Product Requirements.

B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.

C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

2 PART PRODUCTS

2.1 DUCT MATERIALS

A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90/A90M.

B. Steel Ducts: ASTM A1008/A1008M.


D. Fasteners: Rivets, bolts, or sheet metal screws.

E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 INSULATED FLEXIBLE DUCTS

A. UL 181, Class 1, constructed with interior liner of round corrugated steel or aluminum duct with exterior fiberglass insulation and vinyl film vapor barrier.

   1. Pressure Rating: 10 inches wg (2.5 kPa) positive or negative.
2. Maximum Velocity: 4000 fpm (20.3 m/s).
3. Temperature Range: -20 degrees F to 210 degrees F (-28 degrees C to 99 degrees C).
4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.
5. Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings and screws.
6. Join each flexible duct section to main trunk duct through sheet metal fittings. Construct fittings of galvanized steel and equip with factory installed volume damper having positive locking regulator. Provide fittings installed in lined ductwork with insulation guard.
7. Maximum field measured pressure drop shall not exceed 0.1 inches in 5'-0" at design air flow. If it does, increase size until pressure drop is within specification.
8. Flexible ductwork shall be a minimum of 2 inches larger than equipment inlet or that shown on Contract Documents, whichever is larger. Provide reducers to fit equipment or neck sizes of air flow devices.

2.3 SINGLE WALL SPIRAL ROUND DUCTS

A. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel. Snap lock round not allowed.

B. Construct duct with the following minimum gages:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches to 14 inches</td>
<td>26</td>
</tr>
<tr>
<td>15 inches to 26 inches</td>
<td>24</td>
</tr>
</tbody>
</table>

C. Construct fittings with the following minimum gages:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches to 14 inches</td>
<td>24</td>
</tr>
<tr>
<td>15 inches to 26 inches</td>
<td>22</td>
</tr>
</tbody>
</table>

2.4 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with spiral seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.
F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

3PART EXECUTION

3.1 EXAMINATION

A. Division 1 - Administrative Requirements: Coordination and project conditions.
B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
B. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Use high pressure duct sealant on all joints and seams, inside and outer cover.
C. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 10 inch and smaller.
E. Install duct hangers and supports in accordance with SMACNA and such as not to have sags in runs.
F. Use double nuts and lock washers on threaded rod supports.
G. Connect flexible ducts to metal ducts with adhesive draw bands, adhesive plus sheet metal screws. Provide a minimum of two screws opposite of each other on round duct extractors. Install extractor spin ins with four screws, one on each corner.
H. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws.
I. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swing so fan static pressure holds door in closed position.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
B. Connect diffusers boots to low pressure ducts directly above hard ceiling with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp above lay-in ceilings.
C. Connect air terminal units and air outlets and inlets to supply ducts directly or with five foot (1.5 m) maximum length of flexible duct. Do not use flexible duct to change direction above hard ceilings. Direct connections required.
3.4 SCHEDULES

**DUCTWORK MATERIAL SCHEDULE**

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply (Heating Systems)</td>
<td>Galvanized Steel, Aluminum</td>
</tr>
<tr>
<td>Supply (System with Cooling Coils)</td>
<td>Galvanized Steel, Aluminum</td>
</tr>
<tr>
<td>General Exhaust</td>
<td>Galvanized Steel, Aluminum</td>
</tr>
<tr>
<td>Outside Air Intake</td>
<td>Galvanized Steel, Aluminum</td>
</tr>
</tbody>
</table>

**DUCTWORK PRESSURE CLASS SCHEDULE**

<table>
<thead>
<tr>
<th>AIR SYSTEM</th>
<th>PRESSURE CLASS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Volume Supply</td>
<td>3 inch wg regardless of velocity.</td>
</tr>
<tr>
<td>Supply (Heating Systems)</td>
<td>3 inch wg (250 Pa)</td>
</tr>
<tr>
<td>Supply (System with Cooling Coils)</td>
<td>3 inch wg (500 Pa)</td>
</tr>
<tr>
<td>Exhaust</td>
<td>Negative 3 inch wg</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air turning devices/extractors.
B. Backdraft dampers.
C. Duct test holes.
D. Flexible duct connections.
E. Volume control dampers.

1.2 RELATED SECTIONS

A. Section 233100 - Ducts
B. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.
C. Division 26 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
B. NFPA 92A - Smoke Control Systems.
C. NFPA 70 - National Electrical Code.
D. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
E. UL 33 - Heat Responsive Links for Fire-Protection Service.
F. UL 555 - Fire Dampers and Ceiling Dampers.

1.4 SUBMITTALS

A. Submit Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
C. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.
1.5 PROJECT RECORD DOCUMENTS
A. Submit and record actual locations of access doors, test holes and volume dampers.

1.6 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.7 REGULATORY REQUIREMENTS
A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect and handle products to site.
B. Protect dampers from damage to operating linkages and blades.

2PART PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS
A. Multi-blade device with radius blades attached to pivoting frame and bracket, steel or aluminum construction, with worm drive mechanism with 18 inch long removable key operator.

2.2 BACKDRAFT DAMPERS
A. Gravity Backdraft Dampers, Size 24 x 24 inches or Smaller, Furnished with All Air Moving Equipment: Air moving equipment manufacturers standard construction. Aluminum with corrosion resistant polymer bushings or bearings.
B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: 16 gage thick extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, ball bearings, and plated pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 DUCT ACCESS DOORS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum two inch thick insulation with sheet metal cover.
   1. Less Than 12 Inches Square: Secure with sash locks.
   2. Up to 18 Inches Square: Provide two hinges and two sash locks.
C. Access doors with sheet metal screw fasteners are not acceptable.
2.4 DUCT TEST HOLES
A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, threaded plugs, or threaded or twist-on metal caps.
B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.5 FLEXIBLE DUCT CONNECTIONS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Connector: Fabric crimped into metal edging strip.
   1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

2.6 VOLUME CONTROL DAMPERS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Splitter Dampers:
   1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
   2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
D. End Bearings: Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
E. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30 inches provide regulator at both ends.

3PART EXECUTION
3.1 PREPARATION
A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION
A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 17072 23 33 00 -3
233100 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct test holes where indicated and required for testing and balancing purposes.

D. Provide 6 inch flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

F. Use splitter dampers only where indicated.

G. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Centrifugal square inline fans.
   B. Cabinet and ceiling exhaust fans.

1.2 RELATED SECTIONS
   A. Section 230513 - Motors.
   B. Section 233100 - Ductwork.
   C. Section 233300 - Duct Accessories: Backdraft dampers.
   D. Division 26 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES
   B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
   C. AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal.
   D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
   F. NEMA MG1 - Motors and Generators.
   G. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial cooking Equipment.
   H. UL 705 - Power Ventilators.

1.4 SUBMITTALS FOR REVIEW
   A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

1.5 SUBMITTALS FOR INFORMATION
   A. Manufacturer's Instructions: Indicate installation instructions.

1.6 SUBMITTALS AT PROJECT CLOSEOUT
   A. Maintenance Data: Include instructions for lubrication, motor and drive replacement,
spare parts list, and wiring diagrams.

B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer. All fans shall require 5 year warranty.

1.7 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.8 REGULATORY REQUIREMENTS
A. Kitchen Range Hood Exhaust Fans: Comply with requirements of NFPA 96.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.9 EXTRA MATERIALS
A. Supply two sets of belts for each fan.

1.10 PRE-INSTALLATION MEETINGS
A. Convene minimum one week prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING
A. Protect motors, shafts, and bearings from weather and construction dust.

1.12 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.13 MAINTENANCE SERVICE
A. Furnish service and maintenance of fans for one year from Date of Substantial Completion.
B. Examine each fan's components monthly. Clean, adjust, and lubricate equipment.
C. Include systematic examination, adjustment, and lubrication of fans, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.
D. Perform work without removing fans from service during building normal occupied hours.
E. Provide emergency call back service during working hours for this maintenance period.
F. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.
G. Perform maintenance work using competent and qualified personnel under supervision of manufacturer or original installer.
H. Do not assign or transfer maintenance service to agent or subcontractor without prior
PART 2 - PRODUCTS

2.1 CENTRIFUGAL SQUARE INLINE FANS DUCTED

A. Manufacturers:
   1. Greenheck Corp., Loren Cook Company, Penn Ventilation, or equal.

B. Product Description: V-belt drive with galvanized steel housing lined with 1/2 inch (13 mm) acoustic glass fiber insulation, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, backdraft damper.

C. Fan Wheel: Forward curve centrifugal type, galvanized or aluminum construction.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Motor and Drive Mounting: Out of air stream.

F. Motor: In accordance with Division 26.

G. Bearings: ABMA 9 life at 200,000 hours.

H. Accessories:
   1. Belt guard.
   2. Motor cover.
   3. Flexible duct connector (discharge side only).
   4. Inlet and outlet ductwork companion flange.
   5. Disconnect Switch: NEMA 1.
   6. Backdraft damper on discharge.
   7. Spring isolators.

I. Performance: See Drawing Schedule.

J. Electrical Characteristics and Components: In accordance with Division 26.

2.2 CABINET AND CEILING EXHAUST FANS

A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with 1/2 inch (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

B. Disconnect Switch: Cord and plug in housing for thermal overload protected motor solid state speed controller.

C. Grille: Molded white plastic.

D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

E. Direct drive with SCR speed control.

PART 3 - EXECUTION
3.1 EXAMINATION
   A. Verify are installed and isolated as instructed by manufacturer or this specification.

3.2 INSTALLATION
   A. Install backdraft dampers and gravity shutters on wall exhaust fans, as shown on Drawings or required by specifications.
   B. Provide backdraft dampers on outlet from square in-line fans and ceiling fans and as required on Drawings.
   C. Hung Cabinet Fans:
      1. Install fans with resilient mountings and flexible electrical leads.
      2. Install flexible connections specified in Section 23 09 23 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
   D. Install safety screen where inlet or outlet is exposed.
   E. Support ceiling and square in-line exhaust fans separate from ductwork.
   F. Install flex connections on inlet and outlet of all square in-line and ceiling exhaust fans, and where indicated on Drawings.
   G. Provide adjustable pitch sheaves required for final air balance or device similar to VFD or Reostat.

3.3 CLEANING
   A. Vacuum clean fan and inside of fan cabinet.

3.4 DEMONSTRATION
   A. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK
   A. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.
   B. Provide sheaves required for final air balance.
   C. Install backdraft dampers on inlet to wall or eve louvers.
   D. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.
   E. Do not operate fans until ductwork is clean, filters are in place, and bearings are lubricated.

END OF SECTION
SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Diffusers.
   2. Registers
   4. Door grilles.
   5. Louvers. (Wall louvers, exterior)
B. Related Sections:
   1. Section 099000 - Paints and Coatings: Execution and product requirements for
      Painting of ductwork visible behind outlets and inlets specified by this section.
   2. Section 089100 - Wall Louvers: Wall Louvers.

1.2 REFERENCES
A. Air Movement and Control Association International, Inc.:
   1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and
      Inlets.
C. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS
A. Section 013300 - Submittal Procedures: Submittal procedures.
B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and
   inlets showing type, size, location, application, and noise level.
C. Samples: Submit two of each required air outlet and inlet type.
D. Test Reports: Rating of air outlet and inlet performance.
E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS
A. Section 017000 - Execution Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE
A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
B. Test and rate louver performance in accordance with AMCA 500.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 WARRANTY

A. Furnish five year manufacturer warranty for air outlets and inlets.

1.8 EXTRA MATERIALS

A. Furnish 5 percent extra air outlets and inlets; a minimum of one.

2 PART 2 - PRODUCTS

2.1 SQUARE CEILING DIFFUSERS

A. Manufacturers:
   1. Price.
   2. Titus.
   3. Tuttle and Bailey.

B. Type: Square and rectangular, adjustable pattern, multi-louvered diffuser to discharge air in one way or four-way pattern with sector baffles as indicated on Drawings.

C. Frame: Surface mount type. In plaster ceilings, furnish plaster frame and ceiling frame.

D. Fabrication: Aluminum with baked enamel off-white finish.

E. Accessories: Radial opposed-blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.2 CEILING SUPPLY REGISTERS/GRILLES – CURVED BLADE REGISTERS (CBR)

A. Manufacturers:
   1. Price.
   2. Titus.
   3. Tuttle and Bailey.

B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way or two-way deflection as indicated.

C. Frame: 1-1/4 inch margin with concealed mounting and gasket.

D. Fabrication: Aluminum extrusions with factory off-white enamel finish.

E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.3 CEILING GRID CORE EXHAUST REGISTERS/GRILLES

A. Manufacturers:
1. **Price**
2. **Titus.**
3. **Tuttle and Bailey.**
4. **Substitutions:** Permitted.

**B.** Type: Fixed grilles of 1/2 x 1/2 x 1 inch louvers.

**C.** Fabrication: Aluminum with factory off-white baked enamel.

**D.** Frame: 1 inch margin with concealed mounting. Channel lay-in frame for suspended grid ceilings.

**E.** Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

### 2.4 WALL SUPPLY Registers/Grilles

**A.** Manufacturers:
1. **Price**
2. **Titus.**
3. **Tuttle and Bailey.**
4. **Substitutions:** Permitted.

**B.** Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, maximum spacing with spring or other device to set blades, vertical face, double deflection.

**C.** Frame: 1-1/4 inch margin with concealed mounting and gasket.

**D.** Fabrication: Aluminum extrusions, with factory off-white baked enamel finish.

**E.** Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

### 2.5 WALL EXHAUST AND EVE Registers/Grilles

**A.** Manufacturers:
1. **Price**
2. **Titus**
3. **Tuttle and Bailey.**
4. **Substitutions:** Permitted.

**B.** Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, vertical face.

**C.** Frame: 1-1/4 inch margin with concealed mounting.

**D.** Fabrication: Aluminum extrusions, with factory baked enamel finish, color to be selected to match wall or eve.

**E.** Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

**F.** Shall be Miami Dade rated for high wind and impact and shall have a Florida product approved rating number. Submit certifications with product submission.

### 2.6 LOUVERS (Exterior Walls, Intake for AHU Outside Air)
A. See Architectural for type and operational type.

B. Louvers: As specified in Section 10210. See Architectural.

C. Shall be 6” deep, aluminum construction (welded). Miami Dade wind and impact rated. Louver shall have Florida product approval number and rating. Submit certification with product submission.

D. Louvers to be sized to meet a maximum intake velocity of 500 FPM of free area.

3PART EXECUTION

3.1 EXAMINATION

A. Verify inlet and outlet locations.

B. Verify ceiling and wall systems are ready for installation.

3.2 INSTALLATION

A. Install diffusers to ductwork with airtight connection using screws, strapping, and mastic to give airtight assembly.

B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.

C. Paint visible portion of ductwork behind all air outlets and inlets matte black. Refer to Section 09900.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement. Refer to Architect’s reflected ceiling plan for exact placement. Separate all supply and return on maximum spacing when possible. Supply air to remain as close to Mechanical Plan placement as possible.

END OF SECTION
SECTION 23 73 00
AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes modular factory fabricated air-handling units and accessories.

B. Related Sections:
   1. Division 3 - Cast-In-Place Concrete: Execution requirements for housekeeping pads specified by this section.
   2. Section 230700 - Mechanical Insulation: Product requirements for insulation for placement by this section.
   3. Section 230548 - Vibration Isolation: Product requirements for vibration isolators for placement by this section.
   4. Section 232116 - Hydronic Piping: Product requirements for piping by this section.
   5. Section 233300- Duct Accessories: Product requirements for flexible duct connections for placement by this section.
   6. Division 26 - Electrical: Execution and product requirements specified by this division.

1.2 REFERENCES

A. American Bearing Manufacturers Association:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc.:
   2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
   4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
   5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

C. Air-Conditioning and Refrigeration Institute:
   2. ARI 430 - Central-Station Air-Handling Units.
   3. ARI 610 - Central System Humidifiers for Residential Applications.
   4. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.

D. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

E. Sheet Metal and Air Conditioning Contractors:
   1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

F. Underwriters Laboratories Inc.:
   1. UL 900 - Air Filter Units.
   2. UL - Fire Resistance Directory.
1.3 SUBMITTALS

A. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data, Submit the following:
   1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
   2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
   3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
   4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
   5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.

C. Manufacturer's Installation Instructions: Submit.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

B. Installer: Company specializing in performing Work of this section with minimum three years experience approved by manufacturer.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Protect units from weather and construction traffic by storing in dry, roofed location.

1.8 WARRANTY

A. Furnish five year parts and labor manufacturer warranty for air handling units.

1.9 EXTRA MATERIALS

A. Furnish two extra sets for each unit of fan belts and filters at the end of one-year warranty.

B. Provide two sets of fan belts and filters for each for each and all air handling equipment at Final Acceptance.
PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS

A. Manufacturers:
1. American Standard Inc./Trane 100% Outside Air Units.
2. Addison 100% Outside Air Units.
3. Aaon 100% Outside Air Units.
4. Weather King 100% Outside Air Units.
5. McQuay 100% Outside Air Units.

B. Configuration: Fan section, fan and coil section plus accessories, including:
1. Hot gas re-heat coil.
2. Cooling coil section.
3. Electric heating coils
4. Filter section or
5. Combination filter/mixing box section. Merv 8 minimum pre filters with MERV 13 4" final filters.
6. Vertical as indicated on plans.

C. Performance Base: Sea level pressure or altitude.

D. Fabrication: Conform to AMCA 99 and ARI 430.

2.2 CASING

A. Channel base and pan of welded steel. Assemble sections with gaskets and bolts.

B. Outside Casing Minimum thickness:
1. Aluminum: 0.063 thick. (painted)
2. Steel: 0.06 inch thick. (painted)
3. Galvanized Steel: 0.0635 inch.
4. Stainless Steel: 0.0625 thick.

C. Inside Casing:
1. Aluminum or 304 stainless steel perforated 0.0200 inch thick
2. Galvanized Steel: Perforated on Inside Service Units, 0.0276 inch thick with Adsil or Sea Coast coating.

D. Floor Plate:
1. Galvanized Steel: .130 inch thick on Inside of Air Units.
2. Stainless steel : .10 inches thick on inside of Air Units.

E. Insulation: Neoprene coated, glass fiber, applied to internal surfaces with adhesive and weld pins with exposed edges of insulation coated with adhesive – behind double wall.
1. ‘K’ (‘Ksi’) factor at 75 degrees F (42 degrees C): Maximum 0.26 Btuh inch/ sq ft/ degrees F (0.037 W/m/Degree K).
2. Density: 2 inch thick, 3 lbs/cu ft.
3. 2" foamed in place between inner and outer walls.
4. Glass fiber between double wall construction.

F. Finish: Standard finish for all indoor AHUs.

G. Inspection Doors: 18 x 22 inch (minimum) of galvanized steel for flush mounting, with gasket, latch, and handle assembly Air Handling Units.
H. Drain Pans: Single thickness stainless steel or coated galvanized or molded plastic with insulation with welded corners. Cross break and pitch to drain connection. Furnish drain pans under cooling coil section. Provide auxiliary galvanized drain pans with shut off switches, to be interlocked with controls under exterior casing.

I. Strength: Furnish structure to brace casings for suction pressure of 2.5 inch wg, with maximum deflection of 1 in 200.

J. Dampers: Adjustable, of stainless steel, 4 inch deep with plenum, nylon bearings, 1/2 inch (13 mm) mesh, 0.04 inch stainless steel wire bird screen in stainless steel frame, and bearing AMCA Certified Ratings Seal in accordance with AMCA 500. Furnish adjustable dampers with hollow vinyl bulbed edge on blades and foam side stops to limit leakage to maximum 2 percent at 4 inch wg (1 kPa) differential pressure when sized for 200 fpm (10 m/s) face velocity.

2.3 FANS

A. Type: Forward curved, double width, double inlet, centrifugal fan.

B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing. Roof top units shall have aluminum tubing.

E. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Furnish access to motor, drive, and bearings through removable casing panels or hinged access doors. Mount base on vibration isolators.

F. Fan Modulation: Constant Speed Drive. Furnish by AHU manufacturer with auxiliary contacts for interlocks with exhaust fans and controls. See electric for complete specifications.

G. Flexible Connection: Separate unit from connecting ductwork.

2.4 BEARINGS AND DRIVES

A. Bearings: Pillow block type, self-aligning, grease-lubricated L-10 life at 120,000 hours.

B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of motor.

2.5 COILS
A. Casing with access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch (600 mm) downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Eliminators: Three break of Type 304 stainless steel or PVC, mounted over drain pan.

D. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410. 100% Outside Air Coils shall be provided with Sea Coast coating equal to Adsil or constructed with copper fins and tubes.

E. Fabrication:
   1. Tubes: 5/8 inch (16 mm) OD seamless copper expanded into fins, brazed joints.
   2. Fins: Aluminum - Copper on 100% Outside Air Units if not coated.
   3. Casing: Die formed channel frame of stainless steel

F. Refrigerant Coils:
   1. Headers copper tubes with silver brazed joints.
   2. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
   3. Configuration: Down feed with bottom suction.

G. Electric Coils: (Duct Heater or AHU Discharge Air Heater Mounted)
   1. Assembly: UL 1096 listed and labeled, with terminal control box and hinged cover, splice box, coil, casing, and controls.
   2. Coil: Exposed helical coil.
   3. Casing: Die formed channel frame of galvanized steel.
   5. Powered from AHU terminals, fused separately.

2.6 FILTERS

A. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.

B. Filter Media: UL 900 listed, Class I, approved by Engineer.

C. Angle or Flat High Capacity: 2 inches (50 mm) deep disposable extended area panel filters MERV 8 minimum (100% outside air AHUs) with a 4” flat MERV 14 disposable filters. Furnish 3 sets of each with each AHU.

D. Extended Surface: Filter box with holding frames and blank-off sheets, extended surface high efficiency media filters with MERV 8 and 14 efficiency (inside AHUs) filters.

E. Provide a minimum of three sets of filters for each AHU at Final Acceptance.

F. Contractor or Unit Manufacturer shall furnish full maintenance for filter change out and servicing all equipment for one year period to include all labor and parts.

G. Provide frame with 2” Merv 8 filters in pre filler and 4” Merv 14 as final filters prior to coils.

2.7 DAMPERS

A. Mixing Boxes: 100% outside air. Section with outside air dampers of stainless steel and edge seals in stainless steel frame, with stainless steel axles in self-lubricating nylon bearings, in opposed blade arrangement with damper blades positioned across short air opening dimension.
B. Damper Leakage: Maximum 2 percent at 4 inch wg (1 kPa) differential pressure when sized for 2000 fpm (10 m/s) face velocity.

C. Damper Actuators: Furnish factory installed electronic damper actuators for outside air dampers on Air Handling Units. Interlock with AHU to open when AHU is in operation.

2.8 CONTROLS

A. Controls: Self contained to maintain 70°F supply air to all spaces utilizing hot gas reheat and electric unit mounted heaters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with ARI 430.

B. Install flexible connections between AHU and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.

C. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.

D. Install floor mounted units on concrete housekeeping pads at least 3-1/2 inches (87 mm) high and 6 inches (150 mm) wider than unit unless noted otherwise.

E. Provide VFD for air balance.

3.2 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout on quarterly basis.

3.3 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new throwaway filters in units at Substantial Completion.

3.4 DEMONSTRATION

A. Demonstrate unit operation and maintenance.

B. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Owner of training date.

3.5 PROTECTION OF FINISHED WORK

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION
SECTION 23 81 26

SPLIT SYSTEM AIR CONDITIONING UNITS - A

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air handling unit.
   2. Condensing unit.
   3. Mini-Split – See extended spec section 238126 -B.

B. Related Sections:
   1. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
   4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

D. National Fire Protection Association:

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Electrical requirements with electrical characteristics and connection requirements.
   6. Controls.
   7. Accessories.
   8. Coating.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Performance Ratings: 7.0, Seasonal Energy Efficiency Rating (SEER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils.

B. Cooling and Heating Capacity: Rate in accordance with ARI 365.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

A. Coordinate installation of condensing units with roof structure.

B. Coordinate installation of high wall fan coil units with building structure.
1.10  WARRANTY
A. Furnish five year manufacturer's warranty for compressors.

1.11  MAINTENANCE SERVICE
A. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
B. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 8 hours.

1.12  MAINTENANCE MATERIALS
A. Furnish one set for each unit of filters.

PART 2 - PRODUCTS

2.1  AIR HANDLING UNIT
A. General: Indoor, direct-expansion. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with a condensate pump.
B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impacted polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
C. Fans
1. Fan shall be tangential belt-drive-blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard.
2. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.
D. Coil
1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
2. Shall be dipped in Bronz-Glow coating.
E. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 2-speed.
F. Controls:
1. Provide system matched programmable digital thermostats.
   a. Furnish space temperature control with setpoint adjustment for control of unit and equipped with override button for programmed timed override of 2 hours.
G. Filters: Units shall have filter track with factory-supplied cleanable filters.
H. Electrical Requirements: See Division 26 requirements. Power and control connections shall have terminal block connections.

