



**PROJECT MANUAL VOLUME 2 OF 2
PHASE III – CONSTRUCTION DOCUMENTS**

SPECIFICATIONS FOR CONSTRUCTION OF:

**CLASSROOM BUILDING ADDITIONS
WILDLIGHT ELEMENTARY SCHOOL
550 CURIOSITY AVENUE
YULEE, FLORIDA 32097**

**NCSD PROJECT NO. 98950-24200
RDSA PROJECT NO. D-19-14**

APRIL 13, 2020

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TITLE PAGE

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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)

ASSE 1015 (2011) Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C651 (2014) Disinfecting Water Mains

FM GLOBAL (FM)

FMP7825 (2017) Approval Guide

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)

MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13 (2010) Installation of Sprinkler Systems

NFPA 24 (2010) Installation of Private Fire Service Mains and Their Appurtenances

NFPA 70 (2011) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 262 (2004) Gate Valves for Fire-Protection Service

UL Fire Prot Dir (2010) Fire Protection Equipment Directory

1.2 SYSTEM DESCRIPTION

- A. Design and provide new automatic wet pipe fire extinguishing sprinkler systems for complete fire protection coverage throughout all areas.

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 (2010), 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. Each system shall include materials, accessories, and equipment inside and outside the building to provide each system complete and ready for use. Design and provide each 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 1/3 of tiles in two directions.
- 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 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 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 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; submittals not having an "E" designation are for information only. When used, a designation following the "E" designation identifies the office that will review the submittal. All submittals are to be reviewed by Project Mechanical and Electrical Engineer.
- B. SD-02 Shop Drawings
1. Sprinkler heads and piping system layout
 2. Electrical Wiring Diagrams
- C. SD-03 Product Data
1. Piping; E
 2. Alarm Valves
 3. Valves, including gate, check, and globe
 4. Sprinkler heads; E
 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, Data Package 3
 2. Backflow Preventer, Data Package 3
 3. Submit in accordance with Section 017000 Project Closeout, 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.

PART 2 - PRODUCTS

2.1 ABOVEGROUND 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. UL poly plastic piping and fittings are approved for this project after a steel pipe riser assembly.
- 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 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 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 classroom and administrative spaces. Fully recessed in all corridors and Locker Room 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 joists with, Type 19 or 23 clamps and retaining straps. Attach to Steel W or S beams with Type 21, 28, 29, or 30 clamps. Attach to steel angles and vertical web steel channels with Type 20 clamp with beam clamp channel adapter. Attach to horizontal web steel channel and wood with drilled hole on centerline and double nut and washer. Attach to concrete with Type 18 insert or drilled expansion anchor.
- 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.
- 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 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 wall. Do not undermine building footing or slab.
- 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 concrete 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 26 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.

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 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 211313

SECTION 220500 - PLUMBING

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 26. 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. 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 hard back 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.
- 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, alterations 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, which shall be used unless otherwise specifically noted in the specs 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 joining 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 A 74 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. Above Ground Domestic Water Piping: Copper Watertube shall be Type K, hard copper, ASTM B88. Fittings shall be wrought copper, ANSI B16.3, with lead free solder-ASTM approved.
- F. Plastic Pipe and Fittings: Pipe shall be Schedule 40 PVC conforming to ASTM D 1785. Fittings shall be PVC conforming to ASTM D 2466. Solvent cement shall conform to ASTM D 25646.
- G. (CPVC) - Chlorinated Polyvinyl Chloride Pipe - ASTM F 441, shall meet requirements of the NSF Standard 14. Fitting: ASTM F 439, solvent cement socket type.

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. Ball Valves: Full port ball valves with stainless steel stem and ball with teflon seat and rings.
 - 2. Hose Bibb: Chicago #387 with watts No. 8A backflow preventer. Hose bibb shall be key operated.
 - 3. Exterior valves 1½" and smaller shall be curb-stop type. 2" and larger shall be cast iron resilient wedge type. Wedge shall be totally encapsulated with rubber, non-rising stem with bonnet and o-ring plate fusion bond epoxy coated.

2.4 FLOOR DRAINS

- A. Furnish with seepage flange in floors where installed with pans or flashings, furnish clamping ring. Locate drains to suit equipment approved for installation. All floor drains shall be provided with automatic trap primer, and install per manufacturer's recommendations. See Drawings for specifications.

2.5 CLEANOUTS

- A. Where indicated and at the base of all risers. Additional cleanouts at the Contractor's option for the convenience of testing and erection. Cleanouts installed in floors with waterproof membrane shall be provided with clamping rings. Install cleanout frames and covers to be flush with adjoining architectural finishing material. Clean-outs located outside of the building shall be two-way type. Josam Model Numbers are indicated below. Comparable Model Numbers by Wade or Jay 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.
- E. Cleanouts in Vinyl Tile Floor Finishes: Josam 56004-2-15.
- F. Carpeted Floor Finishes: Josam 58410-14.

2.6 PIPE HANGERS

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

2.7 DOMESTIC WATERS HEATERS

- A. As specified on the Drawings and install as per the manufacturer's recommendations.

2.8 PLUMBING FIXTURES

- A. General: All plumbing fixtures shall be "First Quality". All enameled iron fixtures shall have acid resisting white enamel.
 - 1. 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. 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 Elger will be considered for approval. See Drawings for specifications. 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.

2.9 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.

2.10 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 Piping Exposed to Exterior and Horizontal Storm Water Piping (if applicable):
 - 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. Underfloor Conduit: Steel piping 90 degree elbows shall be of the long sweep type.
- D. Waste and vent piping located in a plenum shall be cast-iron.

3.2 DOMESTIC HOT AND COLD WATER PIPING

- A. Pipe shall be Type "K" hard copper with wrought copper fittings. Interior exposed piping shall be painted to match adjacent surfaces.

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,

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 the manufacturer's recommendations and shall conform with Plumbing and Drainage Institute No. PDI-WH-201. 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 be not 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 shall be determined from the Architectural Drawings. Contractor shall replace existing watercloset floor flanges when replacing a water closet. PVC flanges with stainless steel ring will be provided. Waterclosets shall be 12" rough in for new construction.

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 locations 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 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 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 MSS 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 supports 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. Where copper piping comes in contact with hangers and anchors, the piping shall be wrapped with a rubberized tape extended 1/2" on each side of all Clevis hangers and straps.

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 INSTRUCTION MANUALS

- A. Furnish four complete copies of instructions explaining operation and maintenance and replacement parts lists of the following equipment:
 - 1. Electric Water Coolers/Drinking Fountains
 - 2. Flush Valves
 - 3. Faucet Trim
 - 4. Electric Water Heater
 - 5. Thermostatic Mixing Valve
 - 6. Trap Primer

3.19 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.

3.20 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 220500

SECTION 230500 - BASIC MECHANICAL REQUIREMENTS

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

- A. Connect Owner furnished and located on existing pad, a 200 ton chiller addition to the chilled water system to service the new campus Buildings 7 and 8. Both hot and chilled water systems have primary and secondary pumping schemes. The secondary system is variable speed based on system pressure. Contractor to connect primary piping to new chiller CH-3.
- B. All classrooms in Buildings 7 and 8 to be conditioned by individual AHUs with hot and chilled water coils. The outside air to be pre conditioned by a separate 100% outside air AHU and supplied to each classroom AHU at 55°F summer and winter.
- C. Controls are Digital EMCS with display graphics in the Administration Area. New to match existing. New controls to be Automated Logic.
- D. Air distribution to be VAV with hot water heat. All ductwork shall be galvanized per SMACNA low pressure standards as a minimum design criteria.

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.
 - c. 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" "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" 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.
 - h. Electronic submissions are acceptable via an approved and widely accepted program.
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 instruction prior to installation.

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 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.
- 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.
 - 6. Performance Curves.
 - 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 26 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 TO THE OWNER.

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 completion and acceptance of project. Contractor shall provide all parts, labor, filters 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 for installation in or on the building envelope (roof, walls, canopies, etc.) 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.

- 1.35 A. Chiller to carry a one (1) year warranty parts and labor with a complete factory provided service agreement. Chillers (existing and new) to have preventative maintenance, service and testing on a quarterly basis by the factory technician including testing of oils, refrigerant, lubrication and replacement parts for a period of five years beginning upon substantial approval of project.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 230500

SECTION 230503 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.2 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

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.

PART 2 - PRODUCTS

2.1 NAMEPLATES

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

2.3 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.
- C. Stencil Paint: Semi-gloss enamel, colors conforming to ASME A13.1.

2.3 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.

PART 3 - 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 230503

SECTION 230513 - MOTORS

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, parts and labor to replace.
- B. Warranty: Include coverage for motors larger than 2.0 HP.

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 230513

SECTION 230516 - PIPING EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Pipe loops, offsets, and swing joints.

1.2 RELATED SECTIONS

- A. Section 230500 - Plumbing
- B. Section 232113 - Hydronic Piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
- B. Expansion Calculations:
 - 1. Installation Temperature: 50 degrees F.
 - 2. Domestic Hot Water: 140 degrees F.
 - 3. Chilled water 70 degrees F down to 40 degrees F
 - 4. Heating hot water 70 degrees up to 200 degrees F
 - 5. Safety Factor: 30 percent.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit Maintenance Data: Include adjustment instructions.

1.7 QUALIFICATIONS

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

1.8 WARRANTY

- A. Provide one year warranty on all piping joints and connections to new equipment.

PART 2 - PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Basis of Design:
 - 1. Manufacturers:
 - a. Minnesota Flexible Model FFCS.
 - 2. Exterior Sleeve: Single braided stainless steel.
 - 3. Pressure Rating: 125 psig WSP and 450 degrees F.
 - 4. Joint: Flanged.
 - 5. Size: Use pipe sized units.
 - 6. Maximum offset: 3/4 inch on each side of installed center line.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Construct spool pieces to exact size of flexible connection for future insertion.
- C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
- D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- E. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 230516

SECTION 230529 - SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe hangers and supports.
- B. Hanger rods.
- C. Inserts.
- D. Flashing.
- E. Equipment curbs.
- F. Sleeves.
- G. Mechanical sleeve seals.
- H. Formed steel channel.
- I. Firestopping relating to mechanical work.
- J. Firestopping accessories.
- K. Equipment bases and supports.

1.2 RELATED SECTIONS

- A. Section 230548 - Vibration Isolation
- B. Section 220500 - Plumbing
- C. Section 230700 – Mechanical Insulation
- D. Section 232113 - Hydronic Piping.

1.3 REFERENCES

- A. American Society for Testing and Materials:
 - 1. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Method for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Test Method of Fire Tests of Through Penetration Firestops.
 - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- B. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

- C. Factory Mutual System:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

- 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.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL - Fire Resistance Directory.

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

1.4 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.5 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479 to achieve fire ratings not less than 1 hour fire rating.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for support of plumbing hydronic piping.

1.7 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.8 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.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. 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.
- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgments: For conditions not covered by UL or WH listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.9 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.

1.10 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.

1.11 PRE-INSTALLATION MEETINGS

- A. Division 1 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.12 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.

1.13 ENVIRONMENTAL REQUIREMENTS

- A. Division 1 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

1.14 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.15 WARRANTY

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

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Furnish materials in accordance with State of Florida and SREF standards.
- B. Hydronic 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. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Larger: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes 3 inches (76 mm) and Smaller: Cast iron hooks.
 9. Wall Support for Pipe Sizes 4 inches (100 mm) and Larger: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 11. Vertical Support: Steel riser clamp.
 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

13. 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.
14. Floor Support for Hot Pipe Sizes 6 inches (150 mm) and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. 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.

2.2 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.

2.2 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.

2.2 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.

2.2 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.

2.2 FORMED STEEL CHANNEL

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

2.2 FIRE AND SMOKE STOPPING

- A. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 2. Foam Firestopping Compounds: Single component foam compound.
 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 7. Firestop Pillows: Formed mineral fiber pillows.
- B. Color: As selected from manufacturer's full range of colors.

2.2 FIRE AND SMOKE STOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- C. General:
1. Furnish UL listed products.
 2. Select products with rating not less than rating of wall or floor being penetrated.
- D. Non-Rated Surfaces:
1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Division 1 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. 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 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 Counterflashing 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 INSTALLATION – FIRE AND SMOKE STOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.

3.9 FIELD QUALITY CONTROL

- A. Section 017000 Project Closeout: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Section 017000 Project Closeout: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Section 017000 Project Closeout: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING

<u>MAX. HANGER PIPE SIZE</u>	<u>HANGER ROD SPACING</u>	<u>DIAMETER (minimum)</u>
Inches (mm)	Feet (m)	Inches (mm)
1/2 (12)	7 (2.1)	3/8 (9)
3/4 (20)	7 (2.1)	3/8 (9)
1 (25)	7 (2.1)	3/8 (9)
1-1/4 (32)	7 (2.1)	3/8 (9)
1-1/2 (38)	9 (2.7)	3/8 (9)
2 (50)	10 (3)	3/8 (9)
2-1/2 (65)	11 (3.4)	1/2 (13)
3 (75)	12 (3.7)	1/2 (13)
4 (100)	14 (4.3)	5/8 (15)
5 (125)	16 (4.9)	5/8 (15)
6 (150)	17 (5.2)	3/4 (19)
8 (200)	19 (5.8)	3/4 (19)
PVC (All Sizes)	4 (1.8)	3/8 (9)
C.I. Bell and Spigot (or No-Hub) And at Joints	5 (1.5)	5/8 (15)

END OF SECTION 230529

SECTION 230548 - 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 230500 Basic Mechanical 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:

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

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.
3. Conform to the requirements of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook, "HVAC Systems and Applications," Chapter 42, "Sound and Vibration Control."

1.2 QUALITY ASSURANCE

A. Codes: Conform to the ASHRAE Handbook, "HVAC Systems and Applications," Chapter 42.

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.

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.

PART 2 - 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 1I 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 2I 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 ½ 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 3H 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 Kx-Ky 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 ¼ 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.
 6. Drill base plates for bolting.
 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 ½ 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 H₂O.
 - 3. Restraints shall have the same deflection as isolators installed under the fans.

2.4 BASE TYPES

- A. Type A Bases: No supplementary base is required. Vibration isolators, specified elsewhere, shall be attached directly to the supported equipment or structural system.
- B. Type B, Structural Rails or Bases: Provide bases designed and supplied by the isolation equipment manufacturer.
 - 1. Construct bases of mill rolled structural sections of sufficient dimension to limit the midpoint deflection or unsupported spans to 1/1440th of the span between isolators.
 - 2. Include equipment static loadings, power transmission, component misalignment and cantilever loadings when designing structural sections.
 - 3. When head room is limited, coordinate the design of structural rails and isolators to reduce mounting heights.
 - 4. Factory finish with two coats equipment enamel.
- C. Type C, Concrete Inertia Bases: Provide concrete inertia bases designed by the isolator manufacturer and arranged to be filled with concrete in the field.
 - 1. Construct base of mill rolled structural steel sections, factory mitered and welded into a rigid frame and supporting No. 4 reinforcing bars welded to the structural frame 8 inches on centers both ways and located 2 inches from the bottom of the block.
 - 2. Arrange for outrigger isolation mountings, anchor bolts and equipment support.
 - 3. Field fill with 3000 psi cured-strength concrete. Trowel to a smooth hard finish.
 - 4. Clean structural steel of excess concrete and field paint all steel elements with two coats equipment enamel.
 - 5. Configuration of inertia bases shall be rectangular to accommodate equipment supported unless otherwise indicated.
 - 6. Minimum thickness of inertia bases, in addition to providing suitable mass, shall be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power transmission.
 - 7. Minimum thickness shall be sufficient to result in a base deflection at midpoint of unsupported span of not more than 1/1440th of the span between isolators.
 - 8. Minimum thickness shall be 8 percent of the longest base dimension unless otherwise specified or indicated.
 - 9. For centrifugal pumps, the inertia bases shall be a minimum 12 inches thick.
 - 10. Where inertia bases are used to mount pumps, the bases shall be long enough to support piping elbows for all connections. All horizontal pumps shall include inertia bases as detailed in Drawings.

2.5 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 3I 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.

2.6 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)

TYPE EQUIPMENT	ON GRADE	20'-30' FLOOR SPAN	30'-40' FLOOR SPAN	Over 40' FLOOR SPAN
Through 10HP	A 2 0.75	A 3 1.0	A 3 1.0	A 3 1.0
10 HP and Over	A 2 1.5	A 2 1.5	A 3 1.5	A 3 2.5
250 to 500 RPM	A 2 1.5	A 3 1.5	A 3 1.5	A 3 1.5
over 500 RPM				

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

TYPE EQUIPMENT	ON GRADE	20'-30' FLOOR SPAN	30'-40' FLOOR SPAN	Over 40' FLOOR SPAN
Through 20 HP	A 3 0.75	A 3 1.5	A 3 2.0	A 3 1.5
Over 20 HP	A 2 1.5	A 3 2.0	A 3 2.5	A 3.0

- D. Air-Moving Device Locations: Vibration-isolation provisions apply to suspended housed or unhoused freestanding fans of any pressure rating, located in field-erected central-station units or in unhoused return-air or supply-air service.

TYPE EQUIPMENT	20'-30' FLOOR SPAN	30'-40' FLOOR SPAN	over 40' FLOOR SPAN
Up to 5 HP	B 3 1.0	B 3 1.0	B 3 1.0
5 Thru 40 HP	B 3 1.5	B 3 1.5	B 3 2.5
200 to 500 RPM	B 3 1.5	B 3 1.5	B 3 2.5
500 RPM and Over	C 3 1.5	C 3 1.5	C 3 1.5

E. Air-Cooled Condensing and Chiller Units:

TYPE EQUIPMENT	ON GRADE
through 5 tons	I 1 1/16
above 5 tons	I 2 1/4

PART 3 - 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 230548

SECTION 230593 - 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 hydronic and refrigerating systems, existing and new, chilled and hot wter system to Buildings 7 & 8.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.
6. Measurement of final operating conditions of gas and compressed air systems.

B. Related Sections:

1. Section 230923 - Energy Management Control Systems (EMCS): Requirements for coordination between EMCS and testing, adjusting, and balancing work.

1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

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

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

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.

1.5 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.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111, NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- 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.

1.7 QUALIFICATIONS

- A. Test and Balance services for HVAC shall be provided by the Contractor and shall meet all requirements of the Florida Building Code. Nassau County School District may obtain an independent agency to provide confirmation testing.
- B. Perform work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing and Adjusting Supervisor.

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 SEQUENCING

- A. Division 1 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.10 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.

PART 2 -PRODUCTS

Not Used.

PART 3 - 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. Hydronic systems are flushed, filled, and vented. No leaking
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place or in normal position.
 15. 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.
- C. Hydronic Systems: Adjust 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 (Buildings 7 and 8 only)

- 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. Reset barometric relief counterweight for required static pressure in buildings as required.
- M. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- N. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.6 WATER SYSTEM PROCEDURE (Buildings 7 and 8 Only)

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.7 SCHEDULES - For Buildings 7 and 8 only, Pumps to buildings , chillers

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. HVAC Pumps. for total GPM to all buildings
 - 2. Air Cooled Water Chillers - two new units
 - 3. Air Cooled Refrigerant Condensers.
 - 4. Blower Coil Units. - (AHU's in buildings 7 & 8 only)
 - 5. Air Handling Units.
 - 6. Fans.
 - 7. Air Filters.
 - 8. Air Terminal Units.
 - 9. Air Inlets and Outlets.
 - 10. Hot Water Coils.
 - 11. EMCS.
 - 12. Barometric Relief Dampers.
- 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
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. 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
3. 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
4. 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
5. Pump Data:
- a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure

- k. Shut off, discharge and suction pressures
- l. Shut off, total head pressure
- 6. Chillers:
 - a. Identification/number
 - b. Manufacturer
 - c. Capacity
 - d. Model number
 - e. Serial number
 - f. Evaporator entering water temperature, design and actual
 - g. Evaporator leaving water temperature, design and actual
 - h. Evaporator pressure drop, design and actual
 - i. Evaporator water flow rate, design and actual
 - j. Condenser entering water temperature, design and actual
 - k. Condenser pressure drop, design and actual
 - l. Condenser water flow rate, design and actual
- 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: (AHU's)
 - 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. Terminal Unit Data:
- a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
13. 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
14. Sound Level Report:
- a. Location
 - b. Octave bands - equipment off
 - c. Octave bands - equipment on
 - d. RC level - equipment on
15. Vibration Test:
- a. Location of points:
 - 1) Fan bearing, drive end
 - 2) Fan bearing, opposite end
 - 3) Motor bearing, center (when applicable)
 - 4) Motor bearing, drive end
 - 5) Motor bearing, opposite end
 - 6) Casing (bottom or top)
 - 7) Casing (side)
 - 8) Duct after flexible connection (discharge)
 - 9) Duct after flexible connection (suction)
 - b. Test readings:
 - 1) Horizontal, velocity and displacement
 - 2) Vertical, velocity and displacement
 - 3) Axial, velocity and displacement
 - c. Normally acceptable readings, velocity and acceleration
 - d. Unusual conditions at time of test
 - e. Vibration source (when non-complying)

END OF SECTION 23059

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Ductwork insulation.
 2. Duct liner.
 3. Insulation jackets.
 4. Equipment insulation
 5. Piping system insulation.
 6. Insulation accessories including vapor retarders, jackets, and accessories.
- B. Related Sections:
1. Section 078413- Penetration Firestopping: Product requirements for firestopping for placement by this section.
 2. Section 099100 - Painting: Execution requirements for painting insulation jackets and covering specified by this section.
 3. Section 230529 - Supports and Anchors: Product and Execution requirements for inserts at hanger locations.
 4. Section 230503 - Mechanical Identification: Product requirements for mechanical identification.

1.2 REFERENCES

- A. ASTM International:
1. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 2. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 3. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 4. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 5. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 6. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 7. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 8. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 9. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 10. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 11. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
 12. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
15. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.
16. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
17. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
18. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
19. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
20. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
21. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
22. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
23. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
24. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
25. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
26. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
27. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

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

1.3 SUBMITTALS

- A. Section 013300 - Submittals: 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 013119- Project meetings.
- B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 Products, Materials and Equipment: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 Products, Materials and Equipment: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. 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. Section 017000 - Project Closeout - Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for all mechanical insulation on project.

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.
- B. 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.
- C. Vapor Barrier Mastic (in Mechanical Rooms open to ambient):
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, white color.
 2. Jacket not required in closed Mechanical Rooms to ambient.
- D. 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: Kraft paper glass fiber and bonded to aluminized film.
1. For systems operating at temperatures below ambient, close and secure seams and joints. When outward clinching staples are used, seal penetrations.
 2. ASTM C195, hydraulic setting on all joints and seams.
- 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:
 - 3. Compatible with insulation.
- E. Insulating Cement/Mastic:
 - 4. ASTM C195; hydraulic setting on all joints and seams.

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).

E. All joints to be mastic covered.

2.5 CELLULAR GLASS (OUTSIDE DUCTWORK AND ALL CHILLED WATER PIPING)

A. Insulation: ASTM C552, Type II - pipe and tubing insulation, Class 2 - Jacketed.

- 1. 'K' ('ksi') factor: ASTM C177 or ASTM C518, 0.29 at 75 degrees F.

2.6 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.

2.7 ELASTOMERIC CELLULAR FOAM PRE-MOLDED ON CONDENSATE 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.
- C. Liner: Use elastomeric cellular foam in sheets of thickness specified for acoustical liner. Install smooth side towards air flow.

2.8 PIPE INSULATION AND EQUIPMENT JACKETS

- A. PVC Plastic Pipe Jacket: (in Mechanical Room and where exposed within Building)
 - 1. Product Description: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
 - 2. Thickness: 15 mil.
 - 3. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
- B. PVC Plastic Equipment Jacket Inside Building (Pumps, Tanks, Chiller Barrels, Valves):
 - 1. Product Description: PVC sheet material, off-white color.
 - 2. Minimum Service Temperature: -40 F.
 - 3. Maximum Service Temperature: 150 F.
 - 4. Moisture Vapor Transmission: ASTM E96; 0.002 perm-inches.
 - 5. Thickness: 15 mil.
 - 6. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
- C. Covering Adhesive Mastic:
 - 1. Compatible with insulation, 100% glued on all contact surfaces.
- D. 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.

2.9 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.
 - 4. 'K' ('Ksi') value: ASTM C177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
 - 5. Maximum service temperature: 650 degrees F (343 degrees C).
 - 6. Maximum moisture absorption: 0.2 percent by volume.

- C. Vapor Barrier Jacket:
 - 7. ASTM C921, White kraft paper with glass fiber yarn, bonded to aluminized film.
 - 8. 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:
 - 9. Compatible with insulation.
- F. Fibrous Glass Fabric:
 - 10. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 11. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
 - 12. Weave: 5x5.
- G. Indoor Vapor Barrier Finish:
 - 13. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 14. Vinyl emulsion type acrylic, compatible with insulation, white color.

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 078413 for penetrations of assemblies with fire resistance rating greater than one hour.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- I. 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.
- J. Buried Piping: Insulate only with cellular glass for both cold and hot with pittwrap on both. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film. Pre insulated systems with poly and Schedule 40 PVC jacket or approved equal.
- K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. 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. Insulation must have same pittwrap factory fabricated assembly as stated above.
- L. Factory Insulated Equipment: Do not insulate.
- M. Exposed Equipment, Tanks, Pumps, and Valves: Locate insulation and cover seams in least visible locations.
- N. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

- O. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- P. Insulated equipment containing fluids below ambient temperature: Insulate entire system.
- Q. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- R. 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.
- S. Finish insulation at supports, protrusions, and interruptions.
- T. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting on air handling units; PVC jacket and fitting covers or aluminum jacket on piping, tanks, pumps, etc.
- U. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- V. 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.
- W. 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.
- X. 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.
- Y. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or aluminum jacket.
- Z. Exterior Applications: Provide insulation with vapor retarder jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- AA. 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.
- BB. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. SMACNA Standards for spacing. Maximum spacing 12 inches on centers and 3 inches from corners and edges.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

A. Plumbing Systems:

1. Domestic Hot Water Supply:
 - a. Man Made Mineral Fiber Insulation:
 - 1) Pipe Size Range: All.
 - 2) Thickness: 1 inch.
 - b. Cellular Glass Insulation:
 - 1) Pipe Size Range: All.
 - 2) Thickness: 3 inch; ambient exposure; 2" buried and inside building and Mechanical Rooms.
 - c. Cellular Elastomeric Foam Insulation:
 - 1) Pipe Size Range: All.
 - 2) Thickness: 1 inch.
2. Domestic Hot Water Re-circulation:
 - a. Man Made Mineral Fiber Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch (25 mm).
 - b. Expanded Polyethylene Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch (25 mm).
 - c. Cellular Foam Insulation:
 - 1) Pipe Size Range: All sizes.
 - 2) Thickness: 1 inch (25 mm)
3. Domestic Cold Water: 1 inch when exposed to freezing temperatures.
4. Roof Drain Bodies: 1 inch.
5. Roof Drainage Within 10 feet (3 Meters) of Exterior: 1 inch.
6. Plumbing Vents Within 10 feet (3 Meters) of Exterior: 1 inch.
7. Chilled Drinking Water Supply: 1 inch.

B. Cooling Systems:

1. Chilled Water: 3 inch cellular ambient and buried. 2 inch inside building.
2. Cold Condensate Drains: 1 inch.
3. Condensate Drains from Cooling Coils: 1 inch.

C. Other Systems:

1. Piping Exposed to Freezing with Heat Tracing: 3 inch cellular (chiller yard)

- D. Plumbing Systems:
 - 1. Domestic Hot Water Storage Tanks:
 - a. Mineral Fiberboard Insulation: 4 inch thick.
 - b. Cellular Glass Insulation: 3 inch thick.
 - c. Hydrous Calcium Silicate Insulation: 2 inches thick.
 - d. Cellular Foam Insulation: 2 inch thick.
 - 2. Heating Systems:
 - a. Pump Bodies: Same as piping.
 - b. Air Separators: Same as piping.
 - c. Expansion Tanks: Same as piping.
 - d. Hot Thermal Storage Tanks: Same as piping.
 - 3. Cooling Systems:
 - a. Pump Bodies: Same as piping.
 - b. Air Separators: Same as piping.
 - c. Expansion Tanks: Same as piping.
 - d. Chiller Cold Surfaces: 2 inch cellular foam with aluminum jacket.
 - e. Cold Thermal Storage Tanks: Same as piping.
 - f. Equipment Exposed to Freezing without Heat Tracing: Same as piping.
 - g. Ductwork in Mechanical Rooms – 2" rigid fiberglass, foil faced.
 - h. Exposed ductwork 2" rigid fiberglass, foil faced.
- E. Exhaust Ducts within 10 feet (3 m) of Exterior Openings: 2 inches.
- F. Exhaust Ducts Exposed to Outdoor Air: 3 inch.
- G. Outside Air Intake Ducts: 2 inch.
- H. Plenums: 2 inch.
- I. Plenums (Cooling System): 2 inch.
- J. Supply Ducts: 2 inch.
- K. Supply ducts After Terminal Boxes: 2 inch.
- L. Return and Relief Ducts in Mechanical Rooms: 2 inch.
- M. Ducts Exposed to Outdoors: 2 inch cellular foam with aluminum jacket.