I. Refrigerant Lines: The fan coil units shall have rotatable refrigerant lines for penetration through the walls using flare connections. All units shall have flare connections and a 90-degree suction elbow shall be provided for rear connection.

J. 5 ton units to be variable speed. 100% unload to 40% with 256 stages at unloading. 6 - 7.5 ton units to have VFD controlled fans.

2.2 CONDENSING UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, reversing valve, motors, and drives.

C. Compressor: Single refrigeration circuit with rotary or hermetic reciprocating type compressor, resiliently mounted, with positive lubrication, and internal motor overload protection.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum or copper fins, factory leak and pressure tested.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.


G. Condensing Unit Accessories: Furnish the following accessories:
   1. Time delay relay.
   2. Anti-short cycle timer.
   3. Disconnect switch.
   5. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
   6. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following for each circuit:
   1. Charge of compressor oil.
   2. Holding charge of refrigerant.
   3. Replaceable core type filter drier.
   4. Shut-off valves on suction and liquid piping.
   5. Liquid line solenoid valve.
   6. Charging valve.
   7. Oil level sight glass.
   8. Hot gas muffler.
   9. Pressure relief device.

I. Refrigerant: Furnish charge of refrigerant puron 410.
J. Evaporator Coil, Condenser Coil, Interconnecting Piping and Cabinets:
   1. Coil and coating material shall pass a minimum 6000 hour salt spray in accordance with ASTM standard B117.85.
   2. Coating film shall be effective in PH range 7-1-14.
   3. Product shall be a complex chain linked polyelastomer material with properties including 4000 PSI tensile strength and 250% flexibility.
   5. Coating shall have a minimum 5 year manufacturer’s warranty.
   6. Coating can be field repaired, and touch-up material available in aerosol form.

K. 6 – 7.5 ton units to be dual circuit units.

2.3 CONTROLS
   A. Thermostat Spec Stat: Remote space thermostat with single stage cooling/heating. Furnish system selector switch off/cool/heat/fan to be factory matched to equipment.

2.4 ELECTRICAL CHARACTERISTICS AND COMPONENTS
   A. Electrical Characteristics: In accordance with Division 26.
   B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify location for unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT
   A. Install unit on detailed pedestal.
   B. Install condensate piping and route from fan coil to condensate drainage system. Insulate condensate piping with ½ inch pipe insulation. 100% glued to exterior of building.
   C. Install components furnished loose for field mounting.
   D. Install connection to electrical power wiring in accordance with Division 26.

3.3 INSTALLATION - CONDENSING UNIT
   A. Install condensing unit on new exterior equipment pad. See plan.
   B. Bolt unit to pad in compliance with manufacturers recommendation and specifications set forth in the Florida Building Code, Mechanical.
   C. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit.
   D. Install electrical devices furnished loose for field mounting.
   E. Install control wiring between fan coil unit, heat pump unit, and field installed accessories.
F. Install connection to electrical power wiring in accordance with Division 26.

3.4 MANUFACTURER'S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

A. Vacuum clean coils and inside of unit cabinet.

B. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

A. Demonstrate fan coil unit operation and maintenance.

B. Demonstrate starting, maintenance, and operation of heat pump unit.

C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION
SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONING UNITS - B

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Air handling unit – Casset ceiling mount and wall mount.
   2. Heat pump heat recovery unit.
   3. Multi-zone selector box.

B. Related Sections:
   1. Section 232300 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
   4. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

C. National Electrical Manufacturers Association:
   1. NEMA MG 1 - Motors and Generators.

D. National Fire Protection Association:

1.3 SUBMITTALS

A. Division 1 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data indicating:
   1. Cooling and heating capacities.
   2. Dimensions.
   3. Weights.
   4. Rough-in connections and connection requirements.
   5. Electrical requirements with electrical characteristics and connection requirements.
   6. Controls.
   7. Accessories.

C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
E. Manufacturer’s Field Reports: Submit start-up report for each unit.

1.4 CLOSEOUT SUBMITTALS

A. Division 1 - Execution Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of controls installed remotely from units.

C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.5 QUALITY ASSURANCE

A. Performance Ratings: 7.0, Seasonal Energy Efficiency Rating (SEER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils.

B. Cooling and Heating Capacity: Rate in accordance with ARI 365.

C. Sound Rating: Measure in accordance with ARI 270.

D. Insulation and adhesives: Meet requirements of NFPA 90A.

E. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.

B. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.

C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 COORDINATION

A. Coordinate installation of condensing units with roof structure.

B. Coordinate installation of high wall fan coil units with building structure.
1.10 WARRANTY
   A. Furnish five year manufacturers warranty for compressors, selector box, refrigerant leaks, refrigerant and fan coil unit.

1.11 MAINTENANCE SERVICE
   A. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
   B. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period. Furnish capability of response time within 8 hours.

1.12 MAINTENANCE MATERIALS
   A. Furnish three sets of filters for each indoor unit.

PART 2 - PRODUCTS
2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS
   A. Design basis is Daikin mini – VRV IV Series.
   B. Product Description: Split system consisting of ceiling fan coil casset or wall fan coil unit, heat recovery heat pump unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, reversing valve, and refrigeration specialties. Provide an internal condensate pump with self contained controls. Provide with wired wall mounted thermostats for each internal mini split AHU in each space.
   C. Substitutions considered.

2.2 FAN COIL UNIT
   A. General: Indoor, direct-expansion, 2x2 ceiling mounted and wall-mounted fan coil. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall or ceiling mounting bracket and mounting hardware. Condensate pump and one or four way air distribution.
   B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impacted polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
   C. Fans
      1. Fan shall be tangential direct-drive-blower type with air intake at the upper front face of the unit and discharge at the bottom front or side discharge for ceiling mounted type unit. Automatic, motor-driven vertical air sweep shall be provided standard on wall mounted type.
      2. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.
D. Coil
   1. Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header with internal l condensate pump unit.

E. Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be multi-speed.

F. Controls shall consist of a microprocessor-based control system, which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 64F to 84F. The unit shall have the following functions as a minimum.
   1. Provide system matched programmable digital thermostats.
   2. An automatic restart after power failure at the same operating conditions as at failure.
   3. A timer function to provide a minimum 24-hour timer cycle for system Auto. Start/Stop.
   4. Temperature-sensing controls shall sense room-air temperature. Indoor-air high discharge temperature shutdown shall be provided.
   5. Indoor coil freeze protection.
   6. Wired remote control to enter set points and operating conditions.
   7. Auto Stop features shall have integral setback control.
   8. Automatic airsweep control to provide on or off activation of air sweep louvers or fixed for ceiling mounting units.
  10. Fan only operation shall provide room air circulation when no cooling is required.
  11. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
  12. Fan speed control shall be user-selectable: high, low or microprocessor automatic operation during all operating modes.
  13. A time delay shall prevent compressor restart in less than 3 minutes.

G. Filters: Units shall have filter track with factory-supplied cleanable filters or throw away. If throw away, provide three sets per indoor unit.

H. Electrical Requirements: See Division 26 requirements. Power and control connections shall have terminal block connections.

I. Refrigerant Lines: The fan coil units shall have rotatable refrigerant lines for penetration through ceiling or the walls using flare connections. All units shall have flare connections and a 90-degree suction elbow shall be provided for rear connection.

2.3 HEAT PUMP HEAT RECLAIM UNIT

A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.

B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, reversing valve, motors, and drives.
C. Compressor: Single refrigeration circuit with rotary or hermetic reciprocating type compressor, resiliently mounted, with positive lubrication, and internal motor overload protection. Compressors to be inverter duty with one fixed type constant run compressor.

D. Condenser Coil: Constructed of copper tubing mechanically bonded to aluminum or copper fins, factory leak and pressure tested. Provide Sea Coast coating on entire unit to include casing and coils.

E. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.


G. Condensing Unit Accessories: Furnish the following accessories:
   1. Time delay relay.
   2. Anti-short cycle timer.
   3. Disconnect switch.
   5. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
   6. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
   7. Suction and discharge pressure gauges.

H. Refrigeration specialties: Furnish the following for each circuit:
   1. Charge of compressor oil.
   2. Holding charge of refrigerant.
   3. Replaceable core type filter drier.
   4. Shut-off valves on suction and liquid piping.
   5. Liquid line solenoid valve.
   6. Charging valve.
   7. Oil level sight glass.
   8. Hot gas muffler.
   9. Pressure relief device.

I. Refrigerant: Furnish charge of refrigerant R-410 A.

2.4 CONTROLS

A. Thermostat: Remote space thermostat with single stage cooling/heating. Furnish system selector switch off/cool/heat/fan to be factory matched to equipment.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Electrical Characteristics: In accordance with Division 26.

B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify heat pump heat recovery unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT (MS)

A. Install fan coil unit on wall or in ceiling.
B. Install condensate piping and route from fan coil to condensate drainage system. Insulate condensate piping with ½ inch minimum pipe insulation Armaflex or equal.
C. Install components furnished loose for field mounting.
D. Install connection to electrical power wiring in accordance with Division 26.

3.3 INSTALLATION - CONDENSING UNIT

A. Install heat pump unit on concrete slab, per manufacturer’s instructions. Bolt down per Florida building code and plans. Furnish new concrete equipment pad.
B. Bolt heat pump unit to concrete slab structure in compliance with hurricane tie-down specifications set forth in the Florida Building Code, Mechanical.
C. Install refrigerant piping from unit to heat pump unit and distribution box. Install refrigerant specialties furnished with unit. Flash piping through wall for zero leakage, as detailed and required on Drawings.
D. Install electrical devices furnished loose for field mounting.
E. Install control wiring between fan coil unit, heat pump unit, and field installed accessories.
F. Install connection to electrical power wiring in accordance with Division 26.

3.4 MANUFACTURER’S FIELD SERVICES

A. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.
B. Furnish factory installation review prior and post construction before start up.

3.5 CLEANING

A. Vacuum clean coils and inside of unit cabinet.
B. Install new throwaway filters or clean permanent filters in units at Substantial Completion.

3.6 DEMONSTRATION

A. Demonstrate fan coil unit operation and maintenance.
B. Demonstrate starting, maintenance, and operation of heat pump heat recovery unit.
C. Furnish services of manufacturer’s technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION
SECTION 260511
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes the following:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Common electrical installation requirements.

1.3 DEFINITIONS
B. EPDM: Ethylene-propylene-diene terpolymer rubber.
C. NBR: Acrylonitrile-butadiene rubber.

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

1.5 QUALITY ASSURANCE
A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.6 COORDINATION
A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2- PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 SLEEVES FOR RACEWAYS AND CABLES

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

B. Cast-Iron Pipe Sleeves: Cast or fabricated “wall pipe,” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in other divisions of specifications.

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers:

   a. Advance Products & Systems, Inc.

   b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of race or cable.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 – EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, wireways, cable trays, or busways penetrate concrete slabs, gypsum board wall, sum concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Coordinate sleeve selection and application with selection and application of firestopping.
C. 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.
D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
E. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).
F. 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.
G. Cut sleeves to length for mounting flush with both surfaces of walls.
H. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.
I. Size pipe sleeves to provide ¼-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
J. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
K. 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.
L. 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 Division 7 Section “Through-Penetration Firestop Systems.”

M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

N. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Penetrations: Install cast-iron “wall pipes” for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 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 other divisions of specifications.

3.5 FIELD QUALITY CONTROL

A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

END OF SECTION
SECTION 260521
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2.2 CONDUCTORS AND CABLES

A. Manufacturers:
2. General Cable Corporation.

B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

C. Conductor Material: Copper complying with NEMA WC 5; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:
1. AFC Cable Systems, Inc.
2. AMP Incorporated/Tyco International.
3. Hubbell/Anderson.
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M Company; Electrical Products Division.

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 AND INSULATION APPLICATIONS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspaces: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Underground Feeders and Branch Circuits: Type THHN/THWN, single conductors in raceway.

I. Fire Alarm Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

A. Wires and cables shall be in conduit.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Identify and color-code conductors and cables according to Division 16 Section "Electrical Identification."

3.3 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. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

   2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

B. Test Reports: Prepare a written report to record the following:

   1. Test procedures used.

   2. Test results that comply with requirements.

   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION
SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes:
      1. Hangers and supports for electrical equipment and systems.
      2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS
   A. Delegated Design: Design supports for multiple raceways, including comprehensive
      engineering analysis by a qualified professional engineer, using performance requirements and
      design criteria indicated.
   B. Design supports for multiple raceways capable of supporting combined weight of supported
      systems and its contents.
   C. Design equipment supports capable of supporting combined operating weight of supported
      equipment and connected systems and components.
   D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads
      calculated or imposed for this Project, with a minimum structural safety factor of five times the
      applied force.

1.3 SUBMITTALS
   A. Product Data: For steel slotted support systems.
   B. Shop Drawings: Show fabrication and installation details and include calculations for the
      following:
      1. Trapeze hangers. Include Product Data for components.
      2. Steel slotted channel systems. Include Product Data for components.
      3. Equipment supports.
   C. Welding certificates.

1.4 QUALITY ASSURANCE
   A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding
      Code - Steel."
   B. Comply with NFPA 70.
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. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway Supports: As described in NECA 1 and NECA 101.

C. Conduit Support Devices: Steel and malleable-iron hangers, threaded rods, galvanized “U” channels, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported. Raceway support shall be rigid to prevent horizontal movement.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. 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) MKT Fastening, LLC.
         4) 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) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

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.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways: 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.

1. Secure raceways 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 (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70. Raceway
support shall be rigid to prevent horizontal movement. Outlet and junction boxes in ceiling space shall have independent support. Support all conduits within (3) feet from boxes.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
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 by means that meet anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

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

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) 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 (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer’s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer’s written instructions.

3.5 PAINTING

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

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION
SECTION 260533
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
B. Related Sections include the following:
   1. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
   2. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS
A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquid tight flexible metal conduit.
E. LFNC: Liquid tight flexible nonmetallic conduit.
F. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS
A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

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.

1.6 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 METAL CONDUIT AND TUBING

A. Manufacturers:
1. Alflex Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Electri-Flex Co.
4. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
5. LTV Steel Tubular Products Company.
7. O-Z Gedney; Unit of General Signal.
8. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.


E. Plastic-Coated IMC and Fittings: NEMA RN 1.

F. EMT and Fittings: ANSI C80.3.
1. Fittings: Compression type.

G. FMC: Zinc-coated steel.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

2.4 METAL WIREWAYS

A. Manufacturers:

1. Hoffman.
2. Square D.

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 for dry location. NEMA 3R for outdoor locations.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Hinged type.

F. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
10. Spring City Electrical Manufacturing Co.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, NEMA-3R for exterior location, with continuous hinge cover and flush latch.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer’s standard enamel.

G. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer’s standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer’s standard prime-coat finish ready for field painting.

B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer’s standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:
   1. Exposed: Rigid steel.
   2. Concealed: Rigid steel.
   3. Underground, Run: RNC. PVC Schedule 40. Change from nonmetallic tubing (including ells) to rigid steel conduit or IMC before rising above the floor. Primary and secondary
power runs shall be encased in concrete. Provide 3" thick envelope around conduits. Concrete encasements are required for conduit runs property line to transformer, transformer to building and between buildings. Concrete encasements are not required for branch circuits such as site lighting.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
   a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 1/2-inch trade size (DN 16).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
3. EMT conduit: Steel compression type.

3.2 INSTALLATION

A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."

D. Install temporary closures to prevent foreign matter from entering raceways.

E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
4. Change from nonmetallic tubing (including ells) to rigid steel conduit or IMC before rising above the floor.

I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.

1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

J. Join raceways with fittings designed and approved for that purpose and make joints tight.

1. Use insulating bushings to protect conductors.

K. Tighten setscrews of threadless fittings with suitable tools.

L. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

N. Install raceway-sealing fittings at suitable, approved, and accessible locations and fill them with UL-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.

O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
P. **Flexible Connections:** Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

Q. **Surface Raceways:** Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 **PROTECTION**

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 **CLEANING**

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway.
2. Identification for conductors and communication and control cable.
4. Warning labels and signs.
5. Instruction signs.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE


B. Comply with NFPA 70.


1.5 COORDINATION

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 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. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoors use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

   1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.
   5. Provide #12 stainless steel locator wire above tape.

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. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).
E. 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. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and ultraviolet-resistant seal for label.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways Systems: Identify the following systems with color-coded self-adhesive vinyl tape applied in bands at intervals not to exceed 10 feet. Tape shall be 2" wide.

   1. Fire Alarm System: Red.
   2. Emergency power: Orange.
   3. Cable TV: Blue and yellow.
   4. Telecommunication System: Green and yellow.

B. Power-Circuit Conductor Identification: For primary and secondary 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.

C. Conductors to Be Extended in the Future: Attach marker tape 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.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. 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.

G. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

H. 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- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
   d. Transformers.
e. Emergency system boxes and enclosures.
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. Power-generating units.
n. Voice and data cable terminal equipment.
o. Intercommunication and call system.
p. Television/audio components, racks, and controls.
q. Fire-alarm control panel and annunciators.
r. Monitoring and control equipment.
s. Uninterruptible power supply equipment.
t. 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 non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways: Each color band shall completely encircle 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 (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 208/120-V Circuits:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.
4. **Field-Applied, Color-Coding Conductor Tape:** Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) 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. **Aluminum Wraparound Marker Labels and Metal Tags:** Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. **Underground-Line Warning Tape:** During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall. Provide #12 stainless steel locator wire.

J. **Painted Identification:** Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
   a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
   b. Include recommended testing intervals.
1.4 QUALITY ASSURANCE

A. 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 to supervise on-site testing specified in Part 3.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. 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 steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

C. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   3. Connections to Ground Rods at Test Wells: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Dry Type Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and non-current-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 (150 mm) from the foundation.

C. Pad mounted transformer, switches and cable cabinets: Install ground rods and cables as directed by the Power Company.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 2 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Lighting 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.

3.4 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. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) 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.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 2 Section "Underground Ducts and Utility Structures," and shall be at least 12 inches (300 mm) deep, with cover.
1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. 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.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [tinned] bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:

1. Main switchboard: 2 ohms.
2. Power and Lighting Equipment: 5 ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 2 ohm(s).

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION
SECTION 262310
PACKAGED ENGINE GENERATOR

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged diesel engine generators for emergency use with the following features:
   1. Diesel engine.
   2. Diesel fuel-oil system.
   3. Control and monitoring.
   4. Generator overcurrent and fault protection.
   5. Generator, exciter, and voltage regulator.

B. Related Requirements:
   1. Section 264150 “Automatic Transfer Switches” for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Identify fluid drain ports and clearance requirements for proper fluid drain.
   4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
   5. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.3 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Certified test reports.

C. Field quality-control reports.

D. Warranty: For special warranty.
1.4 CLOSEOUT SUBMITTALS
A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.6 WARRANTY
A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components 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 MANUFACTURERS
A. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS
A. B11 Compliance: Comply with B11.19.
B. NFPA Compliance:
   2. Comply with NFPA 70.
   4. Comply with NFPA 110 requirements for Level 1 EPSS.
C. UL Compliance: Comply with UL 2200.
D. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.
E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).
2. Relative Humidity: Zero to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. EPSS Class: Engine generator shall be classified as a Class 96 according to NFPA 110.

D. Service Load: kVA (as shown on drawings).

E. Power Factor: 0.8, lagging.

F. Frequency: 60 Hz.

G. Voltage: 208 V ac (as shown on drawings).

H. Phase: Three-phase, four-wire wye.

I. Induction Method: Naturally aspirated.

J. Governor: Adjustable isochronous, with speed sensing.

K. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

L. Capacities and Characteristics:

   1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.

   2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

M. Engine Generator Performance:

   1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage, from no load to full load.

   2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

   3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency, from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type U, Type 10 system requirements.

2.4 DIESEL ENGINE

A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant, from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant-system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.


a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 12 V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle, with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
   
a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   
b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
   
c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   
   
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   
f. Enclosure and Mounting: NEMA 250, Type 1 wall-mounted cabinet.
2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 30.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Tanks:
   1. Fuel Tank Capacity: Minimum 133 percent of total fuel required for periodic maintenance operations between fuel refills plus fuel for the hours of continuous operation required for the indicated EPSS Class.

2.6 CONTROL AND MONITORING

A. Automatic-Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual-Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 15 minutes, with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

F. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.

G. Control and Monitoring Panel:
1. Digital controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.

2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.

3. Instruments: Located on the control and monitoring panel and viewable during operation.
   a. Engine lubricating-oil pressure gage.
   b. Engine-coolant temperature gage.
   c. DC voltmeter (alternator battery charging).
   d. Running-time meter.
   e. AC voltmeter, connected to a phase selector switch.
   f. AC ammeter, connected to a phase selector switch.
   g. AC frequency meter.
   h. Generator-voltage-adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication as required by NFPA 110 for Level 1 system, including the following:
   a. Cranking control equipment.
   c. Control switch not in automatic position alarm.
   d. Overcrank alarm.
   e. Overcrank shutdown device.
   f. Low water temperature alarm.
   g. High engine temperature pre-alarm.
   h. High engine temperature.
   i. High engine temperature shutdown device.
   j. Overspeed alarm.
   k. Overspeed shutdown device.
   l. Low-fuel main tank.

   1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for the duration required for the indicated EPSS class.

   m. Coolant low-level alarm.
   n. Coolant low-level shutdown device.
   o. Coolant high-temperature prealarm.
   p. Coolant high-temperature alarm.
   q. Coolant low-temperature alarm.
   r. Coolant high-temperature shutdown device.
   s. EPS load indicator.
   t. Battery high-voltage alarm.
   u. Low-cranking voltage alarm.
   v. Battery-charger malfunction alarm.
   w. Battery low-voltage alarm.
   x. Lamp test.
   y. Contacts for local and remote common alarm.
   z. Low-starting air pressure alarm.
   aa. Low-starting hydraulic pressure alarm.
   cc. Air shutdown damper alarm when used.
   dd. Air shutdown damper shutdown device when used.
   ee. Generator overcurrent-protective-device not-closed alarm.
H. Common Remote Panel with Common Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

I. Remote Alarm Annunciator: Comply with NFPA 99. An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low-fuel main tank alarm.
8. Low coolant level alarm.
9. Low-cranking voltage alarm.
10. Contacts for local and remote common alarm.
12. Air shutdown damper when used.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel-supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent protective device not closed.

J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

2. Trip Settings: Selected to coordinate with generator thermal damage curve.
3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Indicate ground fault with other engine generator alarm indications.
2. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six-lead alternator.

E. Range: Provide limited range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Maintain voltage within 20 percent on one step, full load.
3. Provide anti-hunt provision to stabilize voltage.
4. Maintain frequency within 5 percent and stabilize at rated frequency within [two] [five] seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Natural rubber separated by steel shims.
2. Shore A Scale Durometer Rating: 45.
3. Number of Layers: Two.
4. Minimum Deflection: 1 inch (25 mm).

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient, vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch (25 mm).

C. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.


2.11 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, aluminum housing, wind resistant up to 160 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

C. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.12 FUEL OIL STORAGE

A. Comply with NFPA 30.

E. Base-Mounted Double Layer, Diesel Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:
1. Tank level indicator.
2. Capacity: Fuel for 96 hours’ continuous operation at 75 percent rated power output.
3. Vandal-resistant fill cap.
5. Low fuel level sensor: Connect to generator remove annunciator. Alarm at 36 hours.
6. Fill tank with Diesel fuel at completion of project.

2.13 RADIATOR AIRFLOW COOLED LOAD BANK:

A. Radiator Airflow Cooled, Stationary Generator Load Bank designed for permanent installation. Mounted inside Generator enclosure, 100KW, 1.0 power factor, 208V AC, 3-phase, 3-wire, 60 Hertz, Continuous duty cycle, 180°F nominal air temp. rise, Radiator air outflow. Control power shall be internal, from generator. Controls shall operate at 120V via control power transformer circuit.

B. Components: Tubular type, weatherproof, totally enclosed, UL listed, branch circuit magnetic contactors. Current limiting branch circuit fuses.

C. Overheat Protection: Sensor to detect high exhaust air temp above 300°F. Circuits to disconnect load bank on overtemp. Alarm contacts.

D. Enclosure: NEMA type 3R, galvanized steel construction, designed for permanent installation by mounting, directly to engine radiator or within radiator air outflow duct.