END OF SECTION 230700

SECTION 230923 - ENERGY MANAGEMENT CONTROL SYSTEMS (EMCS)

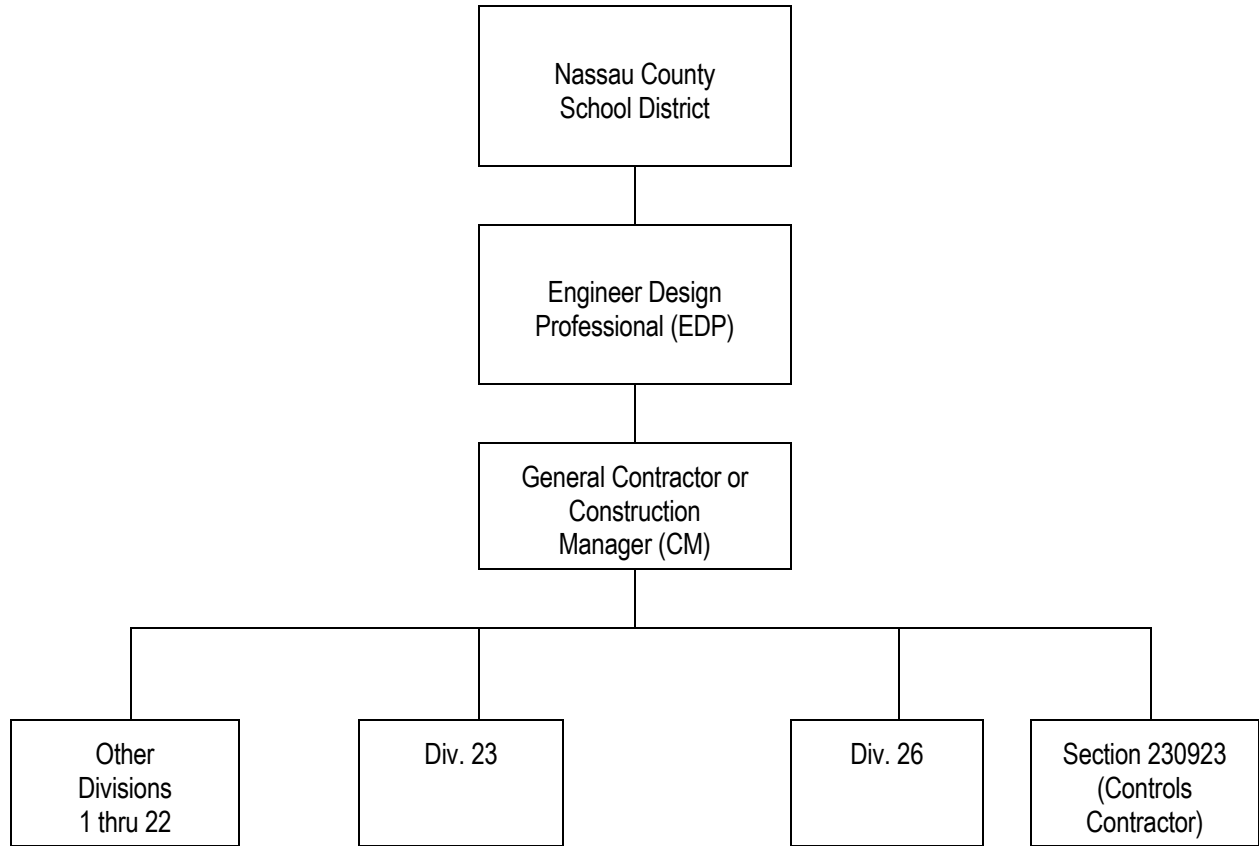
PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work covered by this section includes new EMCS in Buildings 7 and 8 to be tied to existing EMCS and extended from valve boxes to new buildings, shop drawings, plans, equipment, labor, materials, engineering, technical supervision, programming, scheduling, and transportation as required for a fully operational (turn-key) Energy Management and Control System (EMCS) per sequencing to match existing.
1. The EMCS basic design by the Engineering Design Professional (EDP) consists of the Input/Output (I/O) Summary Point List, an EMCS Material List, control system schematics and wiring diagrams, and control sequences of operations, all shown on the drawings or required for complete and operational EMCS system.
 2. The EMCS vendor shall provide DDC controllers of sufficient I/O capacity to control the HVAC and miscellaneous equipment as specified by Mechanical and Electrical Drawings. The system shall have sufficient expansion capability to add future and/or existing equipment not covered by the project unless otherwise specified. Minimum of 35% spare system controller capacity required. At each control module and system EMCS panel all communications wiring in buildings shall be copper plenum rated and in conduit in Mechanical Rooms, or exposed areas, and room sensor drops.
 3. Provide only EMCS software previously proven in earlier Nassau County School projects. The EMCS vendor shall maintain a library of this proven software for the Contractor's reference. All system graphics parameters and Eikon programming shall be integrated to the NCSB existing Automated Logic Web Control Server Software. No exceptions. Placement of a separate standalone EMCS program to NCSB's ALC Web Server is unacceptable and not permitted. Update existing NCSB's ALC Web Server software to latest edition.
 4. The EMCS shall control all outside existing site lighting circuits. Lighting contactors shall be provided and installed under Division 26 (Canopy, Parking Lot, Building Security, etc.) Provide hardware; connect to contactors and software as required to provide complete site lighting control.
 5. Smoke detectors and combination fire/smoke dampers and their associated control/interlock wiring are work of another section. However, they shall be interlocked with EMCS to deactivate systems when detectors or fire alarm system is activated.
 6. Fiber optic cabling between buildings is new and provided by Electrical Contractor. Coordinate with Owner to determine spare fiber optic conductors to be used. EMCS Contractor shall furnish and install Fiber Optic Patch Cords and Fiber Optic Transceivers at LAN IDF and MDF locations to transmit EMCS signals between Buildings.
 7. Float switches in auxiliary drain pans shall be tied to EMCS for monitoring and shut down of associated AHU. Report as an alarm and identify device and system.
 8. The basis of design is Automated Logic Controls and is currently installed in the Nassau County School System.
 9. EMCS contractor to provide fiber patch cords with specified connector from LAN IDF and MDF data rack to EMCS panels with fiber transceivers at LAN IDF and MDF locations, where applicable.
 10. Most of the controls exist and must be extended to Buildings 7 and 8. Re-program systems to include all equipment in Buildings 7 and 8 with new graphics.
- B. The terms for the parties involved in the engineering, design, procurement and installation of the EMCS system are:

1. Owner: The Nassau County School District (NCSD). The Owner's contact is: Nassau County School District Facilities Department; 86334 Goodbread Road; Yulee, Florida 32097 (904) 225-5343; Attention: Jeffrey L. Bunch, Director.
 2. Engineering Design Professional (EDP): The professional firm whose direct responsibility is the engineering design and construction administration of the EMCS system. This EDP may be the firm with whom the Owner has a Professional Agreement, or may be a sub-professional to the firm. Data on the firm is shown on the controls drawing.
 3. EMCS Vendor: The vendor shall provide all Hardware, Software, other material, equipment, electrical power to EMCS modules, repeater devices, EMCS panels, trenching, underground conduit, above ground conduit, etc., and labor required for a complete system, including all control devices, wire, conduit, installation, start-up, commissioning and 5-year warranty, parts, installation and warranty labor and quarterly service under and as required by this contract. The EMCS Vendors are:
 - a. Automated Logic. (Design Basis) (Latest Edition Software)
 - b. Substitution shall meet prior approval section of specifications for authorization to bid work for this district. Authorization shall be by addenda; subject to approval; vendor shall comply with paragraph 1.1.A.3. All others without such letter will be rejected. Prior approval for this section/division shall be 30 days.
 4. Prime Contractor: The party with whom the Owner has a construction contract agreement for this project. The EMCS vendor shall bid directly to Prime Contractor.
- C. General Conditions, Supplementary Conditions, General Requirements, and other provisions and requirements of the contract documents apply to work of Section 230923, Energy Management and Control Systems.
1. Investigate all alternates, addenda and allowances as they relate to work of Section 230923.
 2. All Section 230923 scope of work sections shall be considered to be integrated with each other and will be the responsibility of the Control Contractor.
 3. Consider the terms "provide" and "install" as synonymous with "furnish and install".
 4. Any and all questions about a Subcontractor's scope of work responsibility shall be addressed to and answered by the (General Contractor) (Construction Manager) (Prime Bidder).
 5. The Control Contractor (EMCS Vendor) shall examine drawings relating to work of all trades and become fully informed as to extent and character of work required and its relation to all other work in the project.
 6. Before submitting pricing, the Control Contractor shall visit the site and examine all adjoining existing buildings, equipment and space conditions on which his work is in any way dependent for the best workmanship and operation according to the intent of specifications and drawings. He shall report to the Engineer any condition that might prevent him from installing his equipment in the manner intended.
 7. No consideration or allowance will be granted for failure to visit site, or for any alleged misunderstanding of materials to be furnished or work to be done.
 8. Control contractor to furnish all conduit to extend controls form existing buildings, valve boxes or mechanical rooms to new equipment platforms in Buildings 7 and 8 and to AHU's in Buildings 7 and 8. Provide control panels and power for panels with transformers. Voltage to panels to be 277 v and stepped down to 115 or 24 volts as needed.

1.2 ORGANIZATIONAL CHART



Section 230923 provides approved price to NCSB for Contract award.

All Section 230923 invoices to be submitted through General Contractor / CM and approved by Engineer Design Professional (EDP) or Architect.

Section 230923 will be operationally responsible directly to the General Contractor / CM.

Section 230923 is responsible for complete control installation (turn-key) and its functional operation. This includes termination of all copper twisted wire pairs and provision of fiber optic patch cords at all devices, i.e., fiber to copper, building to building panels.

1.3 QUALITY ASSURANCE

- A. EMCS Vendor's local office shall be responsible for all engineering, programming, and graphics on EMCS projects. Local office shall have capabilities to develop and modify any system engineering, system programming and graphics at the local vendor's office. All system graphics, parameters and programming shall be integrated to the existing NCSB Automated Logic Web Server, no exceptions
- B. The EMCS Vendor shall have local maintenance capabilities available within a 40-mile radius of Nassau County.

1.4 CONTRACT DRAWINGS

- A. Examine all drawings and specifications carefully before submitting a bid. Architectural drawings (and existing conditions) take precedence over mechanical, automation or electrical drawings with reference to building construction. If discrepancies or conflicts occur between drawings, or between drawings and specifications, notify the Engineer immediately. If notification is received within adequate time, a change will be issued by addendum.
- B. For purposes of clearness and legibility, drawings are essentially diagrammatic and, although size and location of equipment are drawn to scale wherever possible, Contractor shall make use of all data in all of the contract documents and shall verify this information at the building site and assume total coordination responsibility.
- C. The drawings indicate required size and points of termination of pipes, conduits and ducts and suggest proper routes to conform to structure, avoid obstructions and preserve clearances. However, it is not intended that drawings indicate all necessary offsets, and it shall be the work of the Contractor to make the installation in such a manner as to conform to structure, avoid obstructions, preserve headroom and keep openings and passageways clear, without further instructions or cost to the Owner.
- D. Furnish, install and/or connect with appropriate services all items shown on any drawing or required for a fully operational and complete system without additional compensation. If not indicated on plans as to who is to provide and install and it is clearly an EMCS device, the EMCS Vendor shall provide and install.
- E. The drawings and specifications are complimentary; each to the other, and the work required by either shall be included in the Contract as if called for by both.

- F. If directed by the Engineer or Owner, the EMCS Vendor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the overall work.
- G. Changes that are required or desired which are materially different from the obvious intent of the drawings or specifications will not be permitted except for those instances where it is necessary to avoid interferences and only where specifically approved by the Engineer.
- H. The Engineer reserves the right to make reasonable changes in location of all control equipment prior to roughing in and final placement.

1.5 CODE REQUIREMENTS AND STANDARDS

- A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction. Applicable codes include the following:
 - 1. American National Standards Institute (ANSI).
 - 2. National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA).
 - 4. National Fire Protection Association (NFPA).
 - 5. Underwriters' Laboratories (UL).
 - 6. Occupational Safety and Health Regulations (OSHA).
 - 7. Local, State and National Codes, Standards and Ordinances.
- B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner/Engineer.
- C. Where there is a conflict between the contract documents and an applicable "CODE", the "CODE" shall govern except where the requirements of the contract documents are more stringent; where there is a conflict between the contract drawings and the contract specifications, the most stringent shall govern.

1.6 PERMITS, FEES AND INSPECTIONS

- A. Obtain all permits, fees and systems inspections.
- B. Deliver all certificates of inspection issued by authorities having jurisdiction to the Engineer.

1.7 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material and work. In instances where capacities, size or other feature of equipment, devices or materials exceed these minimums, meet listed or shown capacities.

1.8 SUPERVISION OF WORK

- A. Perform all work under the direct supervision of an experienced, qualified superintendent. The Engineer or the owner's representative has the right to remove a superintendent who, in his opinion, is not satisfactory. A qualified superintendent shall be on site whenever work is being performed on any aspect of the control or associated systems. The superintendent and installer shall not be one and the same without written approval from Owner and Engineer.

1.9 WORKMANSHIP

- A. Install materials and equipment in a professional manner. The Engineer or Owner's representative may direct replacement of items that, in his opinion, do not present a professional appearance. Replace or reinstall items at the expense of the ECMS Contractor. All conduit shall be hidden and routed plumb and perpendicular with building structure.

1.10 CONNECTING TO WORK OF OTHERS

- A. Examine all work installed by others where it applies to work of Section 230923. Notify the Engineer if conditions exist which prevent satisfactory results. Start of work by the Contractor shall be construed as acceptance by him of all claims or questions as to suitability of the work of others to receive his work.
- B. Furnishing of copper, final termination of all copper to be by EMCS Contractor. Fiber Optic patch cables and connectors shall be furnished and installed by EMCS Contractor.

1.11 DAMAGE TO OTHER WORK AND PERSONNEL

- A. Adequately protect work, equipment, fixtures, and materials. At work completion, all work must be clean and in good condition.
- B. Carry insurance as prescribed by law and as required in this specification for protection of employees, other persons, materials and equipment on the building site.
- C. Contractor shall pay for all damages caused by his personnel, including his Subcontractors.

1.12 CUTTING AND PATCHING

- A. Cut and patch all walls, partitions, floors, pits and chases in wood and masonry as indicated or required by the contract documents or as directed by the Engineer.
- B. Obtain approval of Engineer prior to cutting of steel, wood or other structural member.
- C. Complete all necessary excavation and backfilling incidental to work of Section 230923.
- D. Fire and Smoke Rated Walls, Floors, Roofs and Ceilings. Where "rated" walls, floor, roofs and ceilings are penetrated or cut to install equipment, materials, devices, etc. the Contractor shall provide and install all materials required to re-establish the rating of the wall, floor, roof or ceiling to the satisfaction of the authority having jurisdiction.

- E. All buried conduit shall be a minimum of 18 inches deep or greater as indicated in other Specification Sections, Code, or Plans.

1.13 CLEANING

- A. The EMCS Vendor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

1.14 CONCEALED WORK

- A. Where the word "concealed" is used in connection with insulating, painting, piping, ducts, conduit, wiring and the like, the word is understood to mean hidden from sight as in chases, furred spaces or above suspended ceilings. "Exposed" is understood to mean open to view.

1.15 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies, municipalities, and other interested parties that all available information has been provided. Verify locations given.
- C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- D. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

1.16 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.17 MATERIALS AND EQUIPMENT

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.
- B. Only manufacturer's products specified hereinafter or listed in an addendum, prior to the acceptance of bids, shall be furnished and installed under this contract.

1.18 SUBSTITUTIONS AND PRIOR APPROVAL

- A. No substitutions will be considered unless written request has been submitted and received by the Owners Representative at least thirty (30) calendar days prior to the date for receipt of bids. Include information identical to shop drawing submittals with the request.
- B. Substitutions submitted after the prescribed time for prior approval will not be considered.
- C. All substitutes or alternate manufacturers' products must meet detailed specifications, size and arrangement of equipment specified. Equipment must fit allocated space and comply with paragraph 1.1.A.3, no exceptions. Only products equal to that specified will be considered. The Owner and/or Engineer have final authority in determining what is equal and approval must be in writing.
- D. If the approved substitution contains differences or omissions not specifically called to the attention of the Owners Representative, the Owners Representative reserves the right to require equal or similar features to be added to the substituted product at the Contractor's expense.
- E. Substitute system shall have letter of acceptance from the Owner/Engineer upon submission of bid. The letter shall be submitted with bid, but is only valid if prior approved be addenda. No exceptions.