E. Load Bank Control: Control panel with control power On-Off push-button or toggle switch, master load control switch, load step switches, overtemp indicator, normal operation indicator. Internal control circuit and input terminals to dump load bank off-line on opening of remote control contacts. Connect to generator exerciser.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner’s written permission.

B. Comply with NECA 1 and NECA 404.

C. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.

D. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install packaged engine generator with elastomeric isolator pads, restrained spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure engine generator to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

H. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.2 CONNECTIONS

A. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

B. Connect engine exhaust pipe to engine with flexible connector.
C. Connect fuel piping to engines with a gate valve and union and flexible connector.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

F. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.3 IDENTIFICATION

A. Identify system components according to Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" subparagraphs below, as specified in the NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.
   a) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
   b) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Verify phase rotation, phasing, and synchronized operation as required by the application.
4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
5) Perform vibration test for each main bearing cap.
6) Conduct performance test according to NFPA 110.
7) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

D. Coordinate tests with tests for transfer switches, and run them concurrently.
E. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
I. Remove and replace malfunctioning units and retest as specified above.
J. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component, indicating satisfactory completion of tests.
3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

B. Factory authorized technician shall be present at AHCA inspection to demonstrate function and operational engine/generator set. Provide test result for AHCA inspector reviewer.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes the following:
      1. Distribution panelboards.
      2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS
   A. EMI: Electromagnetic interference.
   B. GFCI: Ground-fault circuit interrupter.
   C. RFI: Radio-frequency interference.
   D. RMS: Root mean square.
   E. SPDT: Single pole, double throw.

1.4 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. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

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. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 EXTRA MATERIALS:

A. All panelboards shall be keyed the same. Provide two additional keys for each panel.
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. Square “D”.
   b. Eaton.
   c. GE.

2.2 MANUFACTURED UNITS

A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.
   a. Outdoor Locations: NEMA 250, Type 3R.
   b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   c. Kitchen Area: NEMA 250, Type 4 stainless steel.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

6. 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.

3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.

4. Extra-Capacity Neutral Bus: Neutral bus rated 100 percent of phase bus.

5. Split Bus: Vertical buses divided into individual vertical sections.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.

2. Ground Lugs and Bus Configured Terminators: Compression type.

3. Feed-Through Lugs: Mechanical 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.

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 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with rating to meet available fault currents.


B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Furnish portable test set to test functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."

C. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.
   1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

H. 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 16 Section "Electrical Identification."

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.

3.3 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Straight-blade convenience receptacles.
   2. USB charger devices.
   3. GFCI receptacles.
   4. Toggle switches.
   5. Wall switch sensor light switches with dual technology sensors.
   7. Wall plates.

1.2 DEFINITIONS

A. Abbreviations of Manufacturers' Names:
   1. Cooper: Copper Wiring Devices; Division of Cooper Industries, Inc.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Samples: One for each type of device and wall plate specified, in each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:
   1. Receptacles: Match plug configurations.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.3 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 12 V, 2.0 A, USB Type A; Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 1310, and FS W-C-596.
   2. USB Receptacles: Dual, Type A.
   3. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.4 GFCI RECEPTACLES

A. General Description:
   1. 125 V, 20 A, straight blade, non-feed-through type, tamper resistant.
   2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles:

C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:
D. Isolated-Ground Duplex SPD Convenience Receptacles:
   1. Description:
      a. Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.
      b. 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.

2.5 TOGGLE SWITCHES
A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
B. Switches, 120/277 V, 20 A:
   1. Single Pole, two pole, three way and four way, quiet type, 20 Amp, commercial duty.
C. GFCI, Non-Feed-Through Type, Convenience Receptacles: Square face, 125 V, 20A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-15R, UL 498, and UL 943 Class A.

2.6 WALL SWITCH SENSOR LIGHT SWITCH, DUAL TECHNOLOGY
A. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.
   1. Connections: Provisions for connection to BAS.
   4. Rated 960 W at 120-V ac for tungsten lighting, 10 A at 120-V ac or 10 A at 277-V ac for fluorescent or LED lighting, and 1/4 hp at 120-V ac.
   5. Integral relay for connection to BAS.
   6. Adjustable time delay of 10 minutes.
   7. Able to be locked to Automatic-On mode.
   8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux).
   9. Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.7 WALL PLATES
A. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, thermoplastic with lockable cover.
2.8 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color "Almond".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. 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 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 right 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. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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 (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by 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:
   1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

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. Verify that dimmers used for fan-speed control are listed for that application.
   3. 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. GFCI Receptacles: Install non-feed-through-type GFCI receptacles.

3.2 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:
   1. Tests for Convenience Receptacles:
      a. Line Voltage: Acceptable range is 105 to 132 V.
      b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
      c. Ground Impedance: Values of up to 2 ohms are acceptable.
      d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
      e. Using the test plug, verify that the device and its outlet box are securely mounted.
f. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 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.
      4. Enclosures.

1.3 DEFINITIONS
   A. GD: General duty.
   B. GFCI: Ground-fault circuit interrupter.
   C. HD: Heavy duty.
   D. RMS: Root mean square.
   E. SPDT: Single pole, double throw.

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. Shop Drawings: Diagram power, signal, and control wiring.
   C. Field quality-control test reports including the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Manufacturer’s field service report.

E. 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 1 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 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.

1.7 EXTRA MATERIALS

B. 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. Fuses: 20% of each type utilized.

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:
   1. Square “D”.
   2. Eaton.
   3. GE.

B. Fusible Switch, 600 A 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, 600 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
   3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Manufacturers:
   1. Eaton Corporation; Cutler-Hammer Products.
   2. General Electric Co.; Electrical Distribution & Control Division.

B. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.


C. Molded-Case Circuit-Breaker Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical style 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.
2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.
5. Indoor locations: NEMA-1.

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 16 Section "Electrical Supports and Seismic Restraints," and concrete materials and installation requirements are specified in Division 3.

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 16 Section "Electrical Supports and Seismic Restraints."

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 16 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Electrical Identification."
3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer’s certification.

B. Perform the following field tests and inspections and prepare test reports:

1. Test mounting and anchorage devices according to requirements in Division 16 Section "Electrical Supports and Seismic Restraints."
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Infrared Scanning:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
   b. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
   c. Instruments, Equipment and Reports:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

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

3.7 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION
SECTION 263353

STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Three-phase, on-line, double-conversion, static-type, UPS units with the following features:
   a. Surge suppression.
   b. Rectifier-charger.
   c. Inverter.
   d. Controls and indications.
   e. Static bypass transfer switch.
   f. Output distribution section.
   g. Battery and battery disconnect device.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of UPS.

B. Shop Drawings: For UPS.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Show access, workspace, and clearance requirements; details of control panels; and battery arrangement.
4. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product, from manufacturer.

B. Factory test reports.

C. Product test reports.

D. Field quality-control reports.

E. Sample warranties.
1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.5 QUALITY ASSURANCE
   A. Power Quality Specialist Qualifications: A registered professional electrical engineer or engineering technician, currently certified by the National Institute for Certification in Engineering Technologies, NICET Level 4, minimum, experienced in performance testing UPS installations and in performing power quality surveys similar to that required in "Performance Testing" Article.

1.6 WARRANTY
   A. Special Battery Warranties: Manufacturer and Installer agree to repair or replace UPS system storage batteries that fail in materials or workmanship within specified warranty period.
   B. Special UPS Warranties: Specified form in which manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within special warranty period.
      1. Special Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. UL Compliance: Listed and labeled by an NRTL to comply with UL 1778.
   B. NFPA Compliance: UPS components shall be listed and labeled by an NRTL as suitable for installation in computer rooms according to NFPA 75.
   C. The UPS shall perform as specified in this article while supplying rated full-load current, composed of any combination of linear and nonlinear load, up to 100 percent nonlinear load with a maximum load crest factor of 3.0, under the following conditions or combinations of the following conditions:
      1. Inverter is switched to battery source.
      2. Steady-state ac input voltage deviates up to plus or minus 15 percent from nominal voltage.
      3. Steady-state input frequency deviates up to plus or minus 5 percent from nominal frequency.
      4. THD of input voltage is 15 percent or more with a minimum crest factor of 3.0, and the largest single harmonic component is a minimum of 5 percent of the fundamental value.
      5. Load is 100 percent unbalanced continuously.
   D. Minimum Duration of Supply: If battery is sole energy source supplying rated full-load UPS current at 80 percent power factor, duration of supply is 11 minutes.
E. Input Voltage Tolerance: System steady-state and transient output performance remains within specified tolerances when steady-state ac input voltage varies plus 10 percent and minus 20 percent from nominal voltage.

F. AC Output-Voltage Regulation for Loads 100 Percent Unbalanced: Maximum of plus or minus 2 percent over the full range of battery voltage.

G. AC Output-Voltage Regulation for Loads 100 Percent Balanced: Maximum of plus or minus 1 percent over the full range of battery voltage.

H. Output Frequency: 60 Hz, plus or minus 0.1 percent over the full range of input voltage, load, and battery voltage.

I. Limitation of harmonic distortion of input current to the UPS shall be as follows:
   1. Description: Rectifier-charger circuits shall limit THD to 5 percent, maximum, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30. Provide tuned harmonic filter if required to meet harmonic distortion limit.
   2. Description: THD is limited to a maximum of 32 percent, at rated full-load UPS current, for power sources with X/R ratio between 2 and 30.

J. Maximum Harmonic Content of Output-Voltage Waveform: 5 percent rms total and 3 percent rms for any single harmonic, for rated full load with THD up to 50 percent, with a load crest factor of 3.0.

K. Minimum Overload Capacity of UPS at Rated Voltage: 125 percent of rated full load for 10 minutes, 200 percent for 60 seconds in normal operation, and 150 percent for 30 seconds in battery operating mode.

L. Maximum Output-Voltage Transient Excursions from Rated Value: For the following instantaneous load changes, stated as percentages of rated full UPS load, voltage shall remain within stated percentages of rated value and recover to, and remain within, plus or minus 2 percent of that value within 50 ms:
   1. 50 Percent: Plus or minus 3 percent.
   2. 100 Percent: Plus or minus 5 percent.
   3. Loss of AC Input Power: Plus or minus 1 percent.
   4. Restoration of AC Input Power: Plus or minus 1 percent.

M. Output Power Factor Rating: Loads with power factor of 0.9 leading to 0.8 lagging shall not require derating of the UPS. For loads with power factors outside this range, derate the UPS output as follows:
   1. Derate the UPS a maximum of 5 percent for 0.7 PF lagging.
   2. Derate the UPS a maximum of 10 percent for 0.6 PF lagging.
   3. Derate the UPS a maximum of 15 percent for 0.5 PF lagging.
   4. Derate the UPS a maximum of 20 percent for a range of 0.4 to 0.1 PF lagging.

N. EMI Emissions: Comply with FCC rules and regulations and with 47 CFR 15 for Class A equipment.
2.2 UPS SYSTEMS

A. Description: Self-contained, battery backup device and accessories that provides three-phase electrical power in the event of failure or sag in the normal power system.

B. Manufacturers: Eaton

C. Electronic Equipment: Solid-state devices using hermetically sealed, semiconductor elements. Devices include rectifier-charger, inverter, static bypass transfer switch, and system controls.

D. Enclosures: Comply with NEMA 250, Type 1, unless otherwise indicated.

E. Control Assemblies: Mount on modular plug-ins, readily accessible for maintenance.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Output Circuit Neutral Bus, Conductor, and Terminal Ampacity: Rated phase current times a multiple of 1.73, minimum.

2.3 SURGE SUPPRESSION

A. Protect internal UPS components from surges that enter at each ac power input connection including main disconnect switch, static bypass transfer switch. Protect rectifier-charger, inverter, controls, and output components.

1. Use factory-installed surge suppressors tested according to IEEE C62.41.1.

2. Additional Surge Protection: Protect internal UPS components from low-frequency, high-energy voltage surges described in IEEE C62.41.1 and IEEE C62.41.2. Design the circuits connecting with external power sources and select circuit elements, conductors, conventional surge suppressors, and rectifier components and controls so input assemblies will have adequate mechanical strength and thermal and current-carrying capacity to withstand stresses imposed by 400-Hz, 180 percent voltage surges described in IEEE C62.41.1 and IEEE C62.41.2.

2.4 RECTIFIER-CHARGER

A. Capacity: Adequate to supply the inverter during rated full output load conditions and simultaneously recharge the battery from fully discharged condition to 95 percent of full charge within 10 times the rated discharge time for duration of supply under battery power at full load.

B. Output Ripple: Limited by output filtration to less than 0.5 percent of rated current, peak to peak.

C. Control Circuits: Immune to frequency variations within rated frequency ranges of normal and emergency power sources.

1. Response Time: Field adjustable for maximum compatibility with local generator-set power source.
2.5 CONTROLS AND INDICATIONS

A. Description: Group displays, indications, and basic system controls on a common control panel on front of UPS enclosure.

B. Minimum displays, indicating devices, and controls include those in lists below. Provide sensors, transducers, terminals, relays, and wiring required to support listed items. Alarms include audible signals and visual displays.

C. Indications:

1. Quantitative indications shall include the following:

   a. Input voltage, each phase, line to line.
   b. Input current, each phase, line to line.
   c. Bypass input voltage, each phase, line to line.
   d. Bypass input frequency.
   e. System output voltage, each phase, line to line.
   f. System output current, each phase.
   g. System output frequency.
   h. DC bus voltage.
   i. Battery current and direction (charge/discharge).
   j. Elapsed time discharging battery.

2. Basic status condition indications shall include the following:

   a. Normal operation.
   b. Load-on bypass.
   c. Load-on battery.
   d. Inverter off.
   e. Alarm condition.

3. Alarm indications shall include the following:

   a. Bypass ac input overvoltage or undervoltage.
   b. Bypass ac input overfrequency or underfrequency.
   c. Bypass ac input and inverter out of synchronization.
   d. Bypass ac input wrong-phase rotation.
   e. Bypass ac input single-phase condition.
   f. Bypass ac input filter fuse blown.
   g. Internal frequency standard in use.
   h. Battery system alarm.
   i. Control power failure.
   j. Fan failure.
   k. UPS overload.
   l. Battery-charging control faulty.
   m. Input overvoltage or undervoltage.
   n. Input transformer overtemperature.
   o. Input circuit breaker tripped.
   p. Input wrong-phase rotation.
   q. Input single-phase condition.
Approaching end of battery operation.
Battery undervoltage shutdown.
Maximum battery voltage.
Inverter fuse blown.
Inverter transformer overtemperature.
Inverter overtemperature.
Static bypass transfer switch overtemperature.
Inverter power supply fault.
Inverter transistors out of saturation.
Identification of faulty inverter section/leg.
Inverter output overvoltage or undervoltage.
UPS overload shutdown.
Inverter current sensor fault.
Inverter output contactor open.
Inverter current limit.

Controls shall include the following:

- Inverter on-off.
- UPS start.
- Battery test.
- Alarm silence/reset.
- Output-voltage adjustment.

Dry-form "C" contacts shall be available for remote indication of the following conditions:

1. UPS on battery.
2. UPS on-line.
3. UPS load-on bypass.
4. UPS in alarm condition.
5. UPS off (maintenance bypass closed).

Emergency Power off Switch: Capable of local operation and operation by means of activation by external dry contacts.

SOURCE QUALITY CONTROL

Factory test complete UPS system before shipment. Include the following:

1. Test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
4. Overload test.
5. Power failure test.

Report test results. Include the following data:

1. Description of input source and output loads used. Describe actions required to simulate source load variation and various operating conditions and malfunctions.
2. List of indications, parameter values, and system responses considered satisfactory for each test action. Include tabulation of actual observations during test.
3. List of instruments and equipment used in factory tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the UPS.

B. Comply with NECA 1.

C. Wiring Method: Install cables in raceways.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

F. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated. Apply oxide inhibitor on battery terminals.

G. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each battery cell individually.

3.2 GROUNDING

A. Separately Derived Systems: If not part of a listed power supply for a data-processing room, comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Separately Derived Systems: If part of a listed power supply for a data-processing room, comply with manufacturer's written instructions that include grounding requirements in excess of NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near isolation transformer. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Inspect interiors of enclosures, including the following:
   a. Inspect anchorage, alignment, grounding, and required clearances.
   b. Component type and labeling verification.
   c. Ratings of installed components.

2. Test electrical and mechanical interlock systems for correct operation and sequencing.

3. Inspect bolted electrical connections for high resistance using one or more of the following methods:
   a. Use of low-resistance ohmmeter according to Section 7.22.2.2 of NETA ATS.
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or Table 100.12 of NETA ATS.
   c. Perform thermographic survey according to Section 9 of NETA ATS.

4. Test static transfer from inverter to bypass and back. Use normal load, if possible.

5. Test dc undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.

6. Verify synchronizing indicators for static switch and bypass switches.

7. Test insulated-case and molded-case breakers.
   a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 of NETA ATS.
   b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components, follow manufacturer's recommendation.
   c. Use primary current injection to determine long time and short time, ground fault, and instantaneous pickup. Use secondary current injection to test trip functions.
   d. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
   e. Verify operation of charging mechanism.
   f. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function, and trip unit battery condition. Reset all trip logs and indicators.

8. Test automatic transfer switches.
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable, according to Section 7.22.3.1 of NETA ATS.
   b. Perform insulation-resistance tests on all control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated
cable. Test duration shall be one minute. For units with solid-state components or
for control devices that cannot tolerate the applied voltage, follow manufacturer's
recommendation.

c. Perform a contact/pole-resistance test.
d. Verify settings and operation of control devices.
e. Calibrate and set all relays and timers according to Section 7.9 of NETA ATS.
f. Verify phase rotation, phasing, and synchronized operation as required by the
application.
g. Perform automatic transfer tests.

1) Simulate loss of normal power.
2) Return to normal power.
3) Simulate loss of emergency power.
4) Simulate all forms of single-phase conditions.

h. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Time delay on transfer.
3) Alternative source voltage-sensing and frequency-sensing relays.
4) Automatic transfer operation.
5) Interlocks and limit switch function.
6) Time delay and retransfer on normal power restoration.

9. Test direct current system's batteries.

a. Verify adequacy of battery support racks, mounting, anchorage, alignment,
grounding, and clearances.
b. Inspect spill containment installation. Measure charger float and equalizing voltage
levels. Adjust to battery manufacturer's recommended settings.
c. Verify all charger functions and alarms.
d. Measure each cell voltage and total battery voltage with charger energized and in
float mode of operation.
e. Perform a load test according to manufacturer's published data or IEEE 450.
f. Measure charger float and equalizing voltage levels. Adjust to battery
manufacturer's recommended settings.
g. Test values.

1) Compare bolted connection resistance values to values of similar
connections. Investigate values that deviate from those of similar bolted
connections by more than 50 percent of the lowest value.
2) Charger float and equalize voltage levels shall be according to battery
manufacturer's published data.
3) The results of charger functions and alarms shall be according to
manufacturer's published data.
4) Cell voltages shall be within 0.05 V of each other or according to
manufacturer's published data.
5) Compare bolted connection resistance values to values of similar
connections. Investigate values that deviate from those of similar bolted
connections by more than 50 percent of the lowest value.
6) Cell internal ohmic values (resistance, impedance, or conductance) shall not vary by more than 25 percent between identical cells that are in a fully charged state.

7) Results of load tests shall be according to manufacturer's published data or IEEE 450.

10. Test communication of status and alarms to remote monitoring equipment.
11. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
   a. Simulate malfunctions to verify protective device operation.
   b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
   c. Test harmonic content of input and output current at 25, 50, and 100 percent of rated loads.
   d. Test output voltage under specified transient-load conditions.
   e. Test efficiency at 50, 75, and 100 percent of rated loads.
   f. Test remote status and alarm panel functions.
   g. Test battery-monitoring system functions.

C. The UPS system will be considered defective if it does not pass tests and inspections.

D. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

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 the UPS.

END OF SECTION
SECTION 264113
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes lightning protection for buildings.

1.2 SUBMITTALS
   A. Product Data: For air terminals and mounting accessories indicated.
   B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
   C. Qualification data.
   D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.
   E. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE
   A. Installer Qualifications: Engage an experienced installer who is NRTL listed or who is certified by LPI as a Master Installer/Designer.
   B. Listing and Labeling: As defined in NFPA 780, Article 2-2, "Definitions."
   C. Provide UL Master Label.
   D. Provide LPI certification of system.
   E. Provide ETL Master Label indicating system complies with specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A.
   B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Harger Lightning Protection, Inc.
5. Independent Protection Company, Inc.
7. Thompson Lightning Protection, Inc.
8. Preferred Lightning Protection.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class I copper, unless otherwise indicated.

C. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 16 Section "Grounding and Bonding" and standards referenced in this Section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

C. Conceal the following conductors:
   1. System conductors.
   2. Down conductors.
   3. Interior conductors.
   4. Conductors within normal view from exterior locations at grade within 200 feet (60 m) of building.
   5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

E. Air Terminals, 12" long minimum.

F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

G. A counterpoise installation based on requirements in Division 16 Section "Grounding and Bonding" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.
1. Bond ground terminals to counterpoise conductor.
2. Bond grounded metal bodies on building within 12 feet (3.6 m) of ground to counterpoise conductor.
3. Bond grounded metal bodies on building within 12 feet (3.6 m) of roof to counterpoise conductor or interconnecting loop at eave level or above.

H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot (18-m) intervals.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials. Use copper conductors and air terminals. For aluminum roof use aluminum conductors and air terminals, except use copper for down conductors.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. UL Inspection: Apply for inspection by UL as required to obtain a UL Master Label for system.

END OF SECTION
SECTION 264150
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes automatic transfer switches rated 600 V and less.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   
B. Shop Drawings:
   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Single-Line Diagram: Show connections between transfer switch, power sources, and load.
   3. Electronic type circuit breaker.

1.3 INFORMATIONAL SUBMITTALS
   A. Source quality control reports.
   
B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS
   A. Operation and maintenance data.

1.5 WARRANTY
   A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components 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 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

G. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

2. Short-time withstand capability for 30 cycles.

H. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

I. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

J. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

K. Service-Rated Transfer Switch:

1. Comply with UL 869A and UL 489.
2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
3. In systems with a neutral, the bonding connection shall be on the neutral bus.
4. Provide removable link for temporary separation of the service and load grounded conductors.
5. Surge Protective Device: Service rated.
L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

N. Battery Charger: For generator starting batteries.
   1. Float type, rated 10 A.
   2. Ammeter to display charging current.
   3. Fused ac inputs and dc outputs.

O. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via front access.

P. Enclosures: General-purpose NEMA 250, Type 1 for indoor location and Type 3R for exterior, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

Q. Circuit Breaker: Electronic type 100% rated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
   4. Conductor Connectors: Suitable for use with conductor material and sizes.
   6. Main and Neutral Lugs: Mechanical type.
   7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
   8. Ground bar.
   9. Connectors shall be marked for conductor size and type according to UL 1008.
C. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
   1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

E. Automatic Transfer-Switch Controller Features:
   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
   10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
   11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
   12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is unavailable.

F. Life Safety Branch Automatic Transfer Switch shall have the by-pass feature in compliance with NFPA.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:

   a. Overvoltage.
   b. Undervoltage.
   c. Loss of supply voltage.
   d. Reduction of supply voltage.
   e. Alternative supply voltage or frequency is at minimum acceptable values.
   f. Temperature rise.
   g. Dielectric voltage-withstand; before and after short-circuit test.
   h. Overload.
   i. Contact opening.
   j. Endurance.
   k. Short circuit.
   l. Short-time current capability.
   m. Receptacle withstand capability.
   n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s).
2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
3. Provide workspace and clearances required by NFPA 70.

B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
C. Identify components according to Section 260553 "Identification for Electrical Systems."
D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

F. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

G. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and required clearances.
d. Verify that the unit is clean.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.
b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
c. Verify settings and operation of control devices.
d. Calibrate and set all relays and timers.
e. Verify phase rotation, phasing, and synchronized operation.
f. Perform automatic transfer tests.
g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.


a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

4. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION
SECTION 265100
LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of LED luminaires:

2. Downlight.
3. Recessed linear.
5. Surface mount, linear.
7. Suspended, linear.
8. Suspended, nonlinear.
10. Finishes.
11. Luminaire support.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color Rendering Index.
C. Fixture: See "Luminaire."
D. IP: International Protection or Ingress Protection Rating.
E. LED: Light-emitting diode.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, arranged by designation.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved:

B. Product Certificates: For each type of luminaire.

C. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standards:

1. ENERGY STAR certified.
2. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
3. UL Listing: Listed for damp location.
4. Recessed luminaires shall comply with NEMA LE 4.

C. Rated lamp life of 50,000 hours to L70.

D. Lamps dimmable from 100 percent to 0 percent of maximum light output.

E. Internal driver.

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.


D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports: Sized and rated for luminaire weight.

E. Flush-Mounted Luminaire Support: Secured to outlet box.

F. Wall-Mounted Luminaire Support:
   1. Attached to structural members in walls backing plate attached to wall structural members.
   2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:
   1. Ceiling mount with two 5/32-inch- (4-mm-) diameter aircraft cable supports.
H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire using approved fasteners in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

K. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Exterior luminaires with lamps and ballasts, but not mounted on exterior surfaces of buildings.
   2. Luminaire-mounted photoelectric switches.

B. Related Sections include the following:
   1. Division 16 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 SUBMITTALS

A. Product Data: For each luminaire, arranged in the order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of fixture, including dimensions and verification of indicated parameters.
   2. Luminaire dimensions, effective projected area, details of attaching luminaires, accessories, and installation and construction details.
   3. Luminaire materials.
   4. Photoelectric relays.
   5. Fluorescent and high-intensity-discharge ballasts.
   6. Fluorescent and high-intensity-discharge lamps.
   7. Electrical and energy-efficiency data for ballasts.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Wiring Diagrams: Power, signal, and control wiring.

D. Coordination Drawings: Mounting and connection details, drawn to scale, for exterior luminaires with requirements specified in Division 2 Section "Lighting Poles and Standards."

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires to include in maintenance manuals.
H. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

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

B. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.


D. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate exterior luminaires with mounting and wind load requirements in Division 2 Section “Lighting Poles and Standards.”

1.6 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace luminaires or components of luminaires and lamps that fail in materials or workmanship; corrode; or fade, stain, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude 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.
   a. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   b. Warranty Period for Color Retention: Five years from date of Substantial Completion.

2. Warranty Period for Lamps: Replace LED lamps and fuses that fail within 5 years from date of Substantial Completion.

1.7 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. LED Driver: 10% of each type and rating installed. Furnish at least one of each type.

2. Glass and Plastic Lenses, Cover, and Other Optical Parts: 3% of each type and rating installed. Furnish at least one of each type.

3. LED Panel: 10% of each type and rating installed. Furnish at least one of each type.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide products specified on drawings.

2.2 LUMINAIRES, GENERAL

A. Complying with UL 1572 and listed for installation in wet locations.
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 relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. 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. 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.
J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

2.3 FACTORY FINISHES

A. Field Painting Finish: Manufacturer's standard prime-coat finish ready for field painting.
B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match process and color of pole or support materials specified in Division 2 Section "Lighting Poles and Standards."

C. Factory-Painted Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Interior Surfaces: Apply one coat of bituminous paint on interior of pole, or otherwise treat to prevent corrosion.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected from manufacturer's standard catalog of colors.
   c. Color: As selected by Architect from manufacturer's full range.

D. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

5. Gold Anodic Finish: AA-M32C22A43 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, impregnated color coating 0.018 mm or thicker) complying with AAMA 611.

2.4 SOURCE QUALITY CONTROL

A. Factory test fixtures with ballasts and lamps; certify results for isofootcandle curves, zonal lumen, average and minimum ratios, and electrical and energy-efficiency data for ballasts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lamps in each fixture.
B. Luminaire Attachment: Fasten to indicated structural supports.

C. Adjust luminaires that require field adjustment or aiming.

3.2 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.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):

1. IESNA LM-5.
2. IESNA LM-50.
3. IESNA LM-52.
4. IESNA LM-64.
5. IESNA LM-72.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION
SECTION 270536
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ladder cable tray.
   2. Wire-mesh cable tray.
   4. Trough cable tray.
   5. Fiberglass cable tray.
   6. Cable tray accessories.
   7. Warning signs.

B. Related Requirements:
   1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For each type of cable tray.
C. Delegated-Design Submittal: For seismic restraints.
   1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting seismic restraints.
   3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
B. Field quality-control reports.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

   1. Component Importance Factor: 1.5.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.3 LADDER CABLE TRAY

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

   1. B-line, an Eaton business.
   2. MonoSystems, Inc.

B. Description:

   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: Size as required for actual cable load plus 25% spare for future. 12 inches (300 mm) minimum.
   3. Minimum Usable Load Depth: 4 inches (100 mm).
   4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
   5. Rung Spacing: 6 inches (150 mm) o.c.
   6. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
   7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
   8. No portion of the rungs shall protrude below the bottom plane of side rails.
   9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
   10. Fitting Minimum Radius: 12 inches (300 mm).
   11. Class Designation: Comply with NEMA VE 1, Class 12C.

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12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:
   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      1) Hardware: Galvanized, ASTM B 633.
      1) Hardware: Galvanized, ASTM B 633.
      1) Hardware: Galvanized, ASTM B 633.
   g. Finish: Epoxy-resin paint.
      1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
      2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
      3) Hardware: Chromium-zinc plated, ASTM F 1136.
   h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
   i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.4 WIRE-MESH CABLE TRAY

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

1. B-line, an Eaton business.
2. Cooper Industries; Cooper B-Line; GS Metals Corp.
3. Hubbell Incorporated; Wiring Device-Kellems.
4. Legrand US.
5. MonoSystems, Inc.
B. Description:

2. Width: Size as required for actual cable load plus 25% spare for future. 12 inches (300 mm) minimum.
3. Minimum Usable Load Depth: 2 inches (50 mm).
4. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb (90-kg) concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, Class 12C.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
   a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
      1) Hardware: Galvanized, ASTM B 633.
      1) Hardware: Galvanized, ASTM B 633.
      1) Hardware: Galvanized, ASTM B 633.
   g. Finish: Epoxy-resin paint.
      1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
      2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
      3) Hardware: Chromium-zinc plated, ASTM F 1136.
   h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
   i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.
2.5 SINGLE-RAIL CABLE TRAY

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

1. B-line, an Eaton business.
2. Cable Management Solutions, Inc.
3. MonoSystems, Inc.

B. Description:

1. Configuration: An extruded-aluminum assembly, consisting of a single longitudinal center rail with transverse rungs arranged symmetrically about the center rail complying with NEMA VE 1.
2. Construction: Aluminum rungs mechanically connected to aluminum center rail in at least two places, with ends finished to protect installers and cables.
3. Width: Size as required for actual cable load plus 25% spare for future. 12 inches (300 mm) minimum.
4. Minimum Usable Load Depth: 4 inches (100 mm).
5. Straight Section Lengths: 10 feet (3.0 m), except where shorter lengths are required to facilitate tray assembly.
6. Rung Spacing: 6 inches (150 mm) o.c.
7. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
8. Support Point: Splice fittings shall be hanger support point.
9. Support Spacing: Support each section at midpoint. Support wall-mounted sections a maximum of one-sixth of the section length from each end.
10. Class Designation: Comply with NEMA VE 1, 12C.
11. Unbalanced Loads: Maintain cable tray rungs within six degrees of horizontal under all loading conditions.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
14. Splices and Connectors: Protect cables from edges of center rail and do not intrude into cable fill area.
15. Covers: Solid type made of same materials and with same finishes as cable tray.

C. Materials: Aluminum alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 according to ANSI H35.1/H 35.1M for fabricated parts.

D. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

E. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.6 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.
C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.7 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.8 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 2.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Fasten cable tray supports to building structure.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

E. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

F. Support wire-basket cable trays with trapeze hangers or wall brackets.

G. Support trapeze hangers for wire-basket trays with 1/4-inch- (6-mm-) diameter rods.

H. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

I. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

J. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."
K. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

L. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

M. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

N. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays with shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.

6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.

7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION
SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
3. Optical fiber cable connecting hardware, patch panels, and cross-connects.

1.2 OPTICAL FIBER BACKBONE CABELING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
   
   a. Telecommunications rooms plans and elevations.
   b. Telecommunications pathways.
   c. Telecommunications system access points.
   d. Telecommunications grounding system.
   e. Cross-connects.
   f. Patch panels.
   g. Patch cords.

5. Cross-connects and patch panels.
C. Fiber optic cable testing plan.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.
B. Source quality-control reports.
C. Field quality-control reports.
D. Product Certificates: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
B. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an RCDD.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician or Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
B. Testing Agency Qualifications: Certified by BICSI.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.
1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Provide along entire length of all walls within dedicated Communications Rooms. Size to accommodate installations in all other areas. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.3 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, 12-fiber, nonconductive, tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Belden CDT Networking Division/NORDX.
   2. Berk-Tek
   3. CommScope, Inc.
   4. Corning Cable Systems.

C. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

D. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
E. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

F. Jacket:
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

G. Comply with ICEA S-83-596 for mechanical properties.

H. Comply with ICEA S-87-640 for mechanical properties.

I. Comply with TIA-568-C.3 for performance specifications.

J. Comply with TIA-492AAAC for detailed specifications.

K. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   2. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   3. Refer to mechanical drawings for locations of plenum spaces. Any cables passing through a plenum space shall be rated accordingly.

2.4 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Belden CDT Networking Division/NORDX.
   2. Berk-Tek Leviton; a Nexans/Leviton alliance.
   3. Corning Cable Systems.
   4. Optical Cable Corporation.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

D. Cable Connecting Hardware:
   1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B for Type ST connectors, TIA-604-3-B for Type SC connectors, TIA-604-10-B for Type LC connectors, TIA/EIA-604-12 for Type MT-RJ connectors, and TIA-604-5-D for Type MPO connectors. Comply with TIA-568-C.3.
   2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.25 dB.
2.5 GROUNDING
A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
B. Comply with TIA-607-B.

2.6 IDENTIFICATION PRODUCTS
A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to evaluate cables.
B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.
C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.
D. Cable will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES
A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS
A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 301.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.
3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: Class 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 4 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent. Manufacture reference; Dymo.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections with the assistance of a factory-authorized service representative.
C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

   a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   b. Link End-to-End Attenuation Tests:

      1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
E. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271323
SECTION 275119.11
SOUND MASKING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Electronic noise generators.
   2. Amplifiers.
   3. Wiring.
   4. Masking speaker assemblies.
   5. Controls.
   6. Component mounting racks.

1.2 DEFINITIONS
A. Covered Spaces: Spaces above which masking speakers are installed.

1.3 SYSTEM DESCRIPTION
A. Zones: Single-zone coverage.
B. Channels: Single channel of masking sound to each zone.
C. Channels: Separate channel of masking sound to each of two groups of speakers in each zone.
D. Signal Levels: Individually adjustable for each of 14 one-third octave bands centered at 200 through 4000 Hz, for sound-masking noise channels.
E. Sound-Power Level Produced by System: Match NC 40 contour between 400 and 2000 Hz, with smooth roll-off above and below those frequencies.
   1. Initial Level: 40 dB, A-weighted.
   2. Final Adjusted Level: 40 to 50 dB, A-weighted. Determine final level for each space individually by measurement as specified in Part 3.
F. Maximum Local Variance of Sound-Power Level: 6 dB for the 500-Hz octave band and 3 dB for the 1000-, 2000-, and 4000-Hz octave bands for 75 percent of the locations in covered spaces.
G. Maximum Average Range of Sound-Power-Level Deviation: 2 dB in the 250-, 2000-, and 4000-Hz octave bands and 1.5 dB for the 500- and 1000-Hz octave bands for all locations.
H. Directional Effect: People in covered spaces under calibration conditions cannot determine source of masking sound.
I. Uniformity with Respect to Time: One-minute time-averaged sound-pressure level of any octave band of masking sound from 250 to 8000 Hz remains constant in any space to within a standard deviation of 2 dB when measured over a 30-minute period.

J. Sound Quality: No audible hum or noise from this system in covered spaces when noise generators are off and power amplifiers are on with input volume controls set at 50 percent.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include nationally recognized testing laboratory listing data.

B. Shop Drawings: Dimensioned plans and elevations showing minimum clearances and installed features and devices for system components. Show types and locations of masking speakers and their wiring connections, channel assignments, and axis orientations. Show ducts, beams, and other significant sound-reflecting and -absorbing elements in ceiling space and show locations of partitions below ceiling. Include a diagram showing interconnection of major system components for each zone and channel and indicating grounding connections.

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer trained and approved by manufacturer of sound-masking equipment.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Comply with UL 813 unless a more stringent standard is specified in Part 2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cambridge Sound.
2.2 GENERAL REQUIREMENTS FOR SOUND-MASKING EQUIPMENT

A. Components: Modular plug-in, heavy-duty, industrial-grade integrated circuit devices.

B. Protection from Power Line Surges: Integral surge protection devices listed in UL 1449.

2.3 NOISE GENERATOR AND FILTER UNITS

A. Digital Masking Generator Spectra: Pink, white, and superwhite.

B. Pink Noise Generator: Output octave bands from 30 to 4000 Hz.

C. Filters for One-Third Octave Bands: Adjustable from 10 dB of boost to 10 dB of cut at each center frequency.

D. Mixer Inputs: Two high level and one microphone level.

E. High-Pass Filter: Approximate range of cutoff adjustment is 37 to 400 Hz.

F. Low-Pass Filter: Adjustable roll-off frequency 100 Hz to 10 kHz.

G. High-Cut Filter: Approximate range of cutoff adjustment is 180 to 9000 Hz with slope varying to 12 dB per octave.

H. Auxiliary Inputs: Able to accept two, high-level, auxiliary signals such as music and telephone paging as well as general paging.

I. Mounting: Shelf or rack 3-1/2 inches (90 mm) high.

2.4 POWER AMPLIFIERS

A. Power Amplifiers: Comply with CEA-426, and have the following minimum features:

1. Mounting: Rack mounted.
2. Output Regulation: Less than 2 dB from zero to full load.
3. Total Harmonic Distortion: Less than 3 percent, at rated power output from 50 to 12,000 Hz.
4. Signal-to-Noise Ratio: 60 dB or greater, at rated output.
5. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
6. Input: From internal masking or mixer board, or from an exterior source such as an automatic level control or other mixer.

2.5 MASKING SPEAKER ASSEMBLIES

A. Speakers: Cone type, with the following minimum features:

1. Minimum Axial Sensitivity: 45 dB.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches (200 mm) with 1-inch (25-mm) voice coil and minimum 5-oz. (142-g) ceramic magnet unless otherwise indicated.
4. Dispersion Angle: 100 degrees.
5. Rated Output Level: 10 W.
B. Configuration: Dual 8-inch (200-mm) and dual 5-inch (125-mm) units mounted on metal baffles and arranged for optimum, multidirectional, angular sound distribution. Arrange units for suspension from the building structure above the ceiling.

C. Matching Transformers: Full-power rated with 4 standard taps, and a maximum insertion loss of 0.5 dB.

D. Assemblies installed in air-handling spaces shall comply with NFPA 70 requirements for rate of heat-release and rate of smoke-release characteristics. Tests for these requirements shall be according to UL 2043.

E. Provide layout showing location and quantity of speakers.

2.6 WIRE

A. Speaker Wire: UTP cable complying with manufacturer's requirements; listed and labeled for environmental air plenums.

2.7 COMPONENT MOUNTING RACKS

A. Configuration: Comply with CEA-310-E. Factory-fabricated units designed for interchangeable mounting and enclosure of standard 19-inch (482-mm) relay rack modules.


C. Cabinet: Factory-finished steel with component mounting rails and prewired plug strips for component power connections. Full front and rear doors with continuous hinges, handles, and cylindrical keyed locks.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Speaker Assemblies: Suspend with chains from building structure above ceilings so bottom of assembly is 6 to 8 inches (150 to 200 mm) above upper plane of finished ceiling material. Use eyebolts on speaker assemblies for attachment. Suspend independently of supports for components of other building systems.

B. Speaker Connections: For two- or three-channel systems, connect speaker assemblies alternatively so masking sound is redundant throughout zones of coverage.

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 16130 "Raceway and Boxes for Electrical Systems."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
E. Exposed Cable: Install parallel to building lines, follow surface contours, and support as recommended by manufacturer.

F. Grounding: As recommended by manufacturers unless more stringent requirements are indicated. Ground equipment and conductors to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments with a maximum of 5-ohm to ground at main equipment location. Measure, record, and report ground resistance.

G. Impedance Matching: For system components, including connecting cable, provide end-to-end level and impedance-matched signal paths. Use matching networks and balancing devices at connections where necessary to avoid mismatches.

H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.2 IDENTIFICATION

A. Use color-coded conductors and apply wire and cable marking tape to designate wires and cables so media are identified in coordination with system wiring diagrams. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Label speaker assemblies as to channel, zone, and address.

3.3 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. Operational Test: Start system to confirm proper operation. Remove malfunctioning units, replace with new units, and retest. Make initial sound-spectrum and -level adjustments for each zone.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
4. Masking Sound-Power-Level Adjustments: Adjust independently for each space to minimum level between 40 and 50 dB that will provide speech privacy between adjacent workstations while complying with other system requirements.

C. Final Acceptance Testing: Provide a minimum of 10 days' notice of acceptance test performance schedule.

1. Tests and Calibration Conditions: Spaces shall be completely furnished but unoccupied; lights and HVAC systems shall be on; HVAC system testing and balancing shall be completed; and electronic ballasts, lighting relay panels, and low voltage transformers shall be in place.
2. Test Conditions: Complying with ASTM E 1130 and calculated according to ANSI S3.5.
3. Instrumentation: Use a professional-quality, sound-level meter with octave-band filters and documentation of recent calibration against recognized standards.
4. Record test observations, readings, and corrective actions.
5. System Tests: Include the following for each system zone:
   a. Speaker Circuit Impedance Test: Measure impedance at 1000 Hz with amplifier disconnected, using a professional impedance meter or bridge. Locate and correct faults denoted by abnormal readings.
   c. Amplifier Noise Test: Check for performance specified in "System Description" Article with masking noise generator off and amplifiers on.
   d. System Noise Test: With masking noise signal on and amplifiers adjusted at a working level 10 dB above ambient sound level, check for hum, buzz, rattle, or other operating deficiencies.
   e. Spatial Uniformity Test: Measure sound level at locations no greater than 15 feet (4.6 m) o.c. throughout covered spaces to determine compliance with specified performance level.
   f. Frequency Response Adjustment and Test: Adjust one-third octave frequency bands and other unit filters to provide response. Adjust to meet requirement of space speech intelligibility and quality of background sound. Comply with ANSI S3.2, CEA 426, and ASTM E 1110.
6. Adjust level of masking sound for each space so one-third octave band centered at 500 Hz has final selected sound-power level for that space. Measure deviation from listed values in one-third octave bands from 100 to 1000 Hz. Measured values must not deviate from those listed by more than 4 dB for open plan areas and 8 dB for enclosed offices. The total of individual band deviations in eight bands must not exceed 16 dB for open plan areas and 30 dB for enclosed offices.
7. Walk-through Test: People in covered spaces cannot discern speaker locations.
8. Temporal Stability Test: Check for uniformity of time by measuring sound level in each of 14 octave bands at one-minute intervals over a 30-minute test period. Deviations must not exceed limits specified in "System Description" Article.
9. Where required, space shall meet the Health Insurance Portability and Accountability Act for privacy and the Gramm-Leach Bliley Act to protect consumer personal and financial information in open office layouts.

D. Retest: Correct deficiencies identified by tests and observations and retest until meeting specified requirements.

E. Recording Control Settings and System Adjustments: Record final control settings and programming, and final tap setting of speaker matching transformers. Record final sound-level measurements and observations.

3.4 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain services.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
7. Magnetic door holders.
10. Digital alarm communicator transmitter.

B. Related Requirements:

1. Section 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
b. Show field wiring required for HVAC unit shutdown on alarm.
c. Locate detectors according to manufacturer’s written recommendations.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified, fire-alarm technician; Level II minimum.
   c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
   a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment.
d. Riser diagram.
e. Record copy of site-specific software.
f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

   1) Equipment tested.
   2) Frequency of testing of installed components.
   3) Frequency of inspection of installed components.
   4) Requirements and recommendations related to results of maintenance.
   5) Manufacturer's user training manuals.

g. Manufacturer's required maintenance related to system warranty requirements.
h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Five years from date of Substantial Completion.
PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.
9. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate preaction system.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Activate emergency lighting control.
13. Record events in the system memory.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Elevator shunt-trip supervision.
4. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 MANUFACTURERS

A. Approved Manufacturers:
2. Gamewell
3. Siemens
4. Simplex Grinell

2.4 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
C. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

D. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
   a. Elevator lobby detectors except the lobby detector on the designated floor.
   b. Smoke detector in elevator machine room.
   c. Smoke detectors in elevator hoistway.
2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
   a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

2.5 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
1. Single-action mechanism, pull-lever, double action type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
   3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   5. Integral Visual-Indicating Light: LED type, indicating detector has operated.
   6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
      a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
      b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).
      c. Multiple levels of detection sensitivity for each sensor.
      d. Sensitivity levels based on time of day.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to
      identify the detector’s location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to
      manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).
   3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the
      supplied detector for smoke detection in HVAC system ducts.
   4. Each sensor shall have multiple levels of detection sensitivity.
   5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific
      duct size, air velocity, and installation conditions where applied.
   6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control
      circuit.

E. Smoke Sensors (Guestroom & Suites):
   1. Guestrooms, suite rooms, and other sleeping units.
      a. Provide smoke sensors with sounder bases to meet the following:
         1) Photoelectric type sensor.
         2) Sounder Base: Provide minimum audible alarm of 85 dBA at 10 feet; minimum of 75 dBA “at the pillow”.
         3) Activation of room smoke sensor to immediately and automatically sound an
            alarm within the room of incident.
         4) System smoke sensor normal and emergency power is provided by the
            FACP.
         5) In Suites or other mixed Sleeping / Living Units, provide smoke sensors in
            each separate sleeping / living rooms (or in areas providing access to the
            corridor doorway). Multiple sensor sounder bases located within the same
            suite or unit shall sound at the same time.
   2. Guestroom Smoke Alarms (Handicap Accessible and Hearing Impaired): Same as
      above with the following additions.
      a. Visible Alarm Device: Xenon Strobe. Activation of detector to cause both alarm
         horn and visible alarm device (xenon strobe) to flash.
   3. Smoke Detectors / Sensors are to be located per NFPA 72 so that the function is not to
      be compromised by air flow to or from grilles or ceiling fans.
   4. Guestrooms Smoke Sensors or Smoke Alarms are to be audibly and visually
      annunciated at the FACP and annunciators as Supervisory Signals.

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.
1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

B. Location: Provide carbon monoxide detectors in mechanical rooms containing gas fired water heaters or other gas appliances. Connect so that detectors provide supervisory alarm at fire alarm panel.

2.8 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.
1. Temperature sensors shall test for and communicate the sensitivity range of the device.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.

C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Mounting: Wall mounted unless otherwise indicated.
2. Flashing shall be in a temporal pattern, synchronized with other units.

D. Mini Horns/Sounder Bases:
a. Guestrooms: Install in all guestrooms, and in bedrooms of all suites, beige in color.
b. Smoke Sensors with sounder bases may be installed in lieu of guestroom mini
horns provided the sounder base meets the following requirements.
   1) Approval from the local authority having jurisdiction.
   2) Listed for general and local evacuation.
   3) Capable of sounding both the local in-room alarm upon activation of the in-
      room / suite smoke sensor(s) and upon activation of the building fire alarm
      notification system.

E. Accessible and Hearing-Impaired Guestrooms: Flashing lights for the hearing impaired shall be
   semi-recessed, with side-viewing tamper-proof lens. White lens with the word “Fire” in raised
   red letters. Flashing lights may be an integral part of the accessible guestroom detector and/or
   mini horn or may be a separate flashing device. Flashing lights shall be located in all sleeping
   areas, living areas and bathrooms.

2.10 MAGNETIC DOOR HOLDERS
A. Description: Units are equipped for wall and are complete with matching doorplate.
   1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
   2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
   3. Rating: 24-V ac.
B. Material and Finish: Match door hardware.

2.11 REMOTE ANNUNCIATOR
A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm,
   supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm
   control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Flush cabinet, NEMA 250, Type 1.
B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall
   match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test
   functions for alarm, supervisory, and trouble signals.

2.12 ADDRESSABLE INTERFACE DEVICE
A. General:
   1. Include address-setting means on the module.
   2. Store an internal identifying code for control panel use to identify the module type.
   3. Listed for controlling HVAC fan motor controllers.
B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices
   for wired applications with normally open contacts.
C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator
   recall.
   1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:
   1. Operate notification devices.
   2. Operate solenoids for use in sprinkler service.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.
PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

B. Equipment Mounting: Install fire-alarm control unit on finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
   3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

H. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

I. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

J. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

L. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

A. Pathways shall be installed in red color EMT, conduits concealed in wall and ceiling space.

3.3 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
10. Supervisory connections at fire-extinguisher locations.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.
a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. END
SECTION 31 11 00
CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.1 DESCRIPTION
A. This section describes the work included in clearing, grubbing, stripping, and otherwise preparing the project site for construction operations.