1.19 ADDITIONAL WORK

- A. Design is based on equipment as described in the drawings and specifications. Any change in foundation bases, electrical, wiring, conduit, connections, piping, controls, openings, etc. required by alternate equipment specified and submitted and approved shall be paid for by this Contractor.

1.20 SUBMITTALS

- A. For all new installations, EMCS Vendor shall submit through the Contractor for EDP and Owner approval a complete list of equipment and materials, including product data sheets, description of program software and installation instructions, and shop drawings. Shop drawings shall contain complete wiring, routing and schematic diagrams and any other details required demonstrating that the system has been coordinated and will function properly.
- B. The EMCS Vendor shall submit through the Contractor schematic wiring diagrams for each type of equipment being controlled. A sequence of operations shall accompany the schematic diagrams. The Contractor shall include shop drawings covering items for which he is responsible for providing such as input and control devices. These shop drawings shall be added to those provided by the EMCS Vendor so that EMCS shop drawings that are submitted for approval are complete in every respect. The Contractor shall retain two (2) sets of approved Shop Drawings.

- C. Submit seven copies of the manufacturer's printed specifications and shop drawings for each item. Include the following information - dimensions; electrical characteristics; materials of construction; finish; guarantee; other information deemed necessary by the manufacturer.
- D. Control drawings with detailed ACAD piping and wiring diagrams, including bill of material and description of operation for all systems. Control drawings shall be a minimum of 11" X 17" in size. Installation/layout drawings shall be generated using the current revision of AutoCAD or Vizio
- E. Provide a letter certifying that all equipment submitted complies with the contract documents and will physically fit in the space allocated.
- F. Shop drawings shall be submitted. Indicate by approved signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Engineer. Each shop drawing submitted shall indicate the submittal number.

1.21 FINAL SUBMITTALS

- A. In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

1.22 TRAINING AND INSTRUCTION

- A. EMCS Hardware: The Contractor shall provide the services of a technician who is familiar with the installed EMCS System and who can demonstrate to school maintenance personnel the physical location, function and operation of all EMCS Hardware Units as well as maintenance and troubleshooting techniques that are specific to this installation.
- B. Instructions to Owner's Representative Personnel: Provide the services of competent instructors who will give full instruction to designated personnel in the operation and maintenance of the Control System. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach.
- C. Provide a training manual for each student at each training phase that describes in detail the data included in each training program. Provide one additional copy for archiving.
- D. Provide up to three (3) training sessions of four (4) hours each, as determined by owner, of training on-site at a time and place determined by the Owner.

1.23 OPERATING AND MAINTENANCE MANUALS AND DOCUMENTATION

- A. The EMCS Vendor shall provide to the Contractor two (2) site-specific operation and maintenance manuals on equipment and software provided by the EMCS Vendor. These manuals shall include start-up procedures, failure and recovery procedures, preventative maintenance procedures, custom software descriptions, sequence of operations, system access requirements, etc. Copies of as-built control and

schematic wiring diagrams for each type of equipment and floor plan drawings showing the as-built physical location of EMCS hardware and routing of conduit and wiring shall be contained in each manual.

- B. The Contractor shall promptly supply the EMCS Vendor with information necessary to show the true as-built conditions. The Contractor shall be responsible for including operations and maintenance documents covering items, which he is responsible for providing such as input and control devices. These documents shall be added to those provided to the Contractor by the EMCS Vendor.
- C. The Contractor shall be responsible for coordinating operations and maintenance documents in order that the two (2) manuals and one (1) set of electronic media on compact disk which are submitted for approval are complete in every respect, with one copy to be provided to the EDP. The EMCS vendor shall provide one (1) copy directly to the appropriate maintenance zone.

1.24 INSTRUCTIONS

- A. Included within the scope of Section 230923 is work where equipment and/or materials are furnished or required by this Division and installed under another Division (designated by the Contractor). It is the responsibility of the Contractor to see that all such work is included in the contract bid amount and completed during construction.
- B. All control wiring and conduit for HVAC equipment shall be furnished and installed under Section 230923, except where otherwise noted.

1.25 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver and store equipment and products in factory wrapped packages that properly protect equipment against weather, dirt and damage. All storage shall be in a Contractor-secured area.
- B. Handle equipment carefully to avoid damage to motors, components, enclosures and finish. Do not install damaged units; replace and return damaged units to manufacturer. Any item with defaced sheet-metal, fins, boxes or other such nomenclature shall be considered damaged products and will not be accepted for installation.

PART 2 - PRODUCTS

2.1 EMCS HARDWARE UNITS - Much of the following exists. Contractor to reprogram as needed for Buildings 7 and 8 and new TV monitor in entrance.

- A. Command Gateway Ethernet Routers: Command Routers shall be provided as networking standalone energy management system enclosed in a Condition Rated (per Code) NEMA enclosure containing a micro-computer with a 32-bit power PC microprocessor with cache memory, 32-bit communication co-processor and I/O expansion CAN processor, network communication ports including a third party communication port sized for the equipment being supported, power supplies, ten year battery backup with 720 continuous operation and necessary software.
- B. Controller Units: Command Units shall be connected to Controller Units with sufficient points to provide the control and monitoring required for the equipment and devices assigned to them. Controller Units may be integral with Command Units or may be stand-alone modules connected to a Command Unit. No more than

one controller unit shall be used to control a single piece of equipment. Provide one controller per system; i.e. AHU and pump, boiler and pump, chiller and pump, etc.

- C. Interface Units: Interface units shall be provided as necessary and required to permit data communication to Operator's Units located within the local transmission range of the LAN and shall permit transmission, via IP connection to Owner's Ethernet network. Off-site access shall be by standard web browser, Internet Explorer, Safari, Chrome, or Fire Fox. Individual access shall be determined by Owner.
- D. Third Party Interface Units: Provide all as required, third party interface portals capable of communication with other manufacturers' equipment such as chillers, package energy recovery units, switchgear, lighting, boilers, VFD's etc. Communication shall be BACnet over ARCNET or MSTP, Modbus, N2, Lonworks, or other protocol as may be required.
- E. Operator's Units: As an interface device, an operator shall be able to communicate from a Portable Operator Unit, a Central Operator Unit, a Hand-held Operator Unit or any other web browser; i.e. Iphone, Ipad, Android, Laptop, etc. Features shall be the most up to date available at time of award, or if construction time exceeds nine months then it shall be at time of thirty days before substantial completion. Coordinate with Facilities designated representative for model number and desired features, memory, etc. For all new installations, the EMCS Vendor shall provide fully developed user-friendly system graphics software, customized for the project, for operation on the Owner's Portable Operator Units and Central Operator Units.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internet work. Controller and operator interface communication shall conform to ASHRAE/ANSI Standard 135-2001, BACnet. Control LAN shall be BACnet over ARCNET.
- B. Controllers shall have the ability to communicate on a standard modem connection if the school does not have an existing or access to school boards network.
- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 15900 Appendix A. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

2.3 OPERATOR INTERFACE (EXISTING)

- A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information.
- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2001, BACnet Annex J.
- C. Hardware. Each workstation, web server or equivalent lap top computer shall consist of the following:
1. Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications. Hard disk shall have sufficient memory to store system software, one year of data for trended points and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server, workstations or lap tops shall be approved by the Nassau County School Technology Division.
 2. Lap Top shall consist of a color monitor. The latest manufacturer approved platform at the time of project activation/vendor purchase. Coordinate with owner prior to purchase.
- D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
1. Log In and Log Out. System shall require user name and password to log in to operator interface.
 2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
 4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
 6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points. Trends shall be able to be configured in time lapse format as well.
 7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
 8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
 9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit

operator function authorization with up to 100 different functions and can be site specific by function level. Operator shall be able to authorize each operator function separately.

E. System Software (Existing)

1. Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows 2000 Pro or later version.
2. System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.
3. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - a. Animation. Graphics shall be able to animate by displaying different image files for changed object status.
 - b. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - c. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
4. Provide Eco-Screen software to the ALC Web Control Database to showcase the school's Energy Conservation and sustainability measures, showing energy consumption, water usage, OA conditions and other items as determined by the Engineer. Install a TV screen (48" minimum) in gallery at main entrance. Pull wiring in existing conduit and box.

F. System Tools: System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.
5. Security. System shall require a user name and password to view, edit, add, or delete data.
 - a. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 230923 Appendix A (Sequences of Operation). Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as Sequences of Operation and point schedules on drawings. Trends shall be BACnet trend objects. All I/O points shall constantly be trended and shall be easily selected, configured and viewed as needed by system operator, No Exceptions.
12. Time Lapse Trends. All forty trends as selected by system operator shall be able to be configured in one, four, eight, twelve or twenty-four hour increments on selectable beginning, ending dates and time from the trend current or stored logs. Trends shall be viewed in the selected time/date configuration as required.
13. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
14. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
15. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 - 1) Alarm History.
 - 2) Trend Data. Operator shall be able to select trends to be logged.
 - 3) Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
16. Energy Reports: Operator shall develop custom energy reports by utilizing the trending capabilities for metering energy consumption, electric, water and gas. Reports shall incorporate occupied and unoccupied usage, cooling and heating degree days, low-medium-high data and benchmark data for comparison. Reports can be in Adobe Acrobat or Microsoft Excel with integrated Report Manager for scheduling reports on a monthly, quarterly and/or yearly basis. Provide necessary programming and equipment as required to accomplish task.

17. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
18. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
19. Floor plan graphics for a building or air handler zone shall show exterior and interior walls, F.I.S.H. space numbers, indicate the boundaries of all heating and cooling zones throughout the building, and provide a visual display of actual space temperatures and their respective setpoints. Locations of space sensors shall be shown for each zone. A range of colors shall provide a visual and dynamic (auto-updated) display of temperatures relative to setpoints. Floor plan graphics shall indicate the locations of major equipment such as central air handling units and a central plant with descriptors (AH-3 for example). From the floor plan graphic, an operator shall be able to easily bring up mechanical system graphics of monitored and controlled components (variable air volume terminals, air handling units or the central plant for example), which serve the areas depicted on the floor plan graphic.
20. The EMCS Vendor will be provided AutoCAD floor plan files for all new installations that have been developed by the architect/engineer or NCSD Facilities staff. However, these Auto-Cad files must be "cleaned up" to make them suitable for EMCS system application. Alternatively, floor plan blueprints may be provided to the EMCS Vendor for use in developing floor plan graphics.
21. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
22. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."
 - b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
 - e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

- f. **Mathematical Functions.** Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
- g. **Variables:** Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1) **Time Variables.** Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2) **System Variables.** Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
- G. **Environmental Indexing:** Provide the required programming and software to indicate the Environmental Index of each zone balancing energy efficiency and comfort. The index is expressed in percentage reflecting how close the zone temperature is to the effective heating and cooling setpoints. It shall be indicated by an analog graphic gauge using red segments to indicate poor environments, graduating to green as conditions improve and the index begins to approach 100%. Humidity and CO₂ (zone or return air) shall also be incorporated if the points are available. This index shall also be trended during both occupied and unoccupied times.
- H. **Portable Operator's Terminal.** Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

2.4 CONTROLLER SOFTWARE (Existing)

- A. **Building and energy management application software** shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. **Scheduling.** System shall provide the following schedule options as a minimum:
 - 1. **Weekly.** Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. **Exception.** Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - 3. **Holiday.** Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- C. **System Coordination.** Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- D. **Remote Communication.** System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- E. **Demand Limiting (if indicated on plans)**
 - 1. System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer, where shown.

2. When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Sequences of Operation. When demand drops below adjustable levels, system shall restore loads as specified.
- F. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Sequences of Operation.
- G. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Sequences of Operation.
- H. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
- I. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- J. Energy Calculations.
 1. System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.
 2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 3. System shall calculate a fixed-window average. Window interval start shall be defined by utility meter digital input signal to synchronize system's and utility's fixed-window averages.
 4. Provide meters, flow measuring devices, etc. in systems to allow all specified calculations.
- K. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- L. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- M. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Sequence of Operations.
- N. Trending: All I/O points shall automatically be trended with a factory default setting modified locally of five days, 1,440 samples at five minute intervals per I/O point.

2.5 CONTROLLERS (Existing and new for Buildings 7 and 8)

- A. BACnet
 1. Building Controller/Gateway BACnet Routers (BCs). Each BC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

2. Advanced Application Controllers for Multi-Equipment and Single-Equipment Applications (AACs). Each AAC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.
 3. Application Specific Controllers/Zone and Room Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 4. BACnet Communication
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.
 - b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC and ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- B. Communication
1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 4. The system shall be capable of stand-alone operation in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
- C. Environment: Controller hardware shall be suitable for anticipated ambient conditions.
1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).
 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

2.6 DEVICES

- A. Space Sensors
1. Space Sensors shall be blank, with set point adjustment and override switch, set point adjustment, override switch, and display. Type to be coordinated with owner.
 2. Sensors shall measure adjusted room temperature with the option for sensing humidity CO₂, VOC or a combination of temperature, humidity with CO₂ or VOC.
 3. Multiple sensors can be "daisy chained" for averaging or high low select from each controller.
 4. Override switch. When pushed shall override selected units or for a period of time as selected by system operator.
 5. Fan speed select button shall be available to three speed fan coil units.
 6. Communicating points shall be provided on all room sensors.
 7. Room sensor shall be mounted in a standard 2"x4" box.

- B. Temperature sensors other than Space Sensors
 - 1. Temperature sensors shall be Resistance temperature Device (RTD) or thermistor.
 - 2. Duct sensors shall be single point or averaging as shown or required.
 - 3. Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
 - 4. Provide matched temperature sensors for differential temperature measurement.

- C. Relative Humidity Transmitters: Relative Humidity Transmitters shall use bulk polymer resistance technology for sensing. Transmitters shall be accurate within 2% and shall have true 4 to 20 mA analog output directly proportional to relative humidity. Provide case and associated hardware for space, duct, outside, or remote mounting as appropriate. Transmitters shall be Veris, Bapi, or pre-approved equal.
 - 1. Room Humidity Sensors. Provide surface mount device for mounting on standard electrical switch box. Cover shall match room temperature element.
 - 2. Duct Humidity Sensors. Provide units with integral conduit mounting box and shield to protect element from damage.

- D. Low Temperature Protection Thermostats: Provide low temperature protection thermostats of automatic or manual-reset type as required by the sequence of operations, with sensing elements 8' or 20' in length. Provide thermostat designed to operate in response to coldest 1'-0" length of sensing element, regardless of temperature at other parts of element.
 - 1. Support element properly to cover the entire duct width.
 - 2. Provide separate thermostats for each 25 square feet of coil face area or fraction thereof.
 - 3. Install sensor per manufacturers published recommendations.
 - 4. Install all outside air intakes and ensure freeze protection of coils.
 - 5. Provide low temperature protection in chilled and hot water system to bring on pumps to circulate water when below system's freezing point.

- E. Flow Status Switches: Fan and pump flow status shall be monitored through motor current status switches in lieu of differential pressure switches. Current status switches shall have an adjustable setpoint and be capable of detecting belt/drive loss and motor failure. Switches shall be Veris Industries' or pre-approved equal model Hawkeye 705, 907 or 908 with LED status except that variable volume now applications must be model Hawkeye 907 (automatically compensates for variable volume effects including VFD's). Control Contractors shall provide piping devices to allow flow indicators to be installed.

- F. Current Monitoring: Provide analog input monitoring of motor KW/Amps for all major pieces of HVAC equipment where required by the control drawings I/O summary. Transducers shall be by Veris Industries, Hawkeye model. Model number provided shall be applicable to the motor size and voltage.

- G. Power Monitoring: Power monitoring of main switchgear or sub-power/lighting shall be Veris Industries Networked Data Stream meters, model H8036 sized for panel loads. Communication shall be Modbus. Control contractor shall provide Third Party Interface Portal for BACnet communications.

- H. Differential Pressure Transducers: Differential pressure transducers shall be as required with internal signal conditioning and true analog output. The devices shall be Modus, Inc. (air) and Robinson Halpern or Auto Tran (water) or pre-approved equal. Provide pressure snubbers and isolation valves for water differential pressure applications to prevent damage due to pressure shocks and facilitate service and calibration.

- I. Flow Measuring Devices/Non Domestic Water: Provide turbine flow meters or turbine electro magnetic flow meters for venturi type metering devices in the main chilled water and where shown on drawings to record the chilled water flow rate in GPM and totalize flow for at least a 24-hour period. Provide calculation value for tonnage on all chilled water generation equipment. Provide piping installation kits with shut off valves for installation of FMD's.
- J. For flow measurement in line sizes of 2 and smaller provide a Belimo FM200 inline ultrasonic flow meter with an output of 0-10vdc or approved equal. For sizes 2 ½ " and larger provide an Onicon F-3500 insertion electromagnetic meter. Provide with installation kits.
- K. BTU Meters – Provide BTU meters where shown. In line sizes 2 ½" and smaller provided an Onicon System-40 compact in-line ultrasonic BTU meter with user display and BACnet MS/TP Communications. For line sizes larger than 2 ½" provide an Onicon system-10 BTU meter with BACnet MS/TP communication and an Onicon F-3500 insertion electromagnetic flow meter. Provide with installation kits.
- L. Domestic water flow measuring devices. Meter shall conform with ANSI/AWWA standards C701 Class II standards. Device shall use floating ball measurement technology and designed for potable water use. Device shall have a pulse output and LCD display. Shall be sensor Model OMNI T2.
- M. CO₂ Transmitters: CO₂ transmitters shall use a non-dispersive infrared technology for sensing CO₂. Transmitters shall be accurate to +/- 50 PPM and shall have a true 4 to 20 mA analog output directly proportional over a range of 0 to 2,500 PPM. Provide room or duct mounted units as appropriate. Transmitters shall be Bapi, Veris or pre-approved equal. Owner's approval is required for all CO₂ transmitters. Provide CO₂ sensors in all assembly areas to allow limiting of outside air.
- N. Air Flow Stations – airflow measurement devices shall use the principle of thermal dispersion and provide self heated bead in glass thermistor and zero power lead in glass thermistor at each node. Shall be Ebtron Series HTx104-PG where indicated.
- O. Relays: Relay contacts shall be rated for the application, with Form C contacts, enclosed in a dust-proof enclosure. Relays shall have contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression. Provide additional relays as necessary to carry the intended load where load requirements exceed the 0.5 amp rating of EMCS Hardware Units. Open relays shall be IDEC, and relays in an enclosure shall be Functional Devices, RIB series or pre-approved equal.
- P. Contactors: Contactors shall be of the single coil, electrically operated, and electrically held type. Contacts shall be double break silver-to-silver type protected from arcing contacts. Number of contacts and ratings shall be selected for application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices. Provide as necessary to carry the intended load where load requirements exceed the 0.5 amp rating of EMCS Hardware Units. Furnas or pre-approved equal.
- Q. The transformers shall be either 120/208/240/480 to 24/12 VAC as required by the voltage and/or application. Provide a resettable circuit breaker at the secondary side of each transformer. Each transformer shall be UL approved class 2 unit with an operating ambient temperature range from -40 Deg. F. to 120 Deg. F. and a humidity level from 10% to 90% noncondensing.

R. Dampers:

1. Provide automatic control dampers in all outside air intakes and/or as indicated for new construction. In cases where dampers and actuators are not existing the EMCS Contractor to provide new and install. In all controls to equipment modules, program to shut off (close) where respective HVAC unit or systems is turned off. EMCS contractor to verify all sizes and placement and indicate on shop drawings. Damper frames not less than formed 16-ga galvanized steel. Provided damper blades shall be not less than formed 18-gage galvanized steel, unless otherwise specified with maximum blade width of 8". Ruskin CD50 or CD36 stainless steel. See drawings.
 - a. Secure blades to 1/2" diameter plated steel axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade.
 - b. Parallel blade operation shall be used for all two position applications and opposed blade configurations for all modulating applications.
 - c. Performance Data
 - 1) Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.
 - a) Closed Position: Maximum pressure of 5 inches w.g. @ a 12 inch blade length.
 - b) Open Position: Maximum air velocity of 2,000 feet per minute.
 - c) Leakage: Maximum 3.7 cubic feet per minute per square foot at 1 inch w.g. for all sizes 36 inches wide and above.
 - 2) Pressure Drop: Maximum 0.07 inch w.g. at 1,500 feet per minute across 24 inch x 24 inch damper.

S. Chilled and Hot Water Control Valves:

1. Ball valves shall be used for all water applications where sizing permits.
2. Valves 1/2" through 3" shall be forged brass body with nickel plating, NPT screw type. The operating range shall be 0°F to 212°F. control valves shall be furnished with a stainless steel ball & stem and fiberglass reinforced Teflon seats and seals.
3. The valves shall have an ISO type 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe. A non-metallic thermal isolation adaptor shall separate the flange from the actuator with high temperature materials rated for continual use at greater than the application temperature. Valve assemblies without thermal isolation as described are not acceptable.
4. The isolation adaptor shall also provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.
5. All control valves shall have a TEFZEL flow-characterizing disc in the inlet of 2-way characterized control valves and in the control port of 3-way valves. Three-way valves shall be applicable for both mixing and diverting.
6. Control valves shall be two-way or three-way type for two-position or modulating service as shown. Valve CV shall be selected for a 3 to 5 psi pressure drop. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve, but not to exceed 5 psi.
7. The Control Contractor shall furnish all the control valves of the type indicated on the drawings for installation by the Mechanical Contractor.
8. Electronic control valve actuators shall be as manufactured, brand labeled, or distributed by Belimo or pre-approved equal.

T. Butterfly Valves

1. Butterfly valves and/or actuators shall be as manufactured, brand labeled, or distributed by Belimo, or pre-approved equal.

2. Butterfly valves 2" to 30" shall have a fully lugged, drilled and tapped cast iron body. Flanges shall meet ANSI 150 standards. The one-piece body shall feature an extended neck allowing sufficient clearance for flanges and 2" of piping insulation. The disc shall be 304 stainless steel and provide bubble-tight close off for water or 50% glycol applications.
3. The 2" through 6" valves shall be rated for a maximum of 50-psi close off using standard Belimo actuators. Valves 2" through 12" shall be available in 50 or 200 pound close off as required by the application. Valves 14" through 30" shall be rated at 150 psi close off.
4. Actuators shall be applied according to the manufacturer's specifications.

U. Damper and Valve Actuators

1. Actuators shall be fully modulating/proportional, pulse width, tri-state, or two position as required and be factory or field selectable. Actuators shall provide a selectable feedback voltage and have visual position indications. Actuators shall operate in sequence with other devices if required.
2. Actuators shall be available to operate on 24 or 120 VAC, or 24 VDC and Class 2 wiring as dictated by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators, and 8 watts for DC applications.
3. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.
4. Manufacturer shall provide a five (5) year unconditional warranty from date of Final Acceptance.
5. Each valve shall fail safe open or closed to the coil as indicated in the sequence of operation or to prevent freezing.
6. The valve actuator shall be capable of providing the minimum torque required for proper valve close off to exceed the dead head pressure of the largest pump within the system, or 60 psi, which ever is greater.
7. Electronic control damper actuators shall be as manufactured, brand labeled, or distributed by Belimo or pre-approved equal.
8. Provide new actuators on all replaced and new dampers.

V. Environmental Conditions: All equipment shall operate under ambient environmental conditions of 35 degrees to 122 degrees F dry bulb and 10 to 95 percent RH noncondensing. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installed location.

W. System Accuracy: The system shall maintain an end-to-end accuracy, as listed for the applications specified.

Table 1 - Reporting Accuracy	
Measured Variable	Reported Accuracy
Space Temperature	0.5°F
Ducted Air	0.5°F
Outside Air	0.5°F
Dew Point	1°F
Water Temperature	0.5°F

Delta-T	0.5°F
Relative Humidity	5% RH
Water Flow	2% of full scale
Airflow (terminal)	10% of full scale
Airflow (measuring stations)	5% of full scale
Airflow (pressurized spaces)	3% of full scale
Air Pressure (ducts)	0.1 in. w.g.
Air Pressure (space)	0.02 in. w.g.
Water Pressure	2% of full scale
Electrical (A, V, W, Power Factor)	5% of reading
Carbon Monoxide (CO)	5% of reading
Carbon Dioxide (CO ₂)	50 ppm
Note 1: 10%-100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

Table 2 - Control Stability and Accuracy		
Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	0.2 in. w.g.	0-6 in. w.g.
Airflow	10% of full scale	
Space Temperature	1.0°F	
Duct Temperature	1.5°F	
Humidity	5% RH	
Fluid Pressure	1.5 psi	1-150 psi

2.7 WIRE, CABLE, CONDUIT AND POWER SUPPLIES

- A. Conduit: EMCS Contractor shall provide conduit for all wire and cable in accordance with Division 26. The Contractor shall take particular care to ensure that conduit run underground is properly sealed to prevent water intrusion and shall have minimum cover of 18 inches.
- B. The EMCS Vendor shall take particular care to provide shielded plenum rated cable in all plenums whether in conduit or not. Failure to do so will require replacement.
- C. Wiring shall be continuous with no joints except at equipment terminations. Drain wire shall be continuous and grounded as per manufactures recommendations.
- D. Transmitter Wiring: Transmitter wiring, or other 4-20 ma. signaling device wiring shall be continuous from the device to its Controller Unit. Drain wire shall be continuous and grounded at the Controller Unit only. Transmitter wiring shall be West Penn 303 or pre-approved equal.
- E. Power Supplies: The EMCS Vendor shall be responsible for providing all power supplies required, including control transformers, and any connections to building electrical system which are required and are not explicitly shown on the Electrical or Mechanical drawings. Control Contractor shall provide and coordinate the HVAC and EMCS controls with the Project Licensed Electrical Contractor in order that the electrical power for controls is proved. Equipment such as unit ventilators, blower coils, and fan terminal units can receive control power from the same power supply that is brought to the unit for the fan. However, variable air volume boxes, wall mounted control panels serving air handling units, building gateway router, etc. require a 120 volt power supply to be brought to the controls. The power supply brought to the controls shall be from 120 volt circuits which are dedicated for controls. The dedicated circuit shall be sized to provide a minimum of 100VA to each variable air volume box and 200 VA to each wall mounted control panel .
- F. Control Contractor shall pick up fiber at LAN Data Rack and provide all equipment fiber patch cord to EMCS panel in Communication Room. Provide copper wiring to route throughout buildings, to HVAC equipment and EMCS panels in all Buildings. Fiber patch cables shall have connector types to match existing building patch panel connectors and EMCS standard type end connector for LAN to fiber transceiver in all Buildings.

2.8 FIBER OPTIC PATCH CABLES

- A. Distribution Frame Fiber Optic Patch Cords: Cords shall be multimode, 62.5/125 micron, duplex fiber optic cable with two (2) Type SC connectors to match patch panel connectors and provided equipment with plenum rated outer jacket. Cable shall be minimum three (3) feet total length or as required to reach EMCS equipment enclosure. Cable ends shall be labeled with transmit and receive markers. Provide a minimum of one (1) patch cord for every pair of fibers terminated at each IDF.
- B. Fiber optic connectors at Building Owners patch panels shall be Type SC and shall be of the hot melt installation type. Crimp type connectors are not acceptable. Connectors shall be preloaded with all necessary adhesive to achieve a permanent connection. Adhesive shall be reheatable to allow fiber repositioning. Connector boot shall be Thermoplastic Elastomer. Connector Housing and Body shall be Engineered Resin Material. Connector Ferrule shall be Zirconia Ceramic. Insertion Loss Typical Field Mount (one mated pair) @ 1300 nm: <0.2dB. Reflection Typical Field Mount: -25dB.
- C. Provide fiber optic patch cords to connect the EMCS panels to the Fiber Optic Cable System. Patch cords shall be multimode, 62.5/125 micron, duplex fiber optic cable with two (2) SC type connectors at

one end. Connectors at the opposite end shall be selected as required to connect to the EMCS equipment. Provide cord length as required to connect EMCS equipment to the Fiber Optic Cable System using conduit routed above Systems room ceilings. See Electrical plans.

PART 3 - EXECUTION

3.1 THE EMCS VENDOR SHALL BE RESPONSIBLE FOR:

- A. Provide and install all fiber patch cord and copper wire system components in accordance with the manufacturers recommendations in buildings 7 and 8.
- B. Providing all input and control devices and necessary interconnections of wire, cable, fiber patch cords and conduit within buildings 7 and 8.
- C. System startup, commissioning and adjustments required for a complete operable system. He shall coordinate with the MDP, and Mechanical Contractor to insure the system operates as required.
- D. Provide operations and maintenance manuals covering the entire EMCS.
- E. Provide all fiber and wire terminations in all EMCS modules and panels. Electrical to provide power required for all EMCS panels. EMCS to provide power to all modules throughout campus.

3.2 INSTALLATION

- A. General. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Mount controllers at convenient locations and heights.
- B. All installation of the EMCS shall be performed by mechanics, electricians and technicians in the direct supervision of the system supplier. Coordinate installation with all other affected trades. Provide necessary project management personnel for this section.

3.3 ELECTRICAL INSTALLATION

- A. Coordination of the EMCS design and installation with the MDP and Owner.
- B. Providing shop drawings and a complete list of all EMCS hardware including input and control devices required for the project with the source of supply clearly indicated.
- C. The EMCS Vendor shall be responsible for providing all wire, cable and conduit required by this section inside the buildings and to outside EMCS devices. All wiring and cable shall be approved for its intended use and shall be run in conduit when exposed in rooms. All wire, cable and conduit shall be installed to conform with the National Electrical Code, NFPA 70 by a licensed Electrical Contractor where voltage is 50 volts or higher per NEC.
- D. Wire shall be labeled at the control panel. Labels shall be Brady PWM Series or pre-approved equal, and shall be marked in accordance with descriptors or abbreviations used on the control drawings.