1.2 EXISTING TREES AND SHRUBBERY
A. Existing trees, shrubbery, and other vegetative material may not be shown on the drawings. Inspect the site as to the nature, location, size, and extent of vegetative material to be removed or preserved, as specified herein. Preserve in place trees that are specifically shown on the drawings and designated to be preserved.

1.3 CLEARING AND GRUBBING LIMITS
A. All excavation and embankment areas associated with new structures, slabs, and roadways shall be cleared and grubbed.

PART 2 - MATERIALS

None Required

PART 3 - EXECUTION

3.1 PRESERVATION OF EXISTING TREES, SHRUBS, AND OTHER PLANT MATERIAL
A. All plant materials (trees, shrubbery, and plants) beyond the limits of clearing and grubbing shall be saved and protected from damage resulting from the work. No filling, excavating, trenching, or stockpiling of materials will be permitted within the drip line of these plant materials. The drip line is defined as a circle drawn by extending a line vertically to the ground from the outermost branches of a plant or group of plants. To prevent soil compaction within the drip line area, no equipment will be permitted within this area.

B. When trees are close together, restrict entry to area within drip line by fencing. In areas where no fence is erected, the trunks of all trees 2 inches or greater in diameter shall be protected by encircling the trunk entirely with boards held securely by 12-gauge wire and staples. This protection shall extend from ground level to a height of 6 feet. Cut and remove tree branches where such cutting is
necessary to effect construction operation. Remove branches other than those required to effect the work to provide a balanced appearance of any tree. Sears resulting from the removal of branches shall be treated with tree sealant.

3.2 CLEARING AND GRUBBING

A. Clearing and grubbing shall be performed in the areas indicated and where required to provide adequate work space, including ditches, areas where fill will be placed and where structures will be erected, and including spaces for control stakes and hubs for pipeline work. Should such items be damaged, they shall be replaced in kind or restored to at least as good condition as that in which they were found immediately before the work was begun, at the expense of the Contractor and to the satisfaction of the Engineer.

B. All weeds, rubbish and all other obstructions resting on or protruding through the surface of the existing ground, shall be collected and satisfactorily disposed of as specified herein and in compliance with the applicable laws and regulations. All such material shall be removed to a depth of two feet below finished grade. Existing trees will be removed entirely. Stump grinding is not permitted.

C. Where excavation is performed within areas cleared and grubbed, all stumps, roots over two inches in diameter, and deleterious material thereby exposed shall be removed to a depth of one foot below the excavated surface.

D. Where debris is removed from areas other than those where subsequent excavation, filling, and grading will be done, no depressions shall be left, but the resulting holes shall be filled and neatly graded to conform to the grades indicated on the drawings.

3.3 STRIPPING

A. Areas to be stripped: All excavation and embankment areas associated with new structures, slabs, walks, and roadway shall be stripped. Stockpile areas shall be stripped.

B. Stripping: Remove and dispose of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped.

3.4 DISPOSAL OF CLEARING AND GRUBBING DEBRIS

A. All material removed in clearing and grubbing shall be disposed of as promptly as practical and shall not be left until the completion of the Contract.
B. Burning combustible clearing and grubbing materials from the site will not be allowed. The Contractor shall be responsible for disposing, clearing and grubbing material at a suitable city dump or private dump in accordance with all applicable laws and regulations. All dumping charges are to be paid by the Contractor.

C. The use of herbicides or blasting in clearing and grubbing is specifically prohibited.

3.5 MEASUREMENT AND PAYMENT

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work provided in this section.

End of Section
PART 1 - GENERAL

1.1 WORK INCLUDED:

A. The work covered by this section of the specifications consists of furnishing all material, labor, tools, equipment, appliances and services necessary to complete the demolition of control structures shown in the drawings and specified herein. The contractor shall examine the various drawings, visit the site and determine for himself the extent of the work, the extent of work affected therein and all conditions under which he is required to perform the various operations.

B. Existing site structures and appurtenances affected herein are indicated generally in the drawings.

1.2 RELATED WORK:

A. Permits and Licenses: Contractor shall obtain all necessary permits and licenses for performing the work and shall furnish a copy of same to the engineer prior to commencing the work. The contractor shall comply with the requirements of the permits.

1.3 JOB CONDITIONS:

A. Sequence of Construction: Demolition and removal work shall be coordinated with the Owner and agreed upon sequence of construction to minimize down time at the site.

1.4 DISPOSITION OF DEMOLISHED MATERIALS:

A. Salvaged materials designated as property of the Owner shall be stored in areas designated by the owner. The contractor shall promptly remove all other materials from the site.

PART 2 - MATERIALS

Not applicable
PART 3 - EXECUTION

3.1 PREPARATION:

A. Salvage: Material to be salvaged shall be removed with the minimum amount of damage and stored on the site as directed by the owner. Material stored on the ground shall be placed on blocks, and all stored material shall be staked and placed in an orderly manner.

3.2 PERFORMANCE:

A. General: Demolition shall result in the complete removal and disposal of existing structures and appurtenances from the site as indicated on drawings, the salvaging of indicated items and the cleanup after completion of the demolition work.

B. Concrete Slabs and Vaults: Concrete slabs and foundation walls shall be removed to a depth of not less than 24 inches below grade.

C. Piping: All abandoned piping not in conflict with the proposed work may either be removed from the site by the Contractor at no extra cost to the owner or ends shall be capped with suitable material and backfilled.

D. Modifications:

1. The cutting and removal of existing work necessary for modifications and installation of new work shall be made with a minimum of damage to the work that is to remain. Any damage done to existing facilities which are to remain shall be repaired at the Contractor's expense to the satisfaction of the owner.

2. The contractor shall follow other specific instructions for the modification work given in other sections of these specifications and as shown on the drawings.

3.3 CLEANUP:

A. Site shall be left in a clean condition satisfactory to the engineer, free from demolished materials, rubbish or debris.

B. The contractor shall restore items intended to remain that have been damaged by demolition work.

C. All interrupted utility services shall be returned to their pre-existing state. Disconnect temporary services, unless otherwise specified.
3.4 **MEASUREMENT AND PAYMENT:**

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work provided in this section.

End of Section
SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.1 SCOPE:

A. The work under this section includes the furnishing of all labor, materials, tools and equipment necessary to complete the earthwork shown on the drawings and specified herein, including rough grading.

1.2 GENERAL REQUIREMENTS:

A. Bidders shall examine the site of the work and make their own determination of the character of materials and the conditions to be encountered on the work, and their proposal shall be based upon their own investigations. Neither the Owner nor the Engineer shall be held responsible for variations found to exist between any soils data which may be included for information only, and actual field conditions that develop through the period of construction.

B. Underground structures and utilities shown on the drawings are located according to the best available records. However, it shall be the Contractor's responsibility to become acquainted with all information and to locate all underground structures and utilities along the line of work in order to avoid conflict with existing facilities. Neither the Owner nor the Engineer shall be held responsible for the inaccuracies or omissions in the location or grade of facilities of this type.

C. Where actual conflicts are unavoidable, work shall be performed so as to cause as little interference as possible with the service rendered by the facility disturbed. Facilities or structures damaged in the prosecution of the work shall be repaired immediately at the Contractor's expense, in conformance with the best standard practice, to the satisfaction of the facility owner and to the extent required, including replacement.

D. Benchmarks and other reference points shall be carefully maintained and, if disturbed or destroyed by the Contractor, shall be replaced by a Professional Surveyor registered to practice in the State of Florida, to the satisfaction of the Engineer and at no additional cost to the Owner. Location of benchmarks and other reference points not shown on the drawings but used during construction shall be recorded on the Contractor's "as-builts" of the Contract Drawings.

E. On paved surfaces the Contractor shall not use or operate tractors, bulldozers, or other power operated equipment which would damage such surfaces. All surfaces
which have been damaged by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods as determined by the Engineer shall be used for such restoration.

F. Core boring data, including groundwater elevations or conditions, existing piping, and structure locations as appended to these specifications and indicated on the drawings, are presented only as information that is available which indicates certain conditions found and limited to the exact locations and on the dates indicated. The inclusion of such data shall not be interpreted as an indication of conditions that may actually be encountered through the period of construction.

PART 2 - MATERIALS

None required.

PART 3 - EXECUTION

3.1 STRIPPING AND STOCKPILING TOPSOIL:

A. When directed by the Owner, topsoil suitable for final grading operations shall be stripped and stockpiled in designated areas for reuse. Unsuitable material shall be removed from the site and disposed of in a manner satisfactory to the Engineer at no additional cost to the Owner.

B. The Owner reserves the right to claim and use for his own benefit all excess spoil material.

3.2 GRADING:

A. Grade all areas as indicated. Fill shall be brought to finish grades shown and shall be graded to drain water away from structures.

B. Overall Area Grading for Which No Grades are Indicated: Within the limits of construction and outer limits of clearing and grubbing, all holes and other depressions shall be filled, all mounds and ridges cut down, and the area brought to sufficiently uniform control so that the Owner's subsequent mowing operation will not be hindered by irregular terrain. This work shall be done regardless of whether the irregularities were the result of the Contractor's operations or originally existed.
3.3 EXCESS MATERIAL:

A. Excess excavated material suitable for reuse as backfill, shall be immediately disposed of by the Contractor at a site selected by the Engineer or Owner, and at no additional cost to the Owner. Material shall be spread and graded in such a manner as to drain properly and not disturb existing drainage conditions.

B. Excess excavated material not suitable as reuse for backfill shall be immediately disposed of by the Contractor at no expense to the Owner.

3.4 DUST CONTROL:

A. If, in the opinion of the Owner or the Engineer, it is necessary to control dust from time to time during the progress of the work, the Contractor shall use water trucks and/or furnish and spread calcium chloride at the site of the work as directed by the Engineer at no additional cost to the Owner.

3.5 Siltation and Erosion:

A. The Contractor shall take steps and make suitable provisions to minimize siltation and erosion which may result from, or as a result of, his operations during the course of construction of this project. All siltation and erosion control shall be in strict accordance with applicable local, state, and federal requirements. All siltation and erosion control shall be in strict accordance with Section 31 25 00 of these specifications.

3.6 Compaction:

A. Unless otherwise specified or shown on the drawings, areas outside the limits of pipe trenches and structures must meet the following compaction requirements:

1. Subgrade Under Fill or Backfill: 90% relative density to a depth of 12 inches.
2. Backfill or Fill Under Pavement: 98% relative density in 6-inch maximum layers.
3. All Other Areas: 95% relative density in 6-inch maximum layers.

B. Compact by using methods acceptable to the owner or his representative (powered tampers, vibrators, etc.). Compact the first two feet of backfill over pipe either by hand-operated tamping devices or with powered equipment which will not damage the pipe. Flooding or puddling with water to consolidate backfill is not acceptable, except where sand is encountered and the specified density can be obtained using this method. This method shall be approved by the Engineer.
C. During the compacting operations, maintain material within ±2% of optimum moisture. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.

3.7 TESTING:

A. Shall be contracted per the contract documents with an independent testing laboratory to perform material and soil testing in accordance with Local Authority Having Jurisdiction Requirements.

3.8 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work involved for each item.

End of Section
SECTION 31 23 16

EXCAVATION AND BACKFILL FOR UTILITIES AND STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section includes materials, testing, and installation of earthwork for excavations, fills, and embankments for structures, pavements, rights-of-way, and sites and trench excavating, backfilling, and compacting for underground pipelines and appurtenant structures.

1.2 STANDARDS:

A. Determine the density of soil in place by the sand cone method, ASTM D1556, by nuclear methods, ASTM D2922, or by the rubber balloon method, ASTM D2167.

B. Determine laboratory optimum moisture-density relations of cohesive soils by ASTM D1557 (modified Proctor).

C. Sample backfill materials by ASTM D75.

D. For cohesive soils, "relative density" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density as determined by ASTM D1557 (modified Proctor).

E. Determine the relative density of cohesionless soils by ASTM D4253.

1.3 DEFINITIONS:

A. Subgrade: The undisturbed material immediately below the bottom of an excavation, below an area of fill, or below a structure.

B. Excavation: Removal of earth or buried material, either temporarily or permanently, as specified or as necessary for construction of the project.

C. Over-excavation: Excavation exceeding that specified or shown on the plans.

D. Backfill: Earth material placed permanently in an excavated area.

E. Fill: Earth material placed permanently above the existing grade.

F. Borrow: Earth material brought from off the site to be used as fill or backfill.
G. Structural Backfill: Backfill placed beneath structures and in over-excavated areas.

H. Structures: Buildings, foundations, and other man-made, stationary features above or below ground.

PART 2 - PRODUCTS

2.1 BACKFILL AND FILL:

A. For structures: Backfill and fill shall be excavated material or borrow that is free from clay balls larger than 2 inches in their largest dimension and contains no more than 15% by weight passing the No. 200 sieve, no more organic matter (peat, humus, leaves, and carbon compounds) than 1% by weight, and no cobbles larger than 2 inches in their largest dimension unless otherwise specified. The gradation of this granular material shall be such as to achieve the specified compaction.

B. For pipe and appurtenance structures conform:

1. First Lift: From the excavation grade to a level 12 inches above the top of the pipeline. Exclude material with fragments larger than the following:

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Fragment Size (Greatest Dimension-Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>½ &quot;</td>
</tr>
<tr>
<td>Concrete, steel, cast or ductile iron and corrugated metal</td>
<td>2&quot;</td>
</tr>
</tbody>
</table>

2. Second Lift: From the top of the First Lift to the ground surface. Exclude material with fragments larger than three inches.

C. In the event there is insufficient satisfactory material from the excavation to meet the requirements for backfill or fill material, obtain borrow which meets the requirements for backfill material from sources secured by the Contractor.

2.2 STRUCTURAL BACKFILL:

A. Structural backfill shall be free from clay balls and shall conform to ASTM D1241, Type I, Gradation
2.3 WATER FOR COMPACTION:

A. Water shall be free of acid, alkali, or organic materials and shall have a pH of 7.0 to 9.0. Provide all water needed for earthwork. Provide temporary piping, valves, and trucks to convey water from the source to the point of use. Provide any meters required if the water is taken from a public water system.

PART 3 - EXECUTION:

3.1 DEWATERING:

A. Provide and operate equipment adequate to keep excavations free of water. Dewater subgrade to a minimum of 2 feet below the bottom of the excavation. Remove water during periods when concrete is being deposited, when pipe is being laid, during the placing of backfill, and for proper inspection and/or testing of the exposed subgrade. These provisions shall apply during the noon hour as well as overnight. Do not drain trench water through the pipeline under construction. Avoid settlement or damage to adjacent property. Dispose of water in a manner that will not damage adjacent property or interfere with normal drainage. When dewatering open excavations, dewater from outside the structural limits and from a point below the bottom of the excavation. Obtain and comply with all required discharge permits from appropriate regulatory authorities.

3.2 EXCAVATION:

A. Excavate to the elevations shown on the drawings, to the bottom elevations of the slabs, structures, and foundations or the bottom of the roadway subbase (top of subbase if only to be compacted), whichever is the lowest elevation.

B. Perform all excavation regardless of the type, nature, or condition of the material encountered to accomplish the construction. Excavate for foundations to a point 5' horizontally behind the outside face of footings and base mats.

C. After the excavation has been completed, the Owner or his representative will observe the exposed subgrade to determine the need for any additional excavation. It is intended that additional excavation be conducted in all areas within the influence of the structure where unacceptable subgrade materials exist at the exposed subgrade. Over-excavation shall include the removal of all such unacceptable material that exists directly beneath the hole or structure for the full width of the hole or structure and to a depth required to reach suitable foundation material. Refill the over-excavated areas with structural backfill. All such over-excavation and backfilling shall be executed in accordance with a change order. Payment for over-excavation and backfill shall be made in accordance with the Standard General Conditions.
D. Do not carry excavation for footings, slabs, or conduits deeper than the elevations shown on the plans. Backfill over-excavations below the elevations shown to the proper elevation with compacted structural backfill material. Correct cuts below grade by similarly cutting adjoining areas and creating a smooth transition.

E. The Contractor will not receive any additional payment for over-excavation or backfill material used for his convenience or which is not authorized by the Owner or his representative.

F. The Contractor shall become acquainted with existing conditions and locate all structures and utilities within the project area in order to avoid conflicts.

G. Protect any pipes, conduits, wires, mains, footings or other underground structures encountered in trenching/excavating/backfilling from damage or displacement. Replace any pipes, conduits, wires, mains, footings or other structures disturbed during construction.

H. Contact all utility companies with underground utilities in the project area and obtain their assistance in locating facilities prior to excavation.

I. Excavate sufficiently in advance of pipe laying to discover obstructions in time to modify alignment, if necessary, to avoid the obstruction. The Owner or his representative must review such alignment modifications.

3.3 PREPARATION OF SUBGRADE PRIOR TO PLACING FOUNDATIONS:

A. Excavate and shape subgrade to line, grade, and cross section. Remove soft material encountered and replace with structural backfill. Fill holes and depressions to the required line, grade, and cross sections with structural backfill. The finished subgrade shall be within a tolerance of ±0.08 feet of the grade and cross section shown, smooth and free from irregularities, and at the specified relative density.

3.4 PREPARATION FOR PLACING FILL OR BACKFILL:

A. Remove loosened and disturbed materials at the subgrade.

B. Remove form materials and trash before placing any fill or backfill. Obtain the specified compressive strength and finish of concrete work before backfilling.

C. Do not operate earthmoving or excavation equipment within five feet of existing structures or newly completed structures. Place and compact fill or backfill adjacent to concrete walls with hand-operated tampers or other equipment that will not damage the structure.
D. Fill or backfill around water-holding basins and channels only after specified leakage tests have been conducted.

3.5 COMPACATION:

A. Unless otherwise specified or shown on the drawings, areas outside pipe trenches must meet the following compaction requirements:

1. Structural Backfill: 95% relative density in 6-inch maximum layers.
2. Subgrade Under Fill or Backfill: 90% relative density to a depth of 12 inches.
3. Subgrade Under Structural Backfill or Structures: 95% relative density to a depth of 24 inches.
4. Backfill or Fill Under Pavement: 98% relative density in 6-inch maximum layers.
5. All Other Areas: 95% relative density in 6-inch maximum layers.

B. Compact by using methods acceptable to the owner or his representative (powered tampers, vibrators, etc.). Compact the first 2 feet of backfill over pipe either by hand-operated tamping devices or with powered equipment which will not damage the pipe. Flooding or puddling with water to consolidate backfill is not acceptable, except where sand is encountered and the specified density can be obtained using this method.

C. During the compacting operations, maintain material within ±2% of optimum moisture. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.

D. Non-Plastic Pipe and Appurtenant Structures: Unless otherwise shown on the drawings or otherwise described in the specifications for the particular type of pipe installed, compact soil in pipe trenches to the following minima:

1. First Lift - 95% relative density.
2. Second Lift not beneath paving - 90% relative density.
3. Second Lift in paved areas and under structures - 98% relative density.
4. Backfill for over-excavation - 95% relative density.

3.6 SHEETING, SHORING, AND BRACING OF TRENCHES:

A. Install adequate sheeting and bracing to prevent damage to property and injury to persons. Comply with all applicable safety regulations and laws.

B. Remove sheeting when the trench has been backfilled to at least one-half its depth or when removal will not endanger proper pipe alignment or support.
C. When conditions or plans and specifications require that sheeting be left in place, cut off the top at an elevation 2.5 feet below finished grade, unless otherwise specified.

D. All sheeting, shoring, and bracing shall be designed by a Professional Engineer registered in the State of Florida.

3.7 SIDEWALK, PAVEMENT, AND CURB REMOVAL:

A. Cut and remove bituminous and concrete pavements, curbs and sidewalks prior to excavation of the trenches. Width of the pavement or brick pavement cut shall be at least one foot wider than the required width of the trench at ground surface. Haul pavement and concrete materials from the site to disposal site secured by Contractor. Do not use for trench backfill.

3.8 TRENCHING:

A. Cut trenches to a minimum width equal to the outside diameter of the pipe at the joint plus eight inches for unsheeted trenches, or 12 inches for sheeted trenches. The maximum width of trench, measured at the top of the pipe, shall not exceed the outside pipe barrel diameter plus two feet, unless otherwise shown on the plans or details.

B. Maintain vertical trench walls from the bottom of the trench to a line measured 12 inches above the top of the pipe.

C. Utility Bedding: The minimum utility bedding allowable shall consist of a shaped trench bottom which provides firm bedding for the utility pipe. Bed the pipe in undisturbed firm soil of hand-shaped unyielding material, so that the pipe will be in continuous contact therewith for its full length and provide a minimum bottom segment support for the pipe equal to 0.6 of the outside diameter of the barrel.

D. Construct special bedding as called for on the plans or in the contract documents.

E. Excavate the trench to the lines and grades shown on the drawings with allowance for pipe thickness and for pipe base or special bedding. If the trench is excavated below the required grade, backfill any part of the trench excavated below the required grade, backfill any part of the trench excavated below the grade at no additional cost to the owner. Place the backfilling material over the full width of trench in compacted layers not exceeding six inches deep to the established grade with allowance for the pipe base or special bedding.

F. During trench excavation, place the excavated material only within the project area. Do not obstruct any roadways or streets. Conform to federal, state, and
local codes governing the safe loading of trenches with excavated material.

G. Limit the length of open trench to 800 feet in advance of laying pipe or amount of pipe that may be installed in one working day. Complete backfilling and temporary or first layer paving not more than 1200 feet in the rear of pipe-laying.

3.9. TRENCH EXCAVATION IN BACKFILL AND FILL AREAS:

A. Construct trench excavation for pipe, pipes, or conduit in backfill or fill areas in accordance with the following procedures:

1. Construct and compact the backfill or fill to an elevation of one foot minimum over the top of the pipe or conduit to be installed.
2. Excavate trench in the compacted backfill or fill. Place pipe base material, install pipe or conduit, and backfill to 12 inches above the pipe as specified for the type of pipe used. Compact backfill above this point to the same relative density as the adjacent embankment.

3.10 STRUCTURAL BACKFILL:

A. Place structural backfill where specified and in over-excavation areas, to the lines and grades shown or specified. Compact each layer. Stop structural backfill at least 6 inches below finished grade in all areas where topsoil is to be replaced. Moisten material as necessary to aid compaction.

3.11 TRENCH BACKFILLING:

A. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint.

B. Backfill for non-plastic pipe and appurtenant structures in accordance with the following procedures:

1. After pipe has been bedded, place "First Lift" material simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Place material on the underside of the pipe in such a manner as to prevent lateral movement during subsequent backfilling.
2. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.
3. Push the backfill material carefully onto the backfill previously placed in the "First Lift". Do not permit free fall of the material until at least two feet of cover is provided over the top of the pipe. Do not drop sharp,
heavy pieces of material directly onto the pipe or the tamped material around the pipe.

C. Place backfill material in maximum 12 inch layers and compact each lift to the specified relative density.

3.12 SITE WORK:

A. Shape the surface of earthwork to conform to lines, grades and cross sections that existed prior to beginning work or as shown on the drawings, within 1/10 of a foot. Round tops of banks to circular curves to not less than a 6-foot radius. Neatly and smoothly trim rounded surfaces. Do not over-excavate and backfill to achieve the proper grade.

B. Remove excess, unsuitable, or cleared material resulting from the facility installation from the work site and dispose of at locations secured by the Contractor.

3.13 DRAINAGE, EROSION AND SEDIMENTATION:

A. Maintain all existing drainage patterns and control run-off from the construction area to prevent erosion, sedimentation, or flooding due to the construction.

3.14 PROTECTION OF PROPERTY:

A. Protect the trunks of trees adjacent to this work by enclosure with padding or wood. Operate excavating machinery and cranes with care to prevent damage to trees, particularly to overhanging branches and limbs.

B. Do not cut branches, limbs and roots unless they are within six inches of the facility under construction. Make all necessary cuts smoothly and neatly without splitting or crushing. Neatly trim and cover the tree with healing paint at all cut or damaged portions.

C. Do not cut or operate on paved surfaces any equipment with treads or wheels which will cut or otherwise damage paved surfaces. Provide adequate protective measures to avoid damages to the paved surfaces.

D. As promptly as practicable, restore existing property or structures. Do not leave restoration until the end of the construction period.
3.15 TESTING:

A. Field density tests will be made in locations reviewed by the Owner, normally in each vertical layer, and using the following approximate spacing.

1. Under structures, pavements, and slabs, one per 2500 square feet with at least two per structure or area.

2. In trenches, one every 300 feet in continuous trenches under pavements or future pavements plus one at each intersection or one every 500 feet in continuous trenches not under pavements, plus one at each pavement of driveway crossing.

B. If any field density tests are below the specified relative density, re-compact or re-excavate, re-backfill and re-compact the area until the specific density is obtained. Make a minimum of two field density tests per re-compacted and/or re-excavated area, but do not exceed the spacing specified above.

3.16 ACCEPTANCE:

A. After the specified density tests have been successfully completed, the Owner or his representative will cross section the excavation and/or fill area to verify that the excavation or fill area conforms to the lines and grades shown on the plans and to determine quantities of material. The Contractor will correct deviations from line and grade in excess of the tolerances specified at the Contractor's expense.

3.17 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work provided in this section.

End of Section
PART 1 - GENERAL

1.1 SCOPE:

A. In general, the work specified in this section of the specifications shall consist of supplying all labor and materials and performing all work necessary to lower and control the groundwater levels and hydrostatic pressures to permit all excavation and construction specified under this Contract to be performed in the dry. The control of all surface water shall be considered as a part of the work.

1.2 EXAMINATION OF THE SITE:

A. The Contractor shall take all steps that he considers necessary to familiarize himself with the site conditions, the ground conditions and the groundwater conditions. The data described is furnished for information only and it is expressly understood that the Owner and the Engineer will not be held responsible for any interpretation or conclusions drawn there from by the Contractor.

1.3 DEWATERING REQUIREMENTS:

A. It is the intent of these specifications that an adequate dewatering system be installed to lower and control the groundwater in order to permit excavation, construction of the structures, and the placement of the fill materials, all to be performed under dry conditions. The dewatering system shall be adequate to pre-drain the water-bearing strata above and below the bottom of the structure foundations, the drains, the sewers and all other excavations. In addition, the system to be used shall reduce the hydrostatic head in the water-bearing strata below the structure foundations, the drains, sewers, and all other excavations, to the extent that the water level and piezometric water levels in the construction area remain below the prevailing excavation surface at all times.

1.4 SUBMITTAL:

A. The Contractor shall submit complete plans and description of the overall dewatering system, including observation wells proposed to be used for the work under this section, showing the details of the dewatering system prior to initiation of any excavation within three feet of the prevailing groundwater levels. These plans shall carry the seal of a professional engineer with Florida registration and specializing in the work or having extensive experience in underground dewatering.
PART 2 - MATERIALS

2.1 Materials used in the dewatering system for the new structures are not to remain in place and may be of steel construction. The dewatering system shall be as manufactured by Griffin Wellpoint Corporation, Moretrench Corporation, or equal.

PART 3 - EXECUTION

3.1 Prior to any excavation below the groundwater level, the dewatering system shall be placed into operation to lower the water levels as required and then shall be operated continuously 24 hours per day, seven days per week until all drains, sewers, and structures have been satisfactorily constructed, including placement of fill materials, and no longer require dewatering. An adequate weight of fill material shall be in place to prevent buoyancy prior to discontinuing operation of the dewatering system.

3.2 The Contractor shall be solely responsible for the arrangement, location, and depths of the dewatering system necessary to accomplish the work described under this section of the specifications. The dewatering shall be accomplished in a manner that will reduce the hydrostatic head below any excavation to the extent that the water level and piezometric water levels in the construction area are below the prevailing excavation surface; will prevent the loss of fines, seepage, boils, quick conditions or softening of the foundation strata; will maintain stability of the sides and bottom of the excavation; and will result in all construction operations being performed in the dry.

3.3 The control of all surface and subsurface water is considered as part of the dewatering requirements. The control should be adequate so that the stability of excavated and constructed slopes are not adversely affected by water, that erosion is controlled and that flooding of excavations or damage to the structures does not occur. Surface water drainage shall not be directed toward the excavations.

3.4 The Contractor shall dispose of all water removed from the excavations in such a manner as will not endanger public health, property, any portion of the work under construction or completed either by him/her or any other Contractor, and shall be performed in such a manner as will cause no inconvenience whatsoever to the Owner, the Engineer, or to others engaged in work about the site.

3.5 The Contractor will provide complete standby equipment, installed and available, for immediate operation as may be required, to adequately maintain the dewatering on a
continuous basis in the event that all or any part of the dewatering system may become inadequate or fail.

3.6 If the dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system, then loosening of the foundation strata or instability of the slopes, or damage to the foundations or structures may occur. The supply of all labor, materials, and plant, and the performance of all work necessary to carry out additional work for reinstatement of the structures or foundation soil resulting from such inadequacy or failure shall be undertaken by the Contractor to the approval of the Owner and at no additional expense to the Owner.

3.7 MEASUREMENT AND PAYMENT

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's lump sum bid as set forth in the Proposal shall constitute full compensation for the work involved for each item.

END OF SECTION
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including the General Conditions, Supplementary Conditions, and Special Conditions, along with the General Requirements, apply to the work specified in this section.

1.2 SUMMARY:

A. The work specified in this section consists of measures required to control erosion on the project so as to prevent pollution of water, detrimental effects of public or private property adjacent to the project right-of-way and damage to work on the project. These measures will consist of construction and maintenance of permanent erosion control features or, where practical, the construction and maintenance of permanent erosion control features as shown in the plans or as may be directed by the Engineer. Contractor will be required to obtain the NPDES permit. Contractor will also be required to prepare the Stormwater Pollution Prevention Plan (SWPPP), to maintain the plan on site, and to comply with inspection and reporting requirements.

1.3 REFERENCED STANDARDS:

A. The Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, are referred to hereinafter as the Standard Specifications. References to the Standard Specifications are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

B. Standard Drawings: Except as otherwise shown on drawings or specified herein, the applicable details of the Florida Department of Transportation (F.D.O.T.) Roadway and Traffic Design Standards, Index Nos. 100 through 106, latest edition, shall apply. References to the F.D.O.T. Roadway and Traffic Design Standards are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. All materials in accordance with the most current edition of the
PART 3 - EXECUTION

3. 1 EROSION CONTROL

A. All installation and construction methods in accordance with Section 104 of the latest edition of the FDOT Standard Specifications for Road and Bridge Construction.

End of Section
1. **GENERAL:**

1.1. **Summary:** Provide soil treatment for termite control as herein specified. Chemically treat the compacted soil under all concrete floor slabs prior to the installation of the vapor barrier. Initial termite treatment (Termador) is required for building and for concrete slab on grade.

1.2. **Submittals**

1.2.1. **Product Data:** Submit manufacturer’s technical data and application instructions.

1.2.2. Termite protection shall be provided by registered termiticides, including soil applied pesticides, baiting systems, and pesticides applied to wood, or other approved methods of termite protection labeled for use as a preventative treatment to new construction. Upon completion of the application of the termite protective treatment, a certificate of compliance shall be issued to the building department by the licensed pest control company that contains the following statement: “The building has received a complete treatment for the prevention of subterranean termites. Treatment is in accordance with rules and laws established by the Florida Department of Agriculture and Consumer Services.”

1.3. **Quality Assurance**

1.3.1. In addition to requirements of these specifications, comply with manufacturer’s instructions and recommendations for work, including preparation of substrate and application.

1.3.2. Engage a professional pest control operator, licensed in accordance with regulations of governing authorities for application of soil treatment solution.

1.3.3. Use only termiticides, which bear a Federal registration number of the U.S. Environmental Protection Agency.
1.4. Job Conditions

1.4.1. Restrictions: Do not apply soil treatment solution until excavating, filling and grading operations are completed, except as otherwise required in construction operations.

1.4.2. To insure penetration, do not apply soil treatment to frozen or excessively wet soils or during inclement weather. Comply with handling and application instructions of the soil toxicant manufacturer.

1.5. Specific Product Warranty

1.5.1. The Subcontractor for the initial soil poisoning must furnish a service agreement stating the Work performed will be guaranteed for a period of 10 years from the date of Substantial Completion and that the structure will be inspected yearly for infestation and treatment provided as necessary. The Service Agreement shall state that in the event of damage during the Guarantee Period, the Subcontractor shall make repairs to structurally damaged surfaces to a dollar value based on the size of the building. An Independent Testing Laboratory shall certify that the treatment meets the requirements of the Specifications.

2. PRODUCTS

2.1. Soil treatment solution

2.1.1. Use an emulsible concentrate termiticide for dilution with water, specially formulated to prevent infestation by termites. Fuel oil will not be permitted as a diluent. Provide a solution consisting of one of following chemical elements and concentrations:

   a. Chloropyrifos (“Dursban TC”); 1.0 percent in water emulsion.

   b. Permethrin (Dragnet”, “Torpedo”); 0.5 percent in water emulsion.

2.1.2. Other solutions may be used as recommended by Applicator if also acceptable to Architect and approved for intended application by jurisdictional authorities.

3. EXECUTION

3.1. Application

3.1.1. Surface Preparation: Remove foreign matter on areas to receive treatment, which could decrease effectiveness of treatment.
a. Loosen rake and level soil to be treated, except previously compacted areas under slabs and foundations.

b. Toxicants may be applied before placement of compacted fill under slabs if recommended by toxicant manufacturer.

3.1.2. Application Rates: Apply soil treatment solution as follows:

a. Under slab-on-grade structures, treat soil before concrete slabs are placed, using the following rates of application:

- Apply 4 gallons of chemical solution per 10 lin. ft. to soil in critical areas under slab, including entire inside perimeter inside of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers.
- Apply one gallon of chemical solution per 10 sq. ft. as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply 1-1.2 gallons of chemical solution to areas where fill is washed gravel or other coarse absorbent material.

b. Apply 4 gallons of chemical solution per 10 lin. ft. of trench, for each foot of depth from grade to footing, along outside edge of building.

- Dig a trench 6” to 8” wide along outside of foundation to a depth of not less than 12”.
- Punch holes to top of footing at not more than 12” o.c. and apply chemical solution.
- Mix chemical solution with the soil as it is being replaced in trench.

c. At hollow masonry foundations or grade beams, treat voids at rate of 2 gal. Per 10 lin. ft. poured directly into the hollow spaces.

3.1.3. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs when areas are covered by other construction.

3.1.4. Reapply soil treatment solution to areas disturbed by subsequent excavation, or other construction activities following application.

END OF SECTION
PART 1 - GENERAL

1.1 SCOPE:

A. The Contractor shall furnish and place all concrete reinforcement as indicated on the drawings or specified herein.

1.2 Except as specified otherwise herein, work under this section shall comply with all applicable provisions of the section of these specifications entitled SITE WORK CONCRETE.

1.3 Concrete reinforcement in sizes No. 3 (3/8") and larger shall be deformed steel bars of the shapes and sizes indicated on the drawings.

1.4 Submit shop drawings including cutting and bending diagrams and schedules for all reinforcement to the Engineer for approval in accordance with the General Conditions. Reinforcing steel shall not be fabricated until shop drawings have been approved.

PART 2 - MATERIALS

2.1 Reinforcing steel shall be newly rolled stock, substantially free from mill scale, rust, dirt, grease, or other foreign matter and shall be domestic billet steel or rail steel.

2.2 Billet steel bars, if used, shall be Grade 60 conforming to ASTM A615-latest.

2.3 Rail steel bars, if used, shall conform to ASTM A616-latest.

2.4 In the case of rail steel bars, the bars shall be rerolled by an approved mill. The Contractor shall submit, at his expense, certified copies of tests of rail steel bars furnished. The tests shall be as specified in ASTM A616-latest and shall be made by an approved laboratory. To be accepted for use, the bars shall show an elongation in 8" of at least that required by ASTM A616-latest.

2.5 Welded wire fabric (mesh) shall conform to ASTM A185-latest.
2.6 Reinforcement shall be accurately formed to the dimensions indicated on the drawings and in accordance with ACI 315-latest. All bars shall be bent cold. No bars partially embedded in concrete shall be field bent, except as shown on the drawings or specifically approved by the Engineer.

2.7 Metal supports for reinforcing in concrete which is to be exposed to the atmosphere or to sewage or water flow shall be plastic-coated or galvanized.

2.8 Bars shall be shipped to the worksite with bars of the same size and shape fastened in bundles with metal identification tags giving size and mark securely wired on.

PART 3 - EXECUTION

3.1 Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings, including ice, that reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.

3.2 Reinforcement shall be accurately positioned as indicated on the drawings and secured against displacement by using annealed iron wire ties or suitable clips at intersections. Bar splices, laps, etc., shall be as called for on the drawings or, if not called for, laps shall be not less than 24 times the nominal diameter of the larger bar spliced. Wire mesh sheets shall have a side lap and end lap of not less than 6''. Concrete blocks having a minimum bearing area of 2'' x 2'' and equal in quality to the concrete specified shall be used for supporting reinforcing bars in footings and slabs on grade. For other concrete work, metal supports, spacers, or hangers may be used. Stones, wood blocks, brick chips, etc., shall not be used to support reinforcement. Wire ties shall be cut back so that no metal is within 1'' of the surface when the concrete is exposed to view.

3.3 Reinforcement which is to be exposed to the atmosphere for a considerable length of time after having been placed shall be painted with a heavy coat of cement grout.

3.4 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work involved in this section.

End of Section
PART 1 - GENERAL

1.1 SCOPE:

A. The work under this section shall include furnishing all labor, materials, and equipment to construct and/or install all construction joints, expansion joints, and waterstops in concrete work including joint sealants and premolded joint filler.

1.2 Except as specified otherwise herein, work under this section shall comply with all applicable provisions of the section of these specifications entitled SITEWORK CONCRETE.

1.3 Construction and expansion joints shall be of the types indicated on the drawings and shall be constructed whenever and only in such places as are indicated on the drawings or directed otherwise or approved. The Contractor shall plan the work to minimize the use of joints in addition to those indicated.

1.4 Unless indicated otherwise, construction joints shall meet the requirements of ACI 301-latest.

1.5 Footings, beams, and slabs shall have no horizontal joints. Unless indicated otherwise, all construction joints shall have keyways the widths of which are equal to 1/3 the thickness of the member in which the keyways are placed. Keyways shall be continuous with a 3/4" minimum depth and beveled sides.

1.6 Expansion joints in exterior sidewalks shall have 1/2" premolded bituminous mastic joint filler.

1.7 WATERSTOPS:

A. Waterstops shall be ribbed or dumbbell type and in expansion joints shall have a center bulb. They shall be continuous along the concrete joint. End joints and corners shall be thermo-spliced to provide water tightness.

B. Unless noted otherwise, waterstops shall be provided in all joints in tanks or other structures that will contain liquid.
C. Waterstops shall be furnished in the longest lengths possible. They shall be accurately positioned with the center at the joint openings, unless indicated otherwise.

1.8 EXPANSION JOINTS:

A. Unless noted otherwise, expansion joints shall be 1/2" wide with joint filler recessed to accommodate a 3/4" diameter backer rod and an area of sealant 1/2" wide and 1/2" deep.

B. Expansion joints in base slabs on grade shall be 1/2" bituminous fiber filler and poured self-leveling sealant. Minimum depth of sealant shall be 1/2".

C. Expansion joints in walls and other vertical elements and elevated slabs and beams shall be 1" bituminous fiber filler and gun grade sealant.

PART 2 - MATERIALS

2.1 Joint sealants shall be 2-part polysulfide or polyurethane conforming to U.S. Federal Specifications TT-S-00227E. Pouring (self-leveling) compounds shall be Type I and gun grade (non-sag) compounds shall be Type II. Sealants shall be applied in strict accordance with the instructions of the manufacturer, using a suitable primer if necessary. Approved: Sikaflex by Sika Chemical Company, Hornflex-L by W.R. Grace and Company, Vulkem 245 by Mameco International or equal.

2.2 Backer rods shall be closed-cell polyethylene foam with a diameter 25% wider than joint width. Approved: Ethafoam by Dow Coming Corporation or equal.

2.3 Premolded mastic joint filler shall conform to ASTM D1751-latest (bituminous fiber) as specified or indicated on the drawings.

2.4 Unless noted otherwise, waterstop shall be of an approved polyvinylchloride (PVC) type conforming to U.S. Army Corps of Engineers Specification CRD-C572, with a width not less than 6" in construction joints and 9" in expansion joints and thickness not less than 3/8".
PART 3 - EXECUTION

3.1 Concrete joints to be sealed with poured joint compound shall be clean and dry and, if required by the manufacturer's instructions, shall be primed. Compound shall be carefully poured to prevent spilling the material over the adjoining surfaces. As the material cools and subsides, additional compound shall be poured until the joint is filled to the required level.

3.2 Premolded mastic joint filler shall be placed against the bulkhead form and lightly fastened with brads to the inside of the form to hold the sheets in place when the concrete is placed. Tenpenny-galvanized nails shall be driven through the sheets with points projecting into the concrete to secure mechanical bond with the concrete placed against them.

3.3 Care shall be taken at all times to prevent any disturbance of or damage to mastic sheets or waterstops.

3.4 CONSTRUCTION JOINTS:

A. Before depositing new concrete on or against hardened concrete which is not more than 90 days old, the surface of the hardened concrete shall be thoroughly cleaned of foreign matter and laitance and roughened in a manner that will not leave loosened particles of aggregate or damaged concrete at the surface. Hardened concrete surface shall be dampened (but not saturated) and thoroughly coated with a rich grout (1 part cement and 2 parts sand with a 6" slump) not more than 20 minutes before placing new concrete.

3.5 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work herein before specified. The Contractor's lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work involved in this section.

End of Section
SECTION 32 12 16

PAVEMENT

PART 1 - GENERAL

1.1 SCOPE:

A. The work under this section includes the furnishing of all labor, material and equipment required to provide the new paving as shown on the drawings and as specified hereinafter.

1.2 GENERAL REQUIREMENTS:

A. Except as otherwise provided herein, materials and methods of operations required to install new and replacement pavements shall be in accordance with the applicable requirements and specifications for roads and streets of the Florida Department of Transportation.

B. Where construction requires removing pavement, or where existing paving is damaged by the Contractor's operation, it is the intent of these specifications that due care be exercised in cutting pavement, backfilling trenches and replacing pavement to the end of securing a condition where no further settlement of trenches will occur and the paved surfaces will be restored to a condition equal to or better than that existing before construction began.

C. No paving work shall be accomplished until all heavy construction equipment is permanently removed from the site and after all lines located under pavement have been tested and accepted.

D. All surfaces which have been injured by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun.

PART 2 - MATERIALS

2.1 STABILIZATION:

A. Roadbed stabilization shall be compacted to 95% density as measured by the Standard Proctor Test. All stabilized areas shall have a minimum limerock bearing value of 40 in state right-of-way and LBR 30 elsewhere. All material, equipment, and workmanship shall be in accordance with Section 160 of the 2016 Florida Department of Transportation Specifications except that paragraphs 160-5 and 160-6 shall be omitted. Thickness of stabilization shall be as shown on the
drawings. Contractor shall bear cost of testing at a laboratory designated by the Owner. Compaction tests shall be conducted at a rate of one test per 350 lineal feet of roadway compaction per foot of lift. Contractor shall give the Owner ample notice to notify the laboratory to perform tests as specified. Immediately upon receipt by the Contractor, two copies of test results shall be furnished the Owner, and one copy furnished to the Engineer.

2.2 BASE COURSE:

A. The base course for the paved areas shall be of limerock constructed to the thickness as shown on the drawings. All materials, equipment, and workmanship shall be in accordance with Section 200 of the 2016 Florida Department of Transportation Specifications except that paragraphs 200-10 and 200-11 shall be omitted. The base course shall be tested at 300 lineal foot intervals at the Contractor's expense at a laboratory designated by the Owner. The Contractor shall give the Owner ample notice to notify the laboratory to perform tests as specified. Immediately upon receipt by the Contractor, two copies of test results shall be furnished the Owner, and one copy furnished to the Engineer.

2.3 PRIME COAT:

A. A prime coat consisting of a bituminous material hereinafter specified shall be applied at a rate of fifteen hundredths (0.15) gallons per square yard to the previously prepared base course. All materials, equipment and workmanship shall be in accordance with Section 300 of the 2016 Florida Department of Transportation Specifications except that Paragraph 300-9 and 300-10 shall be omitted.

2.4 ASPHALTIC CONCRETE SURFACE COURSE, TYPE AS SHOWN:

A. The paving shall have a wearing surface of asphaltic concrete; thickness as shown. All equipment, materials, workmanship, and methods employed on construction of the wearing surface, shall be in accordance with Section 300, 320 and 330 of the aforementioned 2015 Florida Department of Transportation Specifications.

PART 3 - EXECUTION

3.1 BITUMINOUS PAVEMENT:

A. Shall be removed to clean straight lines by sawcutting. Where bituminous pavement adjoins a trench, the edges adjacent to the trench shall be trimmed to neat straight lines before resurfacing to ensure that all areas to be resurfaced are accessible to rollers used to compact the subgrade or paving materials.
3.2 ORDER OF WORK:

A. Work shall be accomplished in the following order:

1. Stabilization and compaction of sub-base
2. Limerock base course
3. Prime coat
4. Asphaltic concrete surface course, type and thickness as shown

3.3 TESTS:

A. Where reference is made in the 2016 Florida Department of Transportation Specifications for design mixes, tests of materials, or work performed, or where in the opinion of the Engineer, tests were required to ascertain compliance with the specifications, the Owner shall make such tests by an independent testing laboratory under a separate contract. All testing expenses shall be borne by the Contractor as specified in the section of these specifications entitled GENERAL CONDITIONS.

3.4 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the Proposal shall constitute full compensation for the work involved in this section.

End of Section
PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including the General Conditions, Supplementary Conditions, and Special Conditions, if any, along with the General Requirements, apply to the work specified in this section.

1.2 CODES AND REGULATIONS:

A. All work shall comply with applicable Local codes and regulations.

1.3 REFERENCED STANDARDS:

A. The Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, are referred to hereinafter as the Standard Specifications. References to the Standard Specifications are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

B. Standard Drawings: Except as otherwise shown on drawings or specified herein, the applicable details of the Florida Department of Transportation (F.D.O.T.) Roadway and Traffic Design Standards, latest edition, shall apply. References to the F.D.O.T. Roadway and Traffic Design Standards are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

PART 2 - MATERIALS

2.1 CONCRETE:

A. Comply with applicable requirements of the Standard Specifications for concrete materials, admixtures, bonding materials, curing materials, and others as required. Mix design to produce standard-weight concrete with minimum compressive strength of 3000 psi at 28 days, 2-inch to 4-inch slump range. All work shall have a minimum strength of 3000 psi and meet the conditions of Class I concrete, Section 347 of the Standard Specifications.
2.2 FORMS:

A. Either steel or wood of sufficient strength to resist movement during concrete placement, straight and free of distortion and defects. Use flexible spring steel forms on radius bends. Coat forms with a non-staining form release agent that will not discolor or deface the surface of the concrete.

2.3 EXPANSION JOINT FILLER:

A. Asphalt impregnated fiber strips ½-inch thick, full depth in accordance with specification section CONSTRUCTION AND EXPANSION JOINTS.

2.4 WELDED WIRE REINFORCEMENT:

A. Welded plain cold-drawn welded wire reinforcement, ASTM A 185.

PART 3 - EXECUTION

3.1 DETAILS:

A. Concrete sidewalk shall conform to F.D.O.T. Roadway and Traffic Design Standards, Index No. 310.

B. Pavement: 6" thick concrete slab installed over compacted bed, reinforced with welded wire reinforcement meeting ASTM A185 standards. Edges neatly tooled. Where slabs have an exposed perimeter edge (i.e., does not abut a wall) or as shown on plans, turn down slab at edge 12" deep total and 6" wide at narrowest point.

3.2 INSPECTION:

A. Examine the prepared subgrade for unstable areas in need of additional compaction. Do not proceed with work until unsatisfactory conditions have been corrected. Remove all trash, debris, and other loose material prior to placement.

3.3 LINES AND GRADES:

A. Set form to required lines and grades, rigidly braced and secured with a tolerance of 1/4-inch in 10 feet. Install sufficient quantity of forms to allow continuous progress of the work and so that forms can remain in place at least 24 hours after concrete placement. It is intended that the lip of the gutter shall match the original existing street elevation.
B. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.

3.4 UTILITIES:

A. Take care not to damage existing utilities. All adjustments to the existing utilities that must be made for the work of this section shall be the responsibility of the Contractor.

3.5 JOINTS:

A. Construct expansion, contraction, and construction joints true-to-line with face perpendicular to surface of the concrete, unless otherwise indicated. Construct transverse joints at right angles to the centerline, unless otherwise indicated. All joints will be constructed per specification section CONSTRUCTION AND EXPANSION JOINTS.