- E. All wiring, conduit and devices pertaining to the fire alarm system shall be provided under Division 28 with the following exceptions:
 - 1. Provide identified terminals in the motor control circuit on those air handling systems requiring automatic shut down from the fire alarm system. Coordinate this with the fire alarm system tradesman who will connect to these terminals and interface with the fire alarm system.
 - 2. Duct mounted smoke detectors shall be physically mounted under Division 23 by the Mechanical Contractor, although all wiring and conduit shall be provided under Division 28. EMCS Contractor shall connect to EMCS for alarm and system shutdown.
- F. Provide all internal control wiring in starters under Section 230923. Final installation of the starter and the provision of all power wiring, conduit and terminations shall be accomplished under Division 26. Provide all final control wiring and conduit to the starter under Section 230923.
- G. Providing operation and maintenance manuals covering equipment and software provided and providing framed control drawings.

3.4 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. Relocate space thermostats/sensors if required due to draft, interference with cabinets, chalkboards, etc., or improper sensing.
- E. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- F. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- G. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m² (1 ft of sensing element for each 1 ft²) of coil area.
- H. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

3.5 DIFFERENTIAL AIR STATIC PRESSURE

- A. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Make pressure tap connections in accordance with the manufacturers instructions.

- B. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Make pressure tap connections in accordance with the manufacturers instructions.
- C. Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
- D. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- E. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a vibration free location accessible for service without use of ladders or special equipment.
- F. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.6 CONTROL WIRING

- A. Provide all electrical work required as an integral part of the digital control work. Install a complete wiring system for the temperature control system including wire, conduit and miscellaneous materials as required for mounting and connecting control devices. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. All wiring to sensors and bus connections is low voltage and should be in accordance with local regulations and the National Electrical Code.
- B. Conduit: Provide conduit for all wire and cable in accordance with Division 26. The Contractor shall take particular care to ensure that conduit run underground is properly sealed to prevent water intrusion. Water intrusion will require conduit re-installation.
- C. The Contractor shall take particular care to provide shielded cable as required. Failure to do so will require replacement at the Contractor's expense.
- D. All wiring that is required to go underground must be rated for that use and approved and installed in conduit.
- E. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- F. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- G. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- H. All control and interlock wiring shall comply with national and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.

- I. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and Division 26 requirements.
- J. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)
- K. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- L. Do not install wiring in raceway containing tubing.
- M. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- N. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- O. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- P. Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- Q. Include one pull string in each raceway.
- R. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- T. Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.
- U. The Contractor shall provide wiring and fiber optic patch cords and terminate all control and/or interlock wiring related to the scope of work of this section and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site. Contractor shall provide all 120v required to the EMCS panels and devices to provide complete system.
- V. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 ft in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- W. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.7 WARNING LABELS

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows:

CAUTION
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.8 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 2 in. of termination. Labels shall be Brady PWM Series or pre-approved equal, and shall be marked in accordance with descriptors or abbreviations used on the control drawings.
- B. Permanently label or code each point of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- E. Identify room sensors relating to terminal box or valves with nameplates.
- F. Manufacturers' nameplates and UL labels are to be visible and legible after equipment is installed.
- G. Identifiers shall match record documents.

3.9 SOFTWARE INSTALLATION

- A. General: Install all components and load all system software in accordance with manufacturer's recommendations.
- B. Load and debug all software required for an operational EMCS, including data base, operational parameters, and system and applications programs. Load and debug all control software necessary to implement all sequences of operation and as shown on the drawings.

PART 4 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

4.1 DEMONSTRATION

- A. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
- B. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process. The engineer (EDP) will be present to observe and review these tests. The EDP shall be notified at least 10 days in advance of the start of the testing procedures.
- C. The EMCS Vendor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
- D. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
- E. Demonstrate compliance with sequences of operation through all modes of operation.
- F. Demonstrate complete operation of operator interface.
- G. Additionally, the following items shall be demonstrated:
 - 1. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over damped control shall require further tuning by the EMCS Vendor.
 - 2. Interface to the building fire alarm system.
 - 3. Trend logs for each system that indicate set points, operating points, valve positions, and other data as specified in the Points List provided with each Sequence of Operation. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes or as specified on

the Points List. The logs shall be accessible through the system's user interface and retrievable for use in an excel spreadsheet.

- H. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The EMCS Vendor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

4.2 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Check and test all systems for shorts, ground, continuity and finally for proper functioning and operation. A certified factory trained technician, employed by the controls representative shall perform final connections of equipment, testing of the system and any other necessary adjustments.
- B. After all EMCS work has completed and put into operation, subject each system to an operating test under design conditions to insure proper sequence and operation throughout the range of operation. Make adjustments as required to insure proper functioning of all systems.
- C. The EMCS Vendor shall provide personnel, tools and equipment and assist the Test and Balance Contractor in making any final adjustments. The EMCS Vendor is responsible to ensure all final Test and Balance numbers are installed for each device.
- D. The EMCS vendor shall provide personnel to coordinate with and assist the commissioning agent as required during the entire commissioning time for EMCS where applicable.
- E. Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner's representative is notified of the system demonstration.
- F. Acceptance Test: An acceptance test shall be performed where a random number of I/O points will be selected, physically inspected and tested in the presence of at least one of the following: EDP, Owner or Owner Representative.
- G. Checkout: Prior to requesting final acceptance of the system, demonstrate to the Engineer that all requirements of this Section have been fully complied with.
- H. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
- I. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
- J. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
- K. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
- L. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and

automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.

- M. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all PID loops and any other control routines that require tuning.
- N. Alarms and Interlocks
 1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.
- O. Any tests that cannot be performed due to circumstances beyond the control of the EMCS Vendor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

4.3 FINAL ADJUSTMENT OF EQUIPMENT

- A. The EMCS Vendor shall be responsible for control system start-up, and shall perform all checkout, calibration and testing to insure proper system operation.
- B. Final adjustment shall be performed by specially trained personnel in the direct employ of the manufacturer of the EMCS Vendor.
- C. Provide system CD-Rom back-ups at all workstations and final manuals.

4.4 WARRANTY AND SERVICE

- A. Labor and materials for routine maintenance and service on a quarterly basis for the control system specified shall be warranted free from defects for a minimal period of 5 years after final completion and Owner receives beneficial use of the system. Control system failures during the 5-year warranty period shall be adjusted, repaired or replaced at no additional cost or reduction in service to the Owner. The contractor shall respond to the Owner's request for warranty service online within 1 hour of complaint or onsite within 4 hours during normal business hours.
- B. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- C. Operator workstation software, project-specific software, graphic software, database software and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the Owner. Written authorization by the Owner must, however, be granted prior to the installation of any of the above mentioned items.

- D. Furnish a letter that states the control system has been tested, checked for operation and calibration, commissioned, and the system is operating as designed. The system shall be fully programmed for temperature, humidity, and time of day as well as occupancy scheduled.
- E. Provide complete coverage, service, adjustment and product replacement warranty for a five year period.
- F. Provide all parts, labor, adjustments, and calibration of entire control system, preventative maintenance, and periodic inspections as recommended by the manufacturers on a minimum schedule of quarterly and annually.
- G. All service work, inspections, etc. shall be reported on a field service report form given to facility daily when performed.
- H. See Mechanical General Guarantee and Service paragraph 1.33 for additional warranty and service requirements.

4.5 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
 - 1. Graphics
 - 2. Software to build graphics and program changes
 - 3. Record drawings
 - 4. Databases and Programs
 - 5. Application programming code
 - 6. Documentation for complete operational manuals

END OF SECTION 230923

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipe fittings for:
 - 1. Chilled and hot water piping system.
 - 2. Equipment drains and overflows.
- B. Valves:
 - 1. Globe or angle valves.
 - 2. Ball valves.
 - 3. Plug valves.
 - 4. Butterfly valves.
 - 5. Check valves.

1.2 RELATED SECTIONS

- A. Section 230503 - Mechanical Identification.
- B. Section 232116 - Hydronic Specialties.
- C. Division 26 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.5 - Refrigeration Piping.
- F. ASME B31.9 - Building Services Piping.
- G. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- H. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- I. ASTM B32 - Solder Metal.
- J. ASTM B88 - Seamless Copper Water Tube.

- K. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- L. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- M. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- N. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe.
- O. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- P. ASTM D2467 - Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- Q. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite-Sewer Piping.
- R. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- S. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- T. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- U. ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- V. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- W. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- X. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Tubing.
- Y. ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- Z. ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
- AA. AWS A5.8 - Brazing Filler Metal.
- BB. AWS D1.1 - Structural Welding Code.
- CC. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- DD. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
- EE. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- FF. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- GG. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

- HH. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- II. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- B. Only use grooved mechanical couplings and fasteners in accessible locations and at all equipment connections.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- D. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- E. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.
- F. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- G. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.
- H. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
- I. Use butterfly valves in chilled and in heating water systems, interchangeably with gate and globe valves.
- J. Use only butterfly valves in chilled water systems for throttling and isolation service, for pipe sizes over 2 inches. Otherwise use ball valves.
- K. Use lug end butterfly valves to isolate equipment.
- L. Use 3/4 inch (20 mm) ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.5 SUBMITTALS

- A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Welders Certificate: Include welder's certification of compliance with ASME SEC 9.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

- A. Record actual locations of valves and buried piping. Provide thrust block layout.

1.7 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing the work of this section with minimum three years experience.
- C. Welders: Certify in accordance with ASME SEC 9.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.12 EXTRA MATERIALS

- A. Provide two repacking kits for each size and valve type.

PART 2 - PRODUCTS

2.1 CHILLED WATER PIPING, BURIED

- A. Steel Pipe: ASTM A53, Schedule 80, black with AWWA C105 polyethylene jacket, or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
 - 1. Fittings: ASTM A234, forged steel welding type with double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
 - 2. Joints: AWS D1.1, welded.
 - 3. Casing: see insulation specification or shall be PVC, HDPE or non corrosive casing for area install.
- B. Aquatherm chilled/hot water piping type SDR7.4MF or SRD 11 Fusion PR-R Fraser composite may be utilized. ASTM F2389 may be utilized. Minimum working pressure for chilled water @ 45 degrees F shall be 195 PSIG, for hot water shall be 100 PSIG @ 180 degrees F @ a 60 year life cycle for both. All fitting shall be factory manufactured and molded. Piping shall be embedded and covered with a 6" layer of clean backfill and tamped. Due to expansion coefficient of material, allow for expansion and construct expansion loops as recommended by manufacturer. However, provide a minimum of expansion loops indicated on mechanical plans or more were required by manufacturer.
- C. Allowable products of ISCO polypropylene, Niron or equal may be substituted when in compliance specification listed in Paragraph A above and intended use.
- D. It is recommended that all underground hot water piping be pre-insulated with PVC, HDPE or allowable jacket. Chilled water if the carrier pipe is a poly material may be installed as direct burial with no jacket or insulation.
- E. All underground no metal pipe or jacket shall be traced with #10 gage stainless steel wire 12" below grade along path of piping system.

2.2 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53, Schedule 40, black for all sizes 4 inches and larger. Below 4 inches, use ASTM B88, copper type "K" piping Propress or Schedule 40 black iron.
 - 1. Fittings: Use criteria for underground piping for sizes 4 inches and above. Otherwise, fittings shall be ASME 16.22, copper type "K" flanged or silver solder type.
 - 2. Joints: Flanged or silver solder connections for sizes below 4 inches. For sizes 4 inches and above, use criteria outlined for underground piping.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type K, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F (220 to 280 degrees C).

2.4 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches (50 mm) and Under:
 - 1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
- B. Flanges for Pipe Over 2 Inches (50 mm):
 - 1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 - 2. Gaskets: 1/16 inch (1.6 mm) thick preformed neoprene.
- C. Grooved and Shouldered Pipe End Couplings:
 - 1. Housing Clamps: Malleable iron galvanized to engage and lock, designed to permit some angular deflection, contraction, and expansion.
 - 2. Sealing Gasket: C-shape elastomer composition for operating temperature range from -30 degrees F to 230 degrees F.
 - 3. Accessories: Steel bolts, nuts, and washers.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.5 BALL VALVES

- A. Up To and Including 2 Inches (50 mm):
 - 1. Bronze two piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, threaded ends with union.
- B. Over 2 Inches (50 mm):
 - 1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.

2.6 BUTTERFLY VALVES

- A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- B. Disc: Stainless steel.
- C. Operator: Infinite position lever handle with memory stop.

2.7 SWING CHECK VALVES

- A. Up To and Including 2 Inches (50 mm):
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, threaded ends.
- B. Over 2 Inches (50 mm):
 - 1. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

PART 3 - EXECUTION

3.1 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.
- E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- F. Install in accordance with manufacturer's instructions.
- G. Install heating water, chilled water, and engine exhaust piping to ASME B31.9.
- H. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- I. Install piping to conserve building space, and not interfere with use of space.
- J. Group piping whenever practical at common elevations.
- K. Sleeve pipe passing through partitions, walls and floors.
- L. Slope piping and arrange to drain at low points.
- M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- N. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 Inches (100 mm).
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- O. Pipe Hangers and Supports:
 - 1. Install in accordance with ASTM B31.9.
 - 2. Support horizontal piping as required to prevent sagging.
 - 3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.

5. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 6. Support riser piping independently of connected horizontal piping.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- P. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- Q. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Architect/Engineer.
- R. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- S. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- T. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- U. Install valves with stems upright or horizontal, not inverted.
- V. Pressure test all chilled water and hot water piping systems to 1-1/2 times operating pressure prior to trench backfill. In the event of a leak, drain system, clean and dry piping at point of leak. Repair piping and re-test.

END OF SECTION 232113

SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Pump suction fittings.
- F. Combination fittings.
- G. Flow indicators, controls, meters.
- H. Relief valves.

1.2 RELATED SECTIONS

- A. Section 232113- Hydronic Piping.

1.3 REFERENCES

- A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model.
- B. Submit inspection certificates for pressure vessels from authority having jurisdiction.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of flow controls, flow meters and valves.

1.6 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of system for one year from date of substantial completion.
- B. Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

PART 2 - PRODUCTS

2.1 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber. Install in non-accessible or above finished spaces.
- B. Automatic air vents shall be installed in Mechanical spaces only, unfinished spaces or outside.

2.2 FLOW CONTROLS

- A. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet.
- B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psig.
- C. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- D. Accessories: In-line strainer on inlet and ball valve on outlet.

2.3 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank on primary pumping system only.
- F. Provide valved drain and hose connection on strainer blow down connection.
- G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- I. Support pump fittings with floor mounted pipe and flange supports.
- J. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- K. Provide radiator balancing valves on water outlet from terminal heating units such as unit heaters and fan coil units.
- L. Provide relief valves on pressure tanks, low pressure side of reducing valves, and expansion tanks.
- M. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- N. Pipe relief valve outlet to nearest floor drain.
- O. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 232116

SECTION 232118 - GAGES AND METERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure gages and Pressure gage taps.
- B. Thermometers and thermometer wells.
- C. Filter gages.

1.2 RELATED SECTIONS

- A. Section 232113 - Hydronic Piping: Installation of Thermometer wells and pressure gage tapings.

1.3 REFERENCES

- A. ASME - B40.1 - Gages - Pressure Indicating Dial Type - Elastic Element.
- B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi.
- C. ASTM E1 - Specification for ASTM Thermometers.
- D. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide list which indicates use, operating range, total range and location for manufactured components.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Operation and Maintenance Data Warranties and Bonds.
- B. Project Record Documents: Record actual locations of components and instrumentation.
- C. Operation and Maintenance Data.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 LIQUID FLOW METERS

- A. Calibrated venturi orifice plate and flanges with valved taps, chart for conversion of differential pressure readings to flow rate, with pressure gage in case.
- B. Provide one (1) on each building secondary pump discharge, chiller and boiler.