B. Unless shown otherwise on the drawings, provide contraction joints at intervals of 10 feet except where a lesser interval is required for closure. No section shall be less than 4 feet in length. Construct joints for a depth equal to at least 1/4 concrete thickness, as follows:

1. Tooled Joints: Form joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.
2. Sawed Joints: Form joints using powered saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by cutting action.

C. Place construction joints at the end of all pours and at locations where placement operations are stopped for a period of more than ½ hour, except where such pours terminate at expansion joints. Construct joints as shown, or, if not shown, use standard metal keyway-section forms.

D. Expansion joints shall be constructed at all radius points and at other locations indicated on the drawings. They shall be located at intervals of 500 feet between other expansion joints, ends of a run and between truck loads that exceed the time limits previously specified. Provide premolded joint filler for expansion joints abutting concrete curbs, walks, and other fixed objects, unless otherwise indicated.

1. Extend joint fillers full width and depth of joint and below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.
2. Furnish joint fillers in one piece lengths for the full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.
3. Protect the top edge of the joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

3.6 REINFORCEMENT:

A. Welded Wire: Shall be placed in accordance with Section 415 of the Standard Specifications.

B. Fiber Reinforcement: Shall be sized and mixed in accordance with the manufacturer’s recommendations.

3.7 PLACING:

A. Comply with the requirements of the Standard Specifications for mixing and placing concrete and as herein specified.

B. Do not place concrete until subgrade and forms have been checked for line and grade. Moisten subgrade if required to provide a uniform dampened condition at the 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 using methods which prevent segregation of the mix. Consolidate concrete along the face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies or side forms. Use only square-faced shovels for hand-spreading and consolidation.

D. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than ½ hour, place a construction joint.

E. 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 which meet or exceed the minimums herein specified. Machine placement must produce curbs and gutters to the 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.

3.8 FINISHING:
A. After striking-off and consolidating concrete, smooth the surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust the floating to compact the surface and produce a uniform texture.

B. After floating, test surface for trueness with a 10-foot straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Work edge of formed joints with an edging tool, and round to ½-inch radius, unless otherwise indicated. Eliminate any tool marks on concrete surface.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface with a broom finish. Draw a fine-hair broom across concrete surface, perpendicular to line of traffic. Repeat operation if required to provide a fine line texture.

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.

3.9 CURING AND PROTECTION:

A. Comply with applicable requirements in the Standard Specifications. Protect and cure finished concrete. Use moist-curing method for initial curing whenever possible.

3.10 REPAIRS AND PROTECTIONS:

A. Minor defects shall be filled with mortar composed of one part Portland Cement and two parts fine aggregate.

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. Sweep concrete pavement and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.
3.11 BACKFILLING AND COMPACTION:

A. After the concrete has set sufficiently, but not later than three (3) days after pouring, the backfill the area adjacent to the new concrete to the required elevation with suitable material which shall be placed and thoroughly compacted in layers not thicker than 6 inches.

END OF SECTION
SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish all labor, materials, equipment and such miscellaneous items as necessary for application of painted pavement markings as shown on the drawings, called for herein, or necessary for the proper completion of the work in accordance with these specifications and to the lines, notes, and dimensions indicated on the drawings or specified herein.

B. The following specifications are a direct reference to Section 710 of the Florida Department of Transportation Manual, "Standard Specifications for Road and Bridge Construction," latest edition, referred to hereinafter as the Standard Specifications unless stated otherwise.

C. All references to “the Department” shall be replaced with “the Owner”.

PART 2 - MATERIALS

2.1 PAINTED PAVEMENT MARKINGS:

A. Standard Specifications 710-2 Materials, including the following with deletions and substitutions as noted:

710-2 Delete the final sentence: “The Engineer will take random…”

PART 3 - EXECUTION

3.1 CONSTRUCTION REQUIREMENTS:

A. The following portions of Standard Specifications Section 710 with deletions and substitutions as noted:

710-4 APPLICATION

710-4.1 Delete "by a method approved by the Engineer" where applicable.

Delete: “Payment for marking removal will be in accordance with 102-5.8.”
Delete: “or other means approved by the Engineer.”

710-4.3 Delete “and submit to the Engineer”.

710-5 TOLERANCES IN DIMENSIONS AND ALIGNMENT

710-5.1.3 Delete

710-6 CONTRACTOR’S RESPONSIBILITY FOR NOTIFICATION – Delete.
710-8 CORRECTIONS FOR DEFICIENCIES TO APPLIED PAINTED PAVEMENT MARKINGS – Delete.

710-9 SUBMITTALS – Delete.

710-10 METHOD OF MEASUREMENT - Delete.

710-11 BASIS OF PAYMENT - Delete.

3.2 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work provided in this section.

End of Section
SECTION 32 92 23

GRASSING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. Furnish all material, equipment, transportation, water, tools and labor, unless otherwise specified, to establish grass plus all items called for or that can be reasonably inferred from the drawings, including sodding, grading, fertilizing, watering, and maintaining the area for a complete job. If any items for a complete job are omitted or not shown, furnish and install the same without cost to the Owner.

1.2 QUANTITIES:

A. Provide all sod required to complete the work as shown on the plans and specified herein.

1.3 APPLICABLE PUBLICATIONS:

A. The portion publications listed below form a part of this specification only to the extent referenced.

1. Florida Department of Transportation, "Standard Specifications for Road and Bridge Construction" (Standard Specifications), latest editions

2. Florida Department of Transportation, "Utility Accommodation Guide" Section 5, paragraphs K, L, and M, except delete "as directed by the Maintenance or Resident Engineer." and delete "or otherwise, to the satisfaction of the Maintenance or Resident Engineer.", July 1979.

1.4 RECORDS:

A. Submit weekly records to the Owner of all grassed areas for use in determining the beginning and end of the maintenance period. Records shall indicate the date of grassing, the type (sod) and quantity (sq. ft., sq. yds, or acres) of grassing as well as the location of the grassed areas.

PART 2 - MATERIALS

2.1 SOD:

A. DOT Spec, Section 981-3, "Argentine Bahia", as indicated and specified herein.
2.2 FERTILIZER:
   A. DOT Spec, Section 982, "Fertilizer"

2.3 WATER:
   A. DOT Spec, Section 983, "Water for Grassing".

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS – GENERAL:
   A. Provide and establish grassing in accordance with FDOT Utility Accommodation Guide; unless specified otherwise herein.
   B. Do not fertilize when wind velocities exceed 15 miles per hour.
   C. When a length of roadway slopes or other areas have been graded and made ready, commence sodding in accordance with these specifications. Incorporate grass covering into the project at the earliest practical time in the life of the contract to reduce potential erosion.
   D. Store fertilizer in dry locations away from contaminants. Lightly sprinkle sod with water, cover with moist burlap, straw or other reviewed covering, and protect from exposure to wind and direct sunlight until planted. Provide covering that will allow air to circulate so that heating will not develop.

3.2 CONSTRUCTION METHODS FOR GRASSING:
   A. Grassing will be required in all areas disturbed during construction.
   B. The type and location of grassing will be as called for in the plans, and/or specified herein.
   C. Sequence of Operations: The several operations involved in the work shall proceed in the following sequence: Preparation of the ground, sodding, fertilizing, watering and maintaining.
   D. Preparation of Area to be Grassed: Bring all planting areas to finished grades, filling as needed or removing weeds, surplus dirt and rock debris over 1 inch in
diameter, and floating to a smooth uniform grade. Slope all areas to drain. Establish flow lines to match existing or as shown on the plans. Finish grass areas 1 inch below top of adjoining pathway.

E. Restore existing lawns adjacent to residential or commercial property using grass sod species to match the existing lawns. Use Argentine Bahia Sod for a minimum of 15 feet around structures and in other areas where sod is specified or indicated.

3.3 SODDING:

A. Incorporate sodding into the project at the earliest practical time in the life of the contract. Do not use sod which has been cut for more than 5 days. Stack any sod which is not planted within 24 hours after cutting and maintain properly moistened.

B. Place the sod on a prepared surface with closely abutting joints. Fill any gaps or cracks between sod blocks with sod. Roll with a minimum one-ton roller to obtain an even surface. Bring the sod edge in a neat, clean manner to the edge of all paving and shrub areas.

C. Replace any pieces of sod which, after placing, show on appearance of extreme dryness.

D. Mow the sod to establish a uniform grass surface to 2-1/2 inches.

3.4 WATERING:

A. Maintain a balanced watering program until the acceptance of work.

B. Apply water in sufficient quantities and as often as seasonal conditions require to keep the grassed areas moist at all times to a depth of 6 inches below the root system.

3.5 FERTILIZATION:

A. Thirty days after the application of seed and sod broadcast fertilizer at a rate of 450 pounds per acre. Notify the Owner and Owner's representative, in writing, within 7 days prior to the date of application.

3.6 SATISFACTORY GROWTH:

A. The term "Satisfactory Growth" as used in this section is defined as even plant growth in healthy conditions without bare spots larger than one square foot. Bare spots larger than one square foot shall be resodded and maintained until satisfactory growth has been demonstrated.
3.7 MAINTENANCE AND GUARANTEE:
   A. Maintain all grassed areas for a period of 90 days from the date of application of sod, and guarantee against all defects and faults of material and workmanship.
   B. Maintain grassed areas by watering, fertilizing, and mowing to establish an even and uniform grass surface of 2-1/2 inches.
   C. In the event that the grass exhibits iron chlorosis symptoms during the establishment period, apply Fe 138 Geigy or equivalent at manufacturer's recommended rates.

3.8 GUARANTEE:
   A. Guarantee all grassed areas to be alive and in satisfactory growth at the end of the maintenance period (90 days from planting date).
   B. Replace any grass that is dead or not in satisfactory growth, as determined by the Owner or Owner's representative. Guarantee and maintain new grass for an additional period of 90 days.
   C. Replace grass with the same variety as initially specified.

3.9 INSPECTION:
   A. Request a review from the Owner or his representative at least 72 hours in advance of the time inspection is required.

3.10 MEASUREMENT AND PAYMENT:
   A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the PROPOSAL shall constitute full compensation for the work provided in this section.

End of Section
PART 1 - GENERAL

1.1 SCOPE:

A. The Contractor shall furnish and install the potable water piping system, complete, tested, disinfected, and ready for operation. This section contains standard specifications for use in general procedures as specified herein or as otherwise shown on the drawings.

1.2 GENERAL REQUIREMENTS:

A. All work shall be proved to be in first class condition and constructed properly in accordance with the drawings and specifications. All defects and leaks disclosed by the tests shall be remedied. All tests shall be performed by the Contractor and observed by the Owner. Water for testing will be furnished by the Contractor.

B. The Contractor shall submit to the Engineer for approval before work begins certificates of inspection from the pipe manufacturer that the pipe and fittings supplied have been inspected at the plant and meet the requirements of these specifications.

C. All work shall be performed in accordance with the requirements of the location authority having jurisdiction.

PART 2 - MATERIALS

2.1 GENERAL:

A. Unless indicated otherwise on the drawings, pipe materials for water mains shall be PVC DR 18.

B. All material shall be free from defects impairing strength and durability and be of the best commercial quality for the purpose specified. It shall have structural properties sufficient to safely sustain or withstand strains and stresses to which it is normally subjected and be true to detail.

2.2 POLYVINYL CHLORIDE:

A. Pipe shall be polyvinyl chloride (PVC) pipe for potable water and shall have a bell type coupling with a thickened wall section integral with the pipe barrel. The
pipe material shall be clean, virgin, NSF approved Class 12454-A or 12454-B PVC compound conforming to ASTM resin specification D-1784. The pipe shall be tested at levels meeting the requirements of the U.S. Department of Commerce Public Standard 22-70, and shall conform to the physical standards specifications of the Plastic Pipe Institute. Pipe shall be approved for potable water by the National Sanitation Foundation. All herein referenced standards shall be of the latest edition or revision.

B. PVC 1120 Pipe, Class 150, DR18 - Pipe shall conform to AWWA Standard C-900-latest for use in sizes 4 inches and larger in diameter. Pipe is to be manufactured to cast iron pipe equivalent outside diameters and may be used in lieu of cast iron and ductile iron pipe. The pipe shall be designed to pass without failure a sustained pressure test of 500 psi in conformance with ASTM D1598 and for a quick burst test of 755 psi in conformance with ASTM D1599. In any case of conflict with standards specified herein, the requirements of AWWA Standard C900 shall prevail.

C. PVC 1120, Schedule 40 – Pipe shall conform to ASTM D-1785 – latest and be NSF-PW rated, for use in sizes 3 inches and smaller. The sustained pressure test shall be conducted in accordance with ASTM D-1598 at test pressures given in ASTM 1785 when tested in accordance with ASTM D-2672 (Section 6.5). The burst pressure test shall be conducted in accordance with ASTM D-1599 at test pressures given in ASTM 1785. When determined in accordance with ASTM D-2672 (Section 6.6). The pipe shall be PVC 1120, Schedule 40, as manufactured by Ethyl Corporation or approved equal. All pipe joints shall meet AWWA Standards.

2.3 DUCTILE IRON PIPE:

A. Unless noted or specified otherwise herein, all pipe 3” and larger shall be ductile iron designed in accordance with ANSI A21.50 (AWWA C150) latest using 60,000 psi tensile strength, 42,000 psi yield strength and manufactured in accordance with ANSI (AWWA C151) latest. The pipe shall be designed for internal operating pressure of 250 psi, at 8 foot depth of cover and type 2 laying condition.

B. The pressure rating, metal thickness class, net weight of pipe without lining, length of pipe, and name of manufacturer shall be clearly marked on each length of pipe.

C. Except as modified herein, the class of ductile iron pipe shall be as follows: mechanical and push-on joint pipe shall be Class 51; flanged pipe shall be Class 53.
2.4 LABORATORY OR PLANT TESTS:

A. Pipe and materials shall be tested in and for conformity with the latest editions of the following:

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<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
<th>Number of Tests</th>
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<tbody>
<tr>
<td>Ductile Iron Pipe And Fittings</td>
<td>ANSI A21.50 (AWWA C150)</td>
<td>Sworn Statement</td>
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<td>ANSI A21.51 (AWWA C151)</td>
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<td>ANSI A21.53 (AWWA C153)</td>
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<td>Polyvinyl Chloride Pipe</td>
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2.5 JOINTS

A. PVC pipe joints shall be the manufacturer’s standard push-on bell type with rubber sealing ring for pipe sizes 3-inches and larger installed in strict accordance with the pipe manufacturer’s recommendations. Ductile iron fitting shall be used for PVC pipe 4-inches and larger.

2.6 FITTINGS

A. Ductile Iron Fittings and special castings, shall conform to the type of pipe being installed and have a minimum working pressure of 200 psi. Fittings shall conform to ANSI Specification A21.53 (AWWA C153) latest. Short radius pattern fittings shall normally be installed. Long radius fittings shall be used where the drawings specifically call for on radius fittings or at the option of the Contractor when the laying length is not controlled by short radius patterns. Fittings shall be mechanical joint fittings unless otherwise specified or indicated on the drawings.

2.7 LININGS AND COATINGS

A. All ductile iron fittings and specials shall be cement mortar lined. The exterior of buried ductile iron pipe shall receive a coat of hot coal-tar. The exterior of all above ground pipe shall receive a coat of rust inhibitor prime compatible with the finish paint schedule. All bolts, nuts, studs and other uncoated parts of joints for underground installation shall be coated with asphalt or coal-tar prior to
backfilling. Pipes crossing ditches, culverts, rivers, creeks, etc., shall be considered as buried pipe.

2.8 INSPECTION:

A. The Contractor shall obtain from the manufacturer and submit to the Engineer a Certificate of Inspection stating the materials furnished have been inspected at the plant, meet the requirements of these specifications and have been tested as called for above.

B. The entire product of any manufacturer or of any one plant may be rejected when, in the opinion of the Engineer, the methods of manufacture fail to secure uniform results acceptable to the requirements of these specifications.

C. All pipe and fittings shall be subject to inspection at time of delivery and also in the field just prior to installation. All pipe and fittings which in the opinion of the Owner do not conform to these specifications will be rejected and shall be removed by the Contractor at no additional cost to the Owner.

PART 3 - EXECUTION

3.1 PIPE LAYING GENERAL REQUIREMENTS:

A. Water mains shall be constructed of the materials specified and as shown on the drawings. Each section of the pipe shall rest upon the pipe bed for the full length of its barrel. Any pipe which has its grade or joint disturbed after laying shall be taken up and relayed. No pipe shall be laid when the trench conditions or the weather is unsuitable for such work, except by permission of the Owner. Pipe fittings shall be carefully handled to avoid damage; they shall be inspected for defects and to detect cracks. Defective, damaged or unsound pipe or fittings shall be rejected. Any section of pipe already laid which is found to be defective or damaged shall be replaced with new pipe without additional cost to the Owner.

B. Pipe Cover: The minimum cover over all piping shall be 30 inches for pipe diameters of 10” or less and 36” for pipe diameters of 12” or greater except where specifically shown otherwise. Bedding details are specified on drawings, backfill, and compaction in earthwork specification.

C. Thrust Blocking: Suitable concrete reaction thrust backing shall be applied on all pressure pipe lines (except for those having screwed or flanged joints) at all tees, plugs, caps, and at bends deflecting 22-1/2 degrees or more. Concrete used for this purpose shall be 2,500 psi minimum. Schedule and details for required thrust blocks are included on the drawings.
3.2 CLEANING AND FLUSHING:

A. Prior to the pressure and leakage tests, all piping shall be thoroughly cleaned of all dirt, dust, oil, grease, and other foreign matter.

B. All lines shall be thoroughly flushed with clean water to clear all lines of foreign matter.

3.3 FIELD TESTING:

A. All field tests shall be made in the presence of the Engineer and a representative from the local authority having jurisdiction. Except as directed otherwise, all pipelines shall be tested. Pipelines laid in excavation (other than trench excavation) or embedded in concrete, shall be tested prior to backfilling of the excavation or placing of the concrete.

B. All piping to operate under liquid pressure shall be tested in sections of approved length. For these tests the Contractor shall furnish clean water, suitable temporary testing plugs or caps, and other necessary equipment and all labor required without additional compensation. The Contractor will furnish suitable pressure gauges, calibrated by an approved testing laboratory, with increments no greater than 2 psi. Gauges used shall be of such size that pressures tested will not register less than 10% nor more than 90% of the gauge capacity.

1. Unless it has already been done, the section of pipe to be tested shall be filled with water of approved quality and all air shall be expelled from the pipe. If hydrants, blowoffs, or other outlets are not available at high points for releasing air, the Contractor shall make the temporary taps at such points and shall plug said holes after completion of the test.

2. Hydrostatic testing shall consist of both pressure tests and leakage tests. Pressure tests shall be of 1-hour duration and leakage tests shall be of 2-hour duration, unless specified otherwise or notified in writing by the Owner. Test pressures shall be as set forth hereinafter. Specified test pressures, based on the elevation of the highest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Owner. Pressure shall be of the minimum pressure applied to the line or section under test. The pump, pipe connection, and all necessary apparatus, including the proper gauges, shall be furnished by the Contractor and shall be subject to the approval of the Engineer.

3. Pressure tests shall be conducted with a pressure loss of not more than 2# per square inch regardless of length being tested. All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test shall be repaired or replaced with...
sound material and the test shall be repeated until it is satisfactory and at no additional cost to the Owner.

4. Leakage tests shall be conducted subsequent to the pressure tests. Leakage is defined as the quantity of water that must be supplied to the line or section under test to maintain constant pressure throughout the duration of the test. No pipe installation will be accepted if the leakage is greater than determined by the following formula from ANSI/AWWA C600-latest:

\[ L = S \times D \times (P)^{1/2} \]

in which \( L \) is the allowable leakage in gallons per hour; \( S \) is the length of pipeline tested in feet; \( D \) is the nominal diameter of the pipe in inches; and \( P \) is the average test pressure during the leakage test in pounds per square inch gauge. If any test discloses leakage greater than that specified above, the Contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance.

5. In the event a section fails to pass the tests, the Contractor shall do everything necessary to locate, uncover (even to the extent of uncovering the entire section), and repair or replace the defective pipe, fitting, or joint. Visible leaks shall be corrected regardless of total leakage. Lines which fail to meet these tests shall be repaired and retested as necessary until test requirements are complied with. All testing shall be performed at no additional cost to the Owner.

6. If, in the judgment of the Engineer, it is impracticable to follow the foregoing procedures exactly for any reason, modifications in the procedure shall be made as required or approved; but, in any event, the Contractor shall be responsible for the ultimate tightness of the piping within the above requirements.

7. Test Pressures - All Polyvinyl-chloride piping shall be pressure and leak tested as follows:

- Pressure Test - 2 hour duration at 150 psig
- Leakage Test - 2 hour duration at 150 psig

3.4 DISINFECTION:

A. All water pipes and fittings at whatever size and wherever installed on potable water lines shall be thoroughly disinfected prior to being placed in service. Disinfection shall conform to the applicable provisions of procedures established for the disinfection of water mains in AWWA C-651-latest and shall be in accordance with both state and local requirements.

B. After disinfection has been completed, samples of water for bacteriological analysis shall be collected and submitted to the appropriate state agency for
testing. Should these samples or subsequent samples prove to be unsatisfactory, then the piping shall be disinfected until satisfactory samples are obtained.

3.5 MEASUREMENT AND PAYMENT:

A. No additional payment shall be made for the work hereinbefore specified. The Contractor's unit price or lump sum bid as set forth in the Proposal shall constitute full compensation for the work involved in this section.

END OF SECTION
SECTION 33 31 00

GRAVITY SEWERS

PART 1 - GENERAL

1.1 SCOPE:

A. The Contractor shall furnish and install all gravity sewer lines, manholes, fittings, and appurtenances required for a complete system as shown on the drawings and specified herein.

1.2 GENERAL REQUIREMENTS

A. All work shall be proved to be in first class condition and constructed properly in accordance with the drawings and specifications. All defects and leaks disclosed by the tests shall be remedied. All tests shall be performed by the Contractor and observed by the Engineer and a representative of the local authority having jurisdiction. Water for testing will be furnished by the Contractor.

B. The Contractor shall submit to the Engineer for approval before work begins certificates of inspection from the pipe manufacturer that the pipe and fittings supplied have been inspected at the plant and meet the requirements of these specifications.

C. Clearing, pavement, excavation and backfill are specified in Division 31, EARTHWORK, Section 31 20 00. Concrete work is specified in Division 32, SITEWORK CONCRETE, Section 32 16 00.

D. All work shall be performed in accordance with the requirements of the local authority having jurisdiction.

PART 2 - MATERIALS

2.1 GENERAL:

A. All material shall be free from defects impairing strength and durability and be of the best commercial quality for the purpose specified. It shall have structural
properties sufficient to safely sustain or withstand strains and stresses to which it is normally subjected and be true to detail. All pipe and fittings shall be clearly marked with the name or trademark of the manufacturer, the batch number, the location of the plant, and strength designation, etc.

2.2 PVC PIPE SDR 35:

A. Polyvinyl Chloride sewer pipe for use in gravity sewer systems, shall conform to ASTM D3034-74 for Type PSM Polyvinylchloride (PVC) sewer pipe and fittings for sizes 4-inch through 12-inch in diameter, except as hereinafter modified. The pipe material shall meet or exceed the approved Class 12 454-B, PVC compound conforming to ASTM D1784, latest. The bell shall be extruded integral with the pipe barrel with a thickness equal to or greater than that of the barrel. The laying length shall not exceed 13'-0" (±1") without specific written approval of the Engineer.

B. Joints: Joints for PVC pipe and fittings shall be in accordance with ASTM D3034-74, sub-paragraphs 6.2 and 6.2.1.

1. Elastomeric Gasket Joint: Provision shall be made for contraction and/or expansion at each joint with a solid cross section rubber ring. The rubber ring shall be factory assembled and secured in the bell, in such a manner so as to prevent sliding or rolling when the spigot end of the adjoining pipe is installed.

C. Fittings: All fittings and accessories shall be manufactured in accordance with ASTM D3034-74, except that saddle tee's or saddle wyes shall not be permitted except by special written approval by the Engineer. Said fittings shall have a thickness equal to or greater than that specified in the aforementioned pipe specification and shall be of the bell and spigot configuration.

D. Test Reports: All pipe and fittings delivered to the job site shall be accompanied by independent testing laboratory reports, certifying that the pipe and fittings conform to the above mentioned ASTM Specification.