2.2 PRESSURE GAGES

- A. Gage: ASME B40.1, drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
- B. Case: Steel with brass bourdon tube.
- C. Size: 4-1/2 inch diameter.
- D. Mid-Scale Accuracy: two percent.
- E. Scale: Psi.

2.3 PRESSURE GAGE TAPPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psig.

2.4 STEM TYPE THERMOMETERS

- A. Thermometer: ASTM E1, adjustable angle, red appearing liquid, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
- B. Size: 9 inch (225 mm) scale.
- C. Window: Clear glass.
- D. Stem: 3/4 inch (20 mm) NPT brass.
- E. Accuracy: ASTM E77 2 percent.
- F. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems.

2.6 TEST PLUGS

- A. Manufacturer: Basis of Design: Petes Plug.

- B. Test Plug: 1/4 inch (6 mm) or 1/2 inch (13 mm) brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
- C. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch (60 mm) diameter pressure gages, one gage adapters with 1/8 inch (3 mm) probes, two one inch (25 mm) 1-1/2 inch (38 mm) dial thermometers.

2.7 STATIC PRESSURE GAGES

- A. Manufacturer: Basis of Design: Dwyer, filter gage with flag.
- B. 3-1/2 inch (90 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide three pressure gages per pump, installing taps before strainers and on suction and discharge of pump. Pipe to each gage.
- C. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch (60 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- E. Install thermometers in air duct systems on flanges.
- F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
- G. Coil and conceal excess capillary on remote element instruments.
- H. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- I. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- J. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets adjacent to pressure gages and pressure gage taps.

L. Install pressure gages across all filter, coil, and fan sections on all systems.

3.2 SCHEDULES

A. Pressure Gage Schedule
LOCATION

Pumps
Chillers - supply
AHU's coils, chilled and hot water
Fan Sections
Boilers
Gas Regulator and Gas Manifolds
Air Regulator and Air Manifolds

B. Pressure Gage Tapping Schedule
LOCATION

Control valves 3/4 inch (20 mm) & larger - inlets and outlets
Major coils - inlets and outlets
Chiller - inlets and outlets
Boiler - inlets and outlets

C. Stem Type Thermometer Schedule
LOCATION

Headers to central equipment
Coils and coil banks - inlets and outlets
Chiller - inlet and outlet
Domestic hot water supply and recirculation

D. Thermometer Socket Schedule
LOCATION

Control valves 1 inch (25 mm) & larger - inlets and outlets
Reheat coils - inlets and outlets

E. Dial Thermometer Schedule
LOCATION

Each supply air zone
Outside air
Return air
Mixed air

F. Static Pressure and Filter Gage Schedule
LOCATION

Built up filter banks
Unitary filter sections
Supply fan discharge
Coil sections

END OF SECTION 232118

SECTION 232216 - CONDENSATE DRAIN PIPING

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 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:
 - 1. American Society for Testing and Materials (ASTM):
 - a. B16.22 Standard Specification for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
 - b. B16.23 Standard Specification for Cast Solder Fittings
 - c. B16.29 Standard Specification for Wrought Solder Fittings
 - 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.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Piping shall be copper type 'K' as specified.

PART 3 - 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 "K" for condensate line material.

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 hub drain.

END OF SECTION 232216

SECTION 232500 - CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Chemical treatment.

1.2 SUBMITTALS

- A. Submit Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment.
- C. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- E. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.3 PROJECT RECORD DOCUMENTS

- A. Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

1.4 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Closed System Treatment (Chilled and Hot Water):
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 3. Conductivity enhancers; phosphates or phosphonates.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
 - 2. One pound per 100 gallons of water contained in the system.
 - 3. One pound per 100 gallons of water for hot systems and one pound per 50 gallons of water for cold systems.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
- D. Use neutralizer agents on recommendation of system cleaner supplier.
- E. Remove, clean, and replace strainer screens and socks.
- F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

- A. Provide one combination filter/feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through combination filter/feeder when required or indicated by test.

- C. Provide 2" inlet and drain to connect to fire hydrant for flushing.
- D. Flush all branches and main circuits pumped with house pumps at velocities above 7FPS until water is clear. Engineer's approval required.

END OF SECTION 2325

SECTION 233100 - DUCTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Duct Materials.
 2. Insulated flexible ducts.
 3. Single wall spiral round ducts.
 4. Ductwork fabrication.
 5. Kitchen hood exhaust ductwork fabrication.
 6. Duct cleaning.
- B. Related Sections:
1. Division 3 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
 2. Division 9 - Paints and Coatings: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
 3. Section 230529 - Supports and Anchors: Product requirements for hangers, supports and sleeves for placement by this section.
 4. Section 233300 - Ductwork Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

- A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 3. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 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.
 7. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 9. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 10. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
 11. ASTM C14M - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).

12. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 13. ASTM C443M - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric).
 14. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. National Fire Protection Association:
1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 3. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Fibrous Glass Duct Construction Standards.
 2. SMACNA - HVAC Air Duct Leakage Test Manual.
 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. Section 017000 - Project Closeout.
- 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. Section 013119 - Project Meetings
- B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Division 016000 - Products, Materials and Equipment.
- 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.

PART 2 - 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.
- C. Aluminum Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Stainless Steel Ducts: ASTM A167, Type 304.
- E. Fasteners: Rivets, bolts, or sheet metal screws.
- F. 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.

- B. Construct duct with the following minimum gages:

	Diameter	Gauge
1.	3 inches to 14 inches	26
2.	15 inches to 26 inches	24
3.	28 inches to 36 inches	22
4.	38 inches to 50 inches	20
5.	52 inches to 84 inches	18

- C. Construct fittings with the following minimum gages:

	Diameter	Gauge
1.	3 inches to 14 inches	24
2.	15 inches to 26 inches	22
3.	28 inches to 36 inches	20
4.	38 inches to 50 inches	20

5.	52 inches to 60 inches	18
6.	62 inches to 84 inches	16

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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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. Install glass fiber ducts in accordance with SMACNA Fibrous Glass Duct Construction Standards. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
- D. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- E. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 10 inch and smaller.

- F. Install duct hangers and supports in accordance with SMACNA and such as not to have sags in runs.
- G. Use double nuts and lock washers on threaded rod supports.
- H. 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.
- I. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws.
- J. 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.
- K. Install kitchen range hoods in accordance with NFPA 96.
- L. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.
- M. Kitchen hood exhaust ducts: Use stainless steel for ductwork exposed to view and stainless steel where ducts are concealed.

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 CLEANING

- A. Section 017413 - Construction Cleaning
- B. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- C. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.
- D. Provide caps on open ductwork to keep debris/dirt from entering hung ductwork.

3.5 SCHEDULES

DUCTWORK MATERIAL SCHEDULE

AIR SYSTEM	MATERIAL
Supply (Heating Systems)	Galvanized Steel, Aluminum
Supply (System with Cooling Coils)	Galvanized Steel, Aluminum
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
Hood and Outside Air Intake	Galvanized Steel

DUCTWORK PRESSURE CLASS SCHEDULE

AIR SYSTEM	PRESSURE CLASS
Constant Volume Supply	2 inch wg regardless of velocity.
Variable Volume-Variable Temperature Supply	3 inch wg regardless of velocity.
Variable Air Volume Supply (downstream of VAV boxes)	1 inch wg regardless of velocity.
Variable Air Volume Supply (upstream of VAV boxes)	3 inch wg
Supply (Heating Systems)	3 inch wg (250 Pa)
Supply (System with Cooling Coils)	3 inch wg (500 Pa)
Return and Relief	1 inch wg (250 Pa) regardless of velocity.
General Exhaust	1 inch wg (250 Pa) regardless of velocity.

END OF SECTION 233100

SECTION 233300 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers/Smoke dampers
- G. Flexible duct connections.
- H. Volume control dampers.

1.2 RELATED SECTIONS

- A. Section 233100 - Ducts
- B. 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.
- G. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

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.

PART 2 - 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 COMBINATION FIRE AND SMOKE DAMPERS

- A. Provide where required by Code having jurisdiction.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure. Provide as required to meet Florida Mechanical and Building Codes.
- G. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally. Provide as required to meet Florida Mechanical and Building Codes.
- H. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4 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.

2.5 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.

2.6 FIRE DAMPERS

- A. Provide where required by Codes having jurisdiction in all fire walls as indicated on Architectural Plans.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated on both Mechanical and Architectural Plans.

- C. Horizontal Dampers: Code approved, Galvanized steel, 22 gage frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
- D. Curtain Type Dampers: Code approved, Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations closure under air flow conditions. Configure with blades out of air stream.
- E. Code approved Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.7 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. Net Fabric Width: Approximately 3 inches wide.

2.8 SMOKE DAMPERS

- A. Provide where required by Code having jurisdiction.
- B. Fabricate in accordance with NFPA 90A and UL 5555, and as indicated.
- C. Dampers: UL Class 1 multiple blade type fire damper, normally open automatically operated by electric actuator.
- D. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.9 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.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.

- 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.

PART 3 - 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 233100 - Ducts 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 access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction whether indicated on Plans or not. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. Provide 6 inch flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators.
- I. 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.

- J. Use splitter dampers only where indicated.
- K. 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 233300

SECTION 233400 - POWER VENTILATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Propeller fans.
- B. Centrifugal square inline fans.
- C. 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

- A. AMCA 99 - Standards Handbook.
- 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.
- E. AMCA 301 - Method of Publishing Sound Ratings for 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 written consent of Owner.

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: Backward inclined centrifugal type, 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.
- 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

- A. Secure roof and wall fans with stainless steel lag screws to roof curb or wall structure.
- B. Install backdraft dampers and gravity shutters on roof and wall exhaust fans and gravity ventilators used in relief air applications, as shown on Drawings.
- C. Provide backdraft dampers on outlet from square in-line fans and ceiling fans and as indicated on Drawings.
- D. Hung Cabinet Fans:
 - 1. Install fans with resilient mountings and flexible electrical leads.
 - 2. Install flexible connections specified in Section 233300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch (25 mm) flex between ductwork and fan while running.
- E. Install safety screen where inlet or outlet is exposed.
- F. Pipe scroll drains to nearest gutter drain.
- G. Support ceiling and square in-line exhaust fans separate from ductwork.
- H. Install flex connections on inlet and outlet of all square in-line and ceiling exhaust fans, and where indicated on Drawings.
- I. Provide adjustable pitch sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Furnish services of factory trained representative for minimum of 4 hours to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

- A. Vacuum clean coils and inside of fan cabinet.

3.5 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.6 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 roof and wall exhausters.
- D. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.
- E. Do not operate fans until ductwork is clean, filters are in place, and bearings are lubricated.

END OF SECTION 233400

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Diffusers.
 - 2. Registers
 - 3. Grilles.
 - 4. Door grilles.
 - 5. Louvers.

- B. Related Sections:
 - 1. Section 089119 - Painting: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
 - 2. Section 089119 - Fixed Louvers.
 - 3. Section 233300 - Duct Accessories: Volume dampers for inlets and outlets.
 - 4. Section 230923 - Energy Management Control Systems (EMCS).

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 - Submittals.

- 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 - Project Closeout

- 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 PRE-INSTALLATION MEETINGS

- A. Section 013119 - Project Meetings
- B. Convene minimum one week prior to commencing work of this section.

1.8 WARRANTY

- A. Section 017000 - Project Closeout: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for air outlets and inlets.

1.9 EXTRA MATERIALS

- A. Section 017000 - Project Closeout : Spare parts and maintenance products.
- B. Furnish 5 percent extra air outlets and inlets; a minimum of one.

PART 2 - PRODUCTS

2.1 RECTANGULAR CEILING DIFFUSERS

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

- A. Manufacturers:
 - 1. Price.
 - 2. Titus.
 - 3. Tuttle and Bailey.
 - 4. Substitutions: Permitted.
- B. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way or two-way deflection.
- 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 AND RETURN 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 RETURN 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.
- E. Damper: Integral, gang-operated, opposed-blade type with removable key operator, operable from face.

2.6 LOUVERS (Exterior Walls)

- A. See Architectural for type and operational type.

PART 3 - 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.

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 233700

SECTION 236400 - ROTARY SCREW WATER CHILLERS (AIR COOLED)

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Chiller package.

1.2 Charge of refrigerant and oil.

- A. Controls and control connections.
- B. Chilled water connections.
- C. Starters.
- D. Electrical power connections.

1.3 RELATED SECTIONS

- A. Section 230923 - Energy Management Control System (EMCS)
- B. Section Div. 26 - Equipment Wiring Systems.

1.4 REFERENCES

- A. ANSI/AHRI 550/590-2011 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. AHRI 370 – Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/ASHRAE 90.1 - Energy Efficient Design of New Buildings.
- E. ANSI/ASME Boiler and Pressure Vessel Code SEC VIII, Division 1
- F. UL 1995 - Central Cooling Air Conditioners.
- G. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.
- H. ASTM B117 - Standard Method of Salt Spray (Fog) Testing
- I. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- J. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

- K. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments
- 1.5 SUBMITTALS
 - A. Submit manufacturer's installation instructions.
- 1.6 OPERATION AND MAINTENANCE DATA
 - A. Submit operation data.
 - B. Include start-up instructions, maintenance data, controls, and accessories.
 - C. Submit maintenance data.
- 1.7 STORAGE AND HANDLING
 - A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- 1.8 WARRANTY
 - A. See Basic Mechanical Requirements, Section 230500, Paragraph 1.25

PART 2 - PRODUCTS

- 2.1 SUMMARY
 - A. The contractor shall install air-cooled water chillers CH-3 as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.
- 2.2 CONTROLS
 - A. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied for each chiller CH-3 by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
 - 1. Phase reversal/unbalance/single phasing and over/under voltage protection.
 - 2. Low chilled water temperature protection.
 - 3. High and low refrigerant pressure protection.
 - 4. Load limit thermostat to limit compressor loading on high return water temperature.
 - 5. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize unit efficiency.

6. Display diagnostics.
 7. Oil pressure control based off of maintaining system differential pressure.
 8. Compressors: Status (on/off), %RLA, anti-short cycle timer, and automatic compressor lead-lag.
- B. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
 2. Chilled water pump output relay that closes when the chiller is given a signal to start.
 3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
 4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
 5. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.
 6. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
 7. Low ambient lockout control with adjustable setpoint.
 8. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.
- C. Provide user interface that displays chilled water temperature setpoint and actual leaving chilled water temperature. Display should be on the front of panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels.
1. Leaving chilled water setpoint adjustment from LCD input
 2. Entering and leaving chilled water temperature output
 3. Percent RLA output for each compressor
 4. Pressure output of condenser for circuits one and two

5. Pressure output of evaporator for circuits one and two
 6. Ambient temperature output
 7. Voltage output
 8. Current limit setpoint adjustment from LCD input.
 9. Remote leaving water temperature setpoint.
 10. Alarm indicating light and relay.
- D. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.
- E. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
- F. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
- G. The chiller control panel shall provide input for leaving chilled water temperature setpoint based upon a 2-10VDC or 4-20mA signal from a building automation system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning.

3.2 MANUFACTURER'S FIELD SERVICES

- A. OEM Startup is to be performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty (Owner furnished).