1. Certification: The Contractor shall submit a notarized statement of certification from the pipe manufacturer as to conformance with the aforementioned ASTM specification(s) and modifications thereto, at the
2.3 DUCTILE IRON PIPE:

A. Ductile iron pipe, 3-inch through 54-inch, shall conform to ANSI Standard A21.51-7 Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids with the minimum rated working pressure. The pipe shall have design values of 60,000 psi tensile strength, 42,000 psi yield strength, and 10% minimum elongation. The wall thickness shall be in accordance with Table 51.2 and the corresponding class designation in Table 521.3 of the above referenced specification using wall thickness for laying condition “B” and thickness as required to the depth of cut, shown on the drawings. In addition to the standard markings required by ANSI A21.51-76, the utility company may require each joint of pipe to be marked for the depth of cut it is to be used on the project, in which case, such markings shall be stenciled on the pipe exterior. Joints for ductile iron pipe shall conform to ANSI Standard Specification A21.11-72, Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings, of the push-on type, unless otherwise specified or shown on the drawings.

B. Fittings: Shall conform to ANSI Standard specifications A21.10-71, American Standard for Cast Iron Fittings, 2-inch through 48-inch, for water and other liquids, Class 150, mechanical unless otherwise noted on the drawings.

C. Polyethylene Lining: The interior of all ductile iron pipe and fittings shall be furnished with factory applied polyethylene lining. The lining material shall be virgin polyethylene complying with ASTM D1248, compounded with sufficient carbon black to resist ultraviolet rays during above ground storage of the pipe. The polyethylene shall be fused to the interior of the pipe by heat forming a tightly bonded lining. Lining shall be the capability of withstanding operating temperatures of minus 20 degrees F. to plus 170 degrees F. and withstanding sewage with a minimum pH of 4.0.

1. Application – The interior surface of each pipe shall be blast-cleaned, ground or otherwise mechanically cleaned to remove high temperature oxide film and to form an anchor pattern over the entire surface prior to heating and lining. Polyethylene lining is to cover the inner surface of the pipe, extending from the plain or beveled end to the rear of the gasket.
socket. A minimum of one in twenty joints or a minimum of one joint per 8 hour shift of production shall be check at the point of manufacture to assure bond of the lining to the pipe. Linings which have separations including those caused by hot slips produced during the lining operation shall be rejected. A “hot slop” defect would appear as a double flow or fold in the lining with evidence of separation. Injurious mechanical damage such as chuck marks and gouges extending to bare metal are also not acceptable.

2. Lining Thickness – Linings of nominal 40 mil thickness shall generally equal or exceed 40 mils throughout the pipe. At pipe ends, of 20 mil thickness. However the lining shall not deviate by more than minus 5 mils and the maximum will not exceed 60 mils. The lining thickness of each pipe and fitting shall be taken at the point of manufacture using a general electric magnetic dry film thickness device, digital coating thickness gauge, PosiTector 2000 or approved equal.

3. Testing – The entire inside lined surface of each pipe or fitting shall be free of pinholes, holidays discontinuities and any blister type surface imperfections. The manufacturer shall chick each pipe or fittings for holidays at the point of manufacture with a high voltage holiday detection device. The voltage shall be established for the actual lining thickness and shall be accomplished with a Tinker & Rasor Model AP-W or approved equal. All holiday testing procedures shall conform to NACE Standard RP-02-74 American Society for Testing materials (ASTM) Designation: G62-latest “Standard Test Methods for Holiday Detection in Pipeline Coatings”. No holidays, misses, or slips larger than a pinhole will be accepted for repair. A maximum of 6 holidays as defined in ASTM Standard G62 and as determined by the detection test described the heat refusing method. Each pipe and fittings shall be inspected in the field by the owner for conformance to these specifications prior to installation. Any defects as specified herein with any pipe or fitting shall be grounds for rejection. Field testing will be conducted at the expense of the Contractor in the case of dispute.

4. Certification: The manufacturer shall furnish notarized certificates of compliance stating that the lining conforms to all requirements of these specifications.
2.4 PRECAST CONCRETE MANHOLES:

A. Manholes shall meet the requirements of ASTM C478-latest, Specification for Precast Reinforced Concrete Manhole Sections, with the exclusion of Section 10(a), except as modified herein. Cement shall meet the requirements of ASTM C 150-latest, Specification for Portland Cement, Type II. Concrete shall meet the minimum requirements for Class A. Minimum wall thickness shall be 5 inches, or \( \frac{1}{12} \) the inside diameter as shown, whichever is greater. Rings shall be custom made with openings to meet indicated pipe alignment conditions and invert elevations. Openings shall be adequately sealed with approved non-shrinking grout, applied and cured in strict conformance with manufacturer's recommendations so that there will be zero leakage around pipes and joints. Approval of the Engineer shall be obtained before placing order for manholes.

B. Bases for manholes shall be cast integrally with the bottom manhole section. The base section shall be set in a 2-inch leveling course of Class C concrete or 8-inch leveling course of granular material directly on the prepared subgrade as shown on the drawings. In order to permit adjustment of the precast base section and insure full bearing on the Class C concrete leveling course, said section shall be placed just prior to initial set.

C. Joints: Joint contact surfaces shall be formed with machined castings; they shall be exactly parallel with a 2 degree slope and nominal \( \frac{1}{16} \)-inch clearance with the tongue equipped with a proper recess for the installation of an O-ring rubber gasket, conforming to ASTM C443, latest, joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gasket or premolded plastic joint sealer with joints pre-primed.

D. Coating: The interior and exterior surfaces of each manhole shall be given two (2) coats of waterproofing paint approved by the Engineer. Total minimum dry film thickness shall be 12 mils. Each coat shall be applied at the rate of not less than one gallon per 100 square feet. The waterproofing materials shall be applied by brush or spray and in accordance with the instructions of the manufacturer. Time shall be allowed between coats to permit sufficient drying so that the application of the second coat has no effect on the first coat. The paint shall be applied at the place of fabrication. Additional coating or touch up work will be required after manhole installation if so directed by the Engineer at no additional cost to the Owner.
E. Manhole Adjustment Materials

1. Brick: Sound, hard and uniformly burned, regular and uniform in shape and size, of compact texture and meeting the requirements of ASTM C32, latest, Specification for Sewer and Manhole Brick (made from clay or shale), Grade MS or MM.
2. Cement: Portland, ASTM C150, latest Specification for Portland Cement, Type II.

F. Cast iron manhole frames and covers shall be as detailed on drawings. Castings shall be made of good quality, strong, tough, even sandholes and defects of any nature which would render them unfit for the service for which they are intended. They shall be thoroughly cleaned and subjected to a careful hammer inspection. Castings shall meet the requirements of ASTM A48, latest, Specifications for Gray Iron Castings, Class No. 30, or Grade 65-45-12, Ductile Iron Castings. In either case, manhole frame and cover shall be designed to withstand an HS20-44 loading defined in the AASHTO Specifications. Before being shipped from the foundry, castings shall be given one (1) coat of coal-tar pitch varnish applied in a satisfactory manner so as to make a smooth coating, tough, tenacious and not brittle or with any tendency to scale off. Frames and covers shall be machined or ground at touching surfaces so as to seat firmly and prevent rocking. Any set not matching perfectly shall be removed and replaced at no additional cost.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION:

A. General: The method of pipe laying shall be subject to the approval of the Engineer. Each pipe length shall be inspected and tested before being laid to ensure that it is sound and of good quality. The pipe laying shall proceed upgrade, beginning at the lower end of the sewer, with pipe bell ends upgrade. Upon discovery, any defective pipe which may have been laid shall be removed and replaced with sound pipe at no additional cost to the Owner. Extreme care shall be taken to keep the pipe in exact alignment and elevation. Pipe shall be laid to conform accurately to the lines and grades indicated on the drawings. It shall
be the Contractor's responsibility to locate all underground utilities in advance of construction, to insure that no conflicts occur with the proposed line and grade. If approved by the Engineer, minor changes in the alignment but not the grade will be permitted to avoid underground facilities, provided that straight alignment can be maintained between manholes. However, if a conflict is found between an existing utility and the proposed grade, the Contractor is to furnish the Engineer all pertinent information, so that remedial design can be performed.

B. Laying and Jointing: The pipe shall be laid on an unyielding foundation with uniform bearing under the full length of the barrel of the pipe. The bedding shall be shaped to conform to the outside of the pipe. Suitable excavation shall be made to receive, where applicable, the bell of each pipe, which shall be carefully laid true to line and grade. All adjustments to line and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe. The spigot end of each pipe shall abut against the base of unevenness of any kind along the bottom halves of the pipes. Just before jointing the pipes, the mating ends shall be thoroughly cleaned of all dirt, debris, and foreign material. The pipe shall be jointed in accordance with the recommendations of the manufacturers of the pipe and gasket. In all jointing operations the trench must be dewatered when joints are made, unless otherwise approved in writing by the Engineer, and kept dewatered until sufficient time has elapsed to assure efficient hardening of the jointing material, or as may be required. The pipe shall not be driven down to grade by striking it with a shovel handle, timber, rammer, or other unyielding object. The Contractor shall take all necessary precautions to prevent flotation of the pipe from flooding of the trench.

C. Stoppers: Openings such as stubs, tees or other services along the lines shall be securely closed by means of an approved gasketed leakproof stopper that fits into the bell of the pipe and is recommended by the pipe manufacturer. This stopper shall be jointed in such a manner that it may be removed at some future time without injury to the pipe itself. At the close of each day's work, and at other times when pipe is not being laid, the end of the pipe shall be temporarily closed with a close-fitting stopper approved by the Engineer.

D. Cleaning: All necessary precautions shall be taken to prevent the entrance of mud, sand or other obstructing materials into the pipelines. As the work progresses, the interior of the sewer shall be cleaned of all dirt, jointing material, and superfluous materials of every description. The Contractor shall flush all
sewer lines constructed under this Contract with clean water prior to final inspection to assure complete removal of all debris and foreign material, and to the satisfaction of the Engineer.

E. Bedding and Backfill: Immediately after the pipe has been jointed and inspected, sufficient backfill shall be performed to protect the pipe adequately from injury and movement. Where so indicated on the drawings, or directed by the Engineer, the pipe shall be supported by compacted granular fill or concrete cradle or encasement according to the applicable detail shown on the plans. Pipe bedded in compacted granular backfill shall not be supported on blocking, wedges, bricks or anything except the bedding material. Where concrete cradle or encasement is required, the pipe shall be supported on solid concrete blocks or precast concrete saddles which shall become part of the completed cradle or encasement. Where no other bedding is indicated, pipe shall be placed on a shaped bed of undisturbed material.

F. Deformation/Deflection: Pipe shall be tested for deformation or deflection. Any pipe found to be deformed and/or deflected in excess of 7.5% of the nominal diameter of the pipe shall be removed and replaced with new pipe at no additional cost to the Owner. Results of the tests shall be submitted to the Owner. The cost of this service shall be included in the price bid for the particular item to which it is related.

3.2 MANHOLE INSTALLATION:

A. Installing Sections: Precast concrete sections shall be set so the manhole will be vertical and with sections in true alignment. Joint surfaces of the base or previously set section shall have an 0-ring installed in the recess or shall be sealed with approved premolded plastic joint sealer. Joints shall be pre-primed.

B. Non-Shrinking Mortar: All holes in sections used for their handling, and the annular space between the wall and entering pipes shall be thoroughly plugged with an approved non-shrinking mortar, applied and cured in strict conformance with the manufacturer's recommendations so that there will be zero leakage through openings and around pipes. The mortar shall be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces. As soon as mortar is hydrated to the point where it will not be marred by such application,
and within two hours after installing mortar, the Contractor shall apply an approved membrane curing compound, conforming to ASTM C309, latest, to the finished mortar surfaces both inside and outside the manhole.

C. Grade Adjustment: For grade adjustment in setting the manhole frame, brick masonry or precast concrete adjustment rings shall be used on top of manhole slabs and precast concrete manhole cones in accordance with the drawings. Mortar shall be one part cement and two parts sand; lime shall not be used.

D. Setting Manhole Frames: Manhole frames and covers shall be set to conform accurately to the finished ground or pavement surface as established by the Contract Drawings, unless otherwise directed by the Engineer. Frames on manhole cones shall be set concentric with the masonry and in a full bed of mortar so that the space between the top of the manhole masonry and the bottom flanges of the frame shall be completely filled and made watertight. A ring of mortar at least one inch thick and pitched to shed water away from the frame shall be placed around the outside of the bottom flange. Mortar shall extend to the outer edge of the masonry and shall be finished smooth and flush with the top of the flange.

E. Flow channels in manhole base shall be formed of Class C concrete and/or brick rubble and mortar while the manholes are under construction. Cut off pipes at inside face of the manhole and construct the invert to the shape and sizes of pipe indicated. All inverts shall follow the grades of the pipe entering the manholes. Changes in direction of the sewer and entering branch or branches shall be laid out in smooth curves of the longest possible radius which is tangent to the centerlines of adjoining pipelines.

F. Drop Inlets: Where shown on the drawings, drop inlets to the manholes shall be constructed as shown on the drawings and specified herein.

3.3 SERVICE CONNECTION:

A. Types of connections shall be as shown on the drawings. Although the general location of connections may be shown on the drawings, the actual location shall be determined by the Contractor, subject to approval by the Engineer. Each service connection shall be accurately recorded by stationing on the as-built
drawings furnished by the Contractor to the Engineer. Unless authorized by the
Engineer in writing, or shown on the drawings, service connections shall not be
tied into new or existing manholes. All service connections shall be terminated at
the property line unless indicated otherwise on the drawings or directed otherwise
by the Engineer.

B. Stoppers: If the service connection is not completed at the time of construction,
the opening at the property line shall be securely closed with an approved stopper
that fits into the bell end of the pipe and is approved by the pipe manufacturer.

3.4 STUB-OUTS:

A. Where shown on the drawings, stub-outs shall be provided for the connection of
future sewer lines to manholes. The end of each stub-out shall be provided with a
bell end which shall be closed by an approved stopper as specified hereinbefore.
Each stub-out shall be accurately referenced to the center of the manhole, and the
actual INVERT ELEVATION OF EACH END OF THE STUB-OUT SHALL BE
ACCURATELY RECORDED on the as-built drawings.

3.5 TESTS:

A. General: All work constructed shall be subject to visual and internal television
inspections for faults or defects and any such deviation or omission shall be
corrected at once. All tests shall be made by the Contractor who shall provide
necessary equipment for testing and televising the system as directed by the
Owner. All costs for testing defined below shall be borne by the Contractor.
Television inspection shall be observed first hand by the Engineer. Upon
completion, each section of sewer lines shall show a straight run, free of structural
defects and joint misalignment between manholes.

B. Air Testing: After completion, the sewers or sections thereof, shall be air tested
where the sewer is installed above the groundwater table.

C. The pressurized air test shall be according to the following procedure:

1. Determine the test time for the section of line to be tested using the table
below:
**MINIMUM TEST TIME FOR VARIOUS PIPE SIZE**

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2. Plug all openings in test section.

3. Add air until internal pressure of line is raised to approximately 4.0 pounds/square inch (psi) greater than average pressure of any ground water. After this pressure is reached, allow pressure to stabilize. Pressure will normally drop as air temperature stabilizes. This usually takes 2 to 5 minutes depending on pipe size. Pressure may be reduce to 3.5 psi before starting the test.

4. When pressure has stabilized and is at or above starting test pressures of 3.5 psi above pipe, start the test. If pressure drops more than 1.0 psi during the test time, the line is presumed to have failed the test. If 1.0 psi drop does not occur within the test time, the line has passed the test.

D. Infiltration Testing: After completion, the sewers or sections thereof installed below the groundwater table, shall be tested and gauged for infiltration.

1. To check the amount of infiltration, the Contractor, at no added compensation over the contract price for the sewers, shall furnish, and install and maintain a V-notch sharp crested weir in a wood frame tightly secured at the low end of each sewer lateral and at locations on the main sewers as directed by the Engineer.

2. Maximum allowable infiltration shall be 100 gallons per mile per inch of diameter of sewer per 24-hour day at any time.

3. The joints shall be tight and visible leakage in the joints or leakage in
excess of that specified above shall be repaired at the Contractor's expense by any means found to be necessary and approved by the Engineer. When infiltration is demonstrated to be within the allowable limits, the Contractor shall remove such weirs.

3.6 COMPLETION OF WORK:

A. Following the tests, the sewer line and manholes shall be thoroughly cleaned. The Engineer shall determine if the lines have been cleaned satisfactorily.

End of Section
SECTION 33 40 00
DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. The General Provisions of the Contract, including the General Conditions, Supplementary Conditions, and Special Conditions, if any, along with the General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION:

A. Perform all the work in connection with all pipe, culverts, inlets, manholes, and auxiliary drainage structures indicated on the drawings or otherwise necessary to collect all surface and subsurface water and discharge such water into existing drainage facilities.

1.3 REFERENCED STANDARDS:

A. The Florida Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition, are referred to hereinafter as the Standard Specifications. References to the Standard Specifications are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

B. Standard Drawings: Except as otherwise shown on drawings or specified herein, the applicable details of the Florida Department of Transportation (F.D.O.T.) Roadway and Traffic Design Standards, latest edition, shall apply. References to the F.D.O.T. Roadway and Traffic Design Standards are used to specify materials, application, and installation. Administrative, contractual, and measurement and payment requirements are not applicable.

1.4 APPROVALS AND PERMITS:

A. The Contractor shall apply for and obtain any permits or approvals as may be required by the governing authorities except those obtained by the Owner. Where the construction requirements of agencies are more stringent that this specification, the Contractor shall abide by such requirements and this specification shall be considered as supplemental to those requirements.

1.5 PIPE:

A. Unless specified otherwise, pipe sizes shown on the drawings are based on a
coefficient of roughness of 0.013 for concrete and 0.012 for PVC.

1.6 WORKMANSHIP:

A. All workmanship, materials, equipment, and plant shall be in accordance with the applicable portions of the Standard Specifications. The specific sections of the above-mentioned Standard Specifications which are applicable are listed below.

PART 2 - MATERIALS

2.1 MATERIAL:

A. Concrete Pipe: Concrete pipe for culverts shall conform to Section 430 of the Standard Specifications. All pipe shall be Class III unless otherwise noted on the drawings. The joints of new pipe shall be sealed with use of round gaskets as described in Section 942 of the Standard Specifications.

B. Polyvinyl Chloride Pipe (PVC): PVC pipe for drainage shall be Schedule 80 and conform to the requirements of ASTM D 1785 for Type II, Grade I for pipes up to 4” diameter. Pipe 4 inches in diameter and larger shall conform to the requirements of AWWA C900-75, DR18, and ASTM D-1785, Type I, Grade I or other types as may be specifically called for in the plans or special provisions.

C. Underdrain Pipe: Pipe shall be polyvinyl chloride (PVC) double walled corrugated sewer pipe with a smooth interior, meeting ASTM F949 requirement. Joints shall be integral wall bell and spigot, rubber gasket, push-on type.

D. Underdrain Filter Material: Aggregate shall be gravel or stone meeting Section 901 of the Standard Specifications, No. 57 standard size.

2.2 INLETS, MANHOLE AND CONTROL STRUCTURES:

A. Drainage structures shall be constructed of reinforced concrete, complete with frames and covers.

1. Concrete and reinforced concrete shall be 4,000 psi and shall meet the requirements in Section 346 of the Standard Specifications.
2. Reinforcing steel in accordance with Section 415 of the Standard Specifications.
3. Manhole frames and covers shall be of cast iron and shall meet the requirements of Paragraph 425-3.2 of the Standard Specifications. Weight, shape, size, and waterway openings for grates and curb inlets shall be as shown on the drawings.
4. Structural steel frames and grates in accordance with Paragraph 425-3.2 of the
5. Inlet grates shall be of the type indicated on the drawings and in accordance with the Standard Specifications.

6. Precast inlets and manholes shall be manufactured in accordance with Section 425-5 of the Standard Specifications and Index No. 201 of the Florida Department of Transportation (F.D.O.T.) Roadway and Traffic Design Standards.

7. Brick and concrete masonry units in accordance with Section 949 of the Standard Specifications.


2.3 MITERED END SECTION:

A. In accordance with Index Nos. 272 and 273 of the F.D.O.T. Roadway and Traffic Design Standards, or approved F.D.O.T. precast alternate.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. All excavation, trenching, backfilling, and compaction operations shall be in accordance with Division 31 Section 31 23 16 - EXCAVATION AND BACKFILL FOR UTILITIES AND STRUCTURES.

1. Pipe: The storm drain shall be installed in accordance with Section 430 of the Standard Specifications.

2. Drainage Structures: Headwalls, manholes, inlets, mitered end sections, and control structures shall be installed in accordance with the details shown. All work and materials shall be in accordance with applicable portions of the Standard Specifications.

3. Adjusting Existing Structures: Existing structures shall be adjusted in accordance with Paragraph 425-6.7 of the Standard Specifications.

PART 4 - TELEVISION INSPECTION OF STORM SEWER

4.1 INSPECTION:

A. The Contractor shall be required to perform a television inspection on all new and/or replacement storm sewers constructed under this project. This service shall be provided by the Contractor as part of this contract. The Engineer shall instruct the Contractor when this requirement shall be performed. The purpose of the inspection is to locate structural damage or other defects which may be present in the storm sewer. All internal inspection shall be performed in the
presence of the Engineer or his appointed representative.

4.2 DEFECTS:

A. Any defects found in the storm sewer(s) shall be documented in writing and a video record made, and the Engineer shall be notified immediately. Defects shall include damaged pipe, leaking joints, presence of mud or other debris, misaligned or sagging pipe, bowed pipe sections, deflected pipe, pipe joints not fully seated, improperly installed gaskets, standing water or other abnormalities not in conformance with the specifications.

4.3 EQUIPMENT:

A. The color television camera used for the inspection shall be one specifically designed and constructed for such inspection. The camera shall be a Pan & Tilt or radial view camera with the ability to look up any connection. Lighting for the camera shall be suitable to allow a clear picture for the entire periphery of the pipe. The camera shall be operable in 100 percent humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing a minimum 500 line resolution video picture. Picture quality and definition shall be to the satisfaction of the Engineer and if unsatisfactory, equipment shall be removed. Video records shall be DVD format. The cable length shall be sufficient to go completely from manhole to manhole without a reverse setup.

4.4 PROCEDURE:

A. The camera color monitor shall be located within a mobile vehicle unit that will accommodate three people to watch the sewer line inspection. The Engineer and Owner shall have access to view the television monitor at all times.

B. A skilled technician shall control the operation of the equipment from a control panel located in the mobile unit and shall have control of the movement of the television camera at all times. This may be accomplished by means of remote-control winches or a self-propelled tractor or other suitable means.

C. The camera shall be moved through the line in the downstream direction at a uniform rate not to exceed 30 ft./min., stopping when necessary to ensure proper documentation of the sewer's condition. The camera shall be stopped and aimed up each connection with the connection properly documented. Power winches, TV cable, power rewinds, tractors, floats or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions will be used to move the camera through the sewer line. If, during the inspection operation the television camera will not pass through the entire manhole section,
then the line is considered failed and must be repaired or cleaned before re-TVing.

4.5 DOCUMENTATION:

A. A log approved by the Engineer shall be provided for all line inspections listing the date, project or subdivision name (section or block number), township, project number, inspection number, manhole numbers and street location where applicable. Printed location records shall be kept by the Contractor and will clearly show the location of each defect observed during inspection. In addition, other points of interest such as locations of connections, unusual conditions, storm sewer connections, presence of scale and corrosion, and other discernible features shall be recorded. A log sheet and video record of the entire inspection shall be supplied to the Engineer. A key to all abbreviations used shall be included on each log sheet.

B. The locations of all defects, connections and other points of interest shall be identified by logging the distance to each defect or point of interest measured from the center of the starting manhole. The importance of accurate distance measurements is emphasized. The measuring device for location of defects shall be above ground by means of a meter device. Marking on the cable or the like, which would require interpolation for depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, cloth tape or other suitable device from manhole to manhole and the accuracy shall be satisfactory to the Engineer. The starting and ending manhole numbers, the running distance from the starting manhole and stationing corresponding to sewer stationing shown on plans for each manholes and service location shall be continuously displayed on the video recording.

4.6 FORMAT:

A. The video shall be in DVD format and be submitted to the Engineer with two (2) of the computer printouts showing manhole numbers and stationing, service stationing and distance between manholes prior to occupancy release for the dwelling units being served by the sewer. The tape and printout shall be labeled with the project name, tract number, street names, and contractor’s name and shall list the station of any defects, dirt, low spots, etc. in the pipe.

4.7 REPAIR OF DEFECTS:

A. All defects discovered by the television inspection shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer at no cost to the Owner prior to occupancy release for the commercial site being served by the sewer. Even though the sewer line may have successfully passed the leakage and
infiltration tests, any defects or low spots in the line shall be repaired to the satisfaction of the Owner.

END OF SECTION