1. Included in OEM Factory Startup:

Centrifugal and Rotary Screw/Scroll Chillers

- B. Applied Chiller manufacturers shall maintain service capabilities no more than 15 miles from the jobsite.
- C. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION 236400

SECTION 237300 - 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.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 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:
 - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
 - 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. Trane.
 - 2. McQuay.
 - 3. York International
 - 4. Carrier.
 - 5. Substitutions shall be considered.
- B. Configuration: Fan section, fan and coil section plus accessories, including:
 - 1. Hot water re-heat coil.
 - 2. Cooling coil section.
 - 3. Filter section or
 - 4. Combination filter/mixing box section.
 - 5. Mixing box section.
 - 6. Vertical or horizontal 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.
 - 3. Galvanized Steel: 0.0635 inch.
 - 4. Stainless Steel: 0.0625 thick.
- C. Inside Casing:
 - 1. 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 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.
 - 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.
- F. Finish: Baked enamel manufacturers standard paint on exterior for RTAH. 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 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.
- 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 bulb edging 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: Variable Frequency Drive. Refer to Division 26 for type only used on inside service AHUs.
- 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 galvanized steel, provide stainless steel or aluminum on 100% Outside Air Units.
- F. Water Cooling Coils:
 - 1. Headers: Cast iron, seamless copper tube with brazed joints.
 - 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

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 High Capacity: 2 inches (50 mm) deep disposable extended area panel filters (RTAH and 100% outside air AHUs).
- D. Extended Surface: Filter box with holding frames and blank-off sheets, extended surface high efficiency media filters with 30 percent dust spot efficiency (inside AHUs).
- E. Provide a minimum of two 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.

2.7 DAMPERS

- A. Mixing Boxes: Section with outside and return 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

2.8 CONTROLS

- A. Controls: Refer to Controls Section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with ARI 430.
- B. Install flexible connections between RTAH or 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 sheaves required for final 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 two 8 hour days 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 237300

SECTION 260305 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical work for this project will include all electrical work necessary to construct the new additions. Electrical work will include all power wiring, 120 volt and above, and certain low voltage wiring for communication systems. Power wiring will include all 120 volt power for any low voltage system including but not limited to the Fire Alarm system, Intercom system, EMCS system, CATV system and LAN/Telephone system.

1.2 CONTINUOUS OPERATION

- A. All existing buildings shall be occupied throughout the duration of construction. All electrical systems shall remain in use and in operation at all times. Notify school personnel before disrupting any electrical system. Minimize all outage durations. Make temporary connections to maintain electrical systems in use when extended outages are required.

1.3 APPLICABLE PUBLICATIONS

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

A. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 100 2000 Dictionary of Electrical and Electronics Terms

B. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6 1993 (Rev. 2016) Enclosures for Industrial Control and Systems

NEMA MG 1 2016 Motors and Generators

NEMA MG 10 2017 Energy Management Guide for Selection and Use of Polyphase Motors

NEMA MG 11 1977 (Rev. 2012) Energy Management Guide of Selection and Use of Single-Phase Motors

C. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 2017 National Electrical Code

NFPA 101 2015 Life Safety Code (Florida Edition)

D. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C2 2020 National Electrical Safety Code

E. CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.147 Control of Hazardous Energy (Lock Out/Tag Out)

F. FEDERAL SPECIFICATIONS (FS)

FS L-P-387 (Rev. A) (Int Am. 2) Plastic Sheet, Laminated, Thermosetting (for Design Plates)

G. Florida Building Code 2017 Sixth Edition

Chapter 4 Special Occupancy, Section 453 State Requirements for Educational Facilities

1.4 APPLICATION

- A. This section applies to all sections of Division 26, "Electrical," of this project except as specified otherwise in each individual section.

1.5 DEFINITION OF ELECTRICAL TERMS

- A. Unless otherwise specified or indicated, electrical terms used in these specifications, and on the drawings, shall be as defined in IEEE Standard No. 100.

1.6 SUBMITTALS

- A. Obtain approval before procurement, fabrication, or delivery of items to the job site. Partial submittals will not be acceptable and will be returned without review. Submittals shall include the manufacturer's name, trade name, place of manufacture, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable Federal, Military, industry, and technical society publication references, and other information necessary to establish contract compliance of each item to be furnished.
- B. Shop Drawings: In addition to the requirements specified elsewhere, shop drawings shall meet the following requirements. Drawings shall be a minimum of 8.5 inches by 11 inches in size, except as specified otherwise. Drawings shall include complete ratings information, wiring diagrams, and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to assure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If equipment is disapproved, revise drawings to show acceptable equipment and resubmit.
- C. Manufacturer's Product Data: Submittals for each manufactured item shall be current manufacturer's descriptive literature of cataloged products, equipment drawings, diagrams, performance and characteristic curves, and catalog cuts.
- D. Submit only pages which are pertinent; mark each copy of standard printed data to identify pertinent products, referenced to Specification Section and Article number. Show reference standards,

performance characteristics, and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.

- E. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the Work. Delete information not applicable.
- F. Publication Compliance: Where equipment or materials are specified to conform to industry and technical society publications of organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears. In lieu of the label or listing, submit a certificate from an approved independent testing organization, adequately equipped and competent to perform such services, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's publication.
- G. Certificates of Compliance: Submit manufacturer's certifications as required on products, materials, finish, and equipment indicated in the technical sections. Certifications shall be documents prepared specifically for this contract. Preprinted certifications and copies of previously submitted documents will not be acceptable. The manufacturer's certifications shall name the appropriate products, equipment, or materials and the publication specified as controlling the quality of that item. Certification shall not contain statements to imply that the item does not meet requirements specified, such as "as good as"; "achieve the same end use and results as materials formulated in accordance with the referenced publications"; or "equal or exceed the service and performance of the specified material." Certifications shall simply state that the item conforms to the requirements specified. Certificates shall be printed on the manufacturer's letterhead and shall be signed by the manufacturer's official authorized to sign certificates of compliance.

1.7 WARRANTY

- A. All equipment, material, accessories and installation shall carry a guarantee against defects and workmanship 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 and required labor 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.
- B. Provide a warranty statement to be included in all Operations and Maintenance Manuals.
- C. Provide extended manufacturer's warranties where required by specific technical sections of these specifications.
- D. Where extended guarantees are called for herein, provide a warranty statement detailing the extended guarantees and length coverage for each required system(s) to be included in all Operations and Maintenance Manuals.
- E. Warranty maintenance shall be provided by the Contractor during his normal working hours at no expense to the Owner.
- F. This warranty shall not apply if damage is caused by abuse, accident, improper operation, or negligence.

1.8 OPERATION AND MAINTENANCE MANUAL

- A. Submit as required for systems and equipment indicated in the technical sections. Furnish five copies, bound in hardback binders or an approved equivalent. Furnish one complete manual prior to performance of systems or equipment tests, and furnish the remaining manuals prior to contract completion. Inscribe the following identification on the cover: the words "OPERATION AND MAINTENANCE MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment. Include a table of contents and assemble the manual to conform to the table of contents, with the tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in. The manual shall include:
1. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the system or equipment.
 2. A control sequence describing startup, operation, and shutdown.
 3. Description of the function of each principal item of equipment.
 4. Installation and maintenance instructions.
 5. Safety precautions.
 6. Diagrams and illustrations.
 7. Testing methods.
 8. Performance data.
 9. Lubrication schedule including type, grade, temperature range, and frequency.
 10. Parts list: The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
 11. Appendix: List qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

1.9 POSTED OPERATING INSTRUCTIONS

- A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment including startup, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction as recommended by the manufacturer of each system or equipment. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

1.10 DELIVERY AND STORAGE

- A. Handle, store, and protect equipment and materials in accordance with the manufacturer's recommendations and with the requirements of NFPA 70B, Appendix I, titled "Equipment Storage and Maintenance During Construction." Replace damaged or defective items with new items.

1.11 CATALOGED PRODUCTS/SERVICE AVAILABILITY

- A. Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The 2-year period shall be satisfactorily completed by a product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.12 MANUFACTURER'S INSTRUCTIONS

- A. Where installation procedures or any part thereof are required to be in accordance with manufacturer's instructions, furnish printed copies of the instructions prior to installation. Installation of the item shall not proceed until instructions are received. Failure to furnish instructions shall be cause for rejection of the equipment or material.
- B. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

1.13 MOTORS AND MOTOR CONTROLS FOR MECHANICAL EQUIPMENT

- A. The electrical components of mechanical equipment, such as motors, motor starters, control or push-button stations, float or pressure switches, solenoid valves, and other devices functioning to control mechanical equipment, and control wiring and conduit for circuits rated 100 volts or less, are specified in the section covering the associated mechanical equipment, rather than in Division 26. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, and the electrical power circuits shall be furnished and installed under Division 26.

1.14 AS BUILT DRAWINGS

- A. Maintain one complete set of drawings on the job site for the purpose of recording changes and modifications in the Contract Documents. Do not use the job set for any purpose except entry of new data.
- B. Using an erasable colored pencil (not ink or indelible pencil), clearly and accurately record all changes to the construction. Locate all conduits, circuits, junction boxes, pull boxes, panels, starters and similar items where different from that shown on the Contract Documents and where not shown. Clearly indicate the location of any junction containing splices, taps or terminations. Date all entries.
- C. At a time nearing the completion of the work, complete all changes to the job set of drawings and forward the drawings to the Architect/Engineer for review and approval.
- D. The work shall not be considered substantially complete until As-Built Drawings are submitted for review.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All materials, equipment, and devices shall, as a minimum, meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70. All items shall be new unless specified or indicated otherwise.

PART 3 - EXECUTION

3.1 MATERIAL AND EQUIPMENT

- A. All material and equipment shall, as a minimum, be installed in accordance with NFPA 70, National Electrical Code.

3.2 PAINTING OF EQUIPMENT

- A. Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.
- B. Field Applied: Paint electrical equipment as required to match finish or to meet safety criteria.

3.3 AS-BUILT DRAWINGS

- A. Submit As-Built Drawings for review and approval at or before Substantial Completion Inspection.

END OF SECTION 260305

SECTION 260519 - WIRE AND CABLE

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Building wire.
- B. Metal Clad Cable
- C. Wiring connections and terminations.

1.2 REFERENCES

- A. NEMA WC 3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- B. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of Section 260305.
- B. Submit manufacturer's instructions.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Thermoplastic-insulated Building Wire: NEMA WC 5.
- B. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600 volt insulation, THWN.
- C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600 volt insulation, THWN 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid conductor.
- D. Control Circuits: Copper, stranded conductor 600 volt insulation, THW.

2.2 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600 volt insulation, rated 75 degree C, individual conductors twisted together and covered with aluminum sheath, and overall PVC jacket.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300 volt insulation, rated 75 degree C, individual conductors twisted together and covered with a PVC jacket; UL listed.

2.3 METAL CLAD CABLE

- A. Conductor: Copper. Do not use aluminum.
- B. Insulation Voltage Rating: 600 volts.
- C. Insulation Temperature Rating: 75 degrees C.
- D. Insulation Material: Thermoplastic.
- E. Armor Material: Steel.
- F. Armor Design: Corrugated tube.
- G. Jacket: None.

PART 3 - EXECUTION

3.1 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet and 277 volt branch circuit home runs longer than 200 feet.
- C. Place an equal number of conductors for each phase of a circuit in same raceway or cable.
- D. Splice only in junction or outlet boxes.
- E. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- F. Make Conductor lengths for parallel circuits equal.
- G. Provide a separate neutral conductor for every circuit requiring a neutral. "Common" neutrals shall not be installed.
- H. Provide a separate grounding conductor in every raceway. Provide a separate grounding conductor for every feeder and branch circuit. Multiple ground conductors are required where more than one circuit is installed in a common raceway. "Common" ground conductors shall not be installed.

3.2 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricate for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors for copper wire splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
- H. Terminate spare conductors with electrical tape.
- I. All splices, taps and terminations of any Fire Alarm conductors shall be made using binder head screw terminals only.

3.3 CABLE WIRING TECHNIQUES

- A. Wiring in raceways may be converted to metal clad cable above accessible ceilings. Do not install metal clad cable in walls, under floors or underground or above hard ceilings.
- B. Protect exposed cable from damage.
- C. Support cables above accessible ceiling, using spring metal clips to support cables from structural members. Do not rest cable on ceiling panels.
- D. Use suitable cable fittings and connectors.

3.4 WIRE COLOR

- A. General
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
 - a. Black, red, and blue for circuits at 120/208 volts single or three phase.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 FIELD QUALITY CONTROL

- A. Inspect wire and cable for physical damage and proper connection.
- B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

3.6 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Use building wire in raceways in all exposed locations and in all locations concealed by permanently installed materials.

END OF SECTION 260519

SECTION 260526 - SECONDARY GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Power system grounding.
- B. Communication system grounding.
- C. Electrical equipment and raceway grounding and bonding.
- D. Grounding Systems Testing.

1.2 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral at service entrance equipment to supplementary grounding electrodes.
- B. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 260305.
- B. Submit grounding electrode test results in tabulated format at substantial completion
- C. Indicate location of system grounding electrode connections, and routing of grounding electrode conductor.

1.4 QUALITY ASSURANCE

- A. Compliance: Testing shall be accomplished by an independent testing firm and comply to the following standards:
 - 1. NEMA
 - 2. NETA
 - 3. NFPA
 - 4. IEEE
- B. Qualification: The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, supplier, and installers of equipment or systems evaluated by the testing firm.
- C. Experience: The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- D. Accreditation: The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29,

Part 1907, or be a Full Member Company of the International Electrical Testing Association.

- E. Certification: The lead, on-site, technical person shall be currently certified by the International Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- F. Personnel: The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services.
- G. Proof of Qualifications: The testing firm shall submit proof of the above qualifications when requested.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground Rods: Copper-encased steel, 3/4 inch diameter, minimum length 10 feet.

2.2 EQUIPMENT

- A. Instruments: Supply all instruments required to read and record data. Calibration date shall be submitted on test reports.
- B. Adjustments: Adjust system to operate at the required performance levels within all tolerances as required NETA standards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a separate, insulated equipment grounding conductor in every raceway. Provide a separate grounding conductor for every feeder and branch circuit. Multiple ground conductors are required where more than one circuit is installed in a common raceway. "Common" ground conductors shall not be installed. Terminate each end on a grounding lug, bus, or bushing.
- B. Provide three (3) twenty foot (20) supplementary grounding electrodes a minimum of six (6) feet apart near the service entrance location. Connect the electrodes to the service system using copper conductor in nonmetallic conduit in accordance with the National Electrical Code.
- C. Connect grounding electrode conductors to supplementary grounding electrodes using exothermically welded connections after grounding electrode test are complete.
- D. Connect grounding conductors to interior metal water pipes using suitable ground clamps, using copper conductor in accordance with the National Electrical Code.
- E. Use minimum 6 AWG copper conductor for communications service grounding conductor. Leave 10 feet slack conductor at terminal board.

3.2 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Electrode Ground: The resistance of all electrodes (main services, generators, transformer, etc.) shall not exceed 25 ohms and shall be measured by the testing firm before conductors are connected and before equipment is placed in operation. Any measurement exceeding 5 ohms shall be reported to the Owner and direction from the Owner shall be received before any final connections are made. Testing shall be performed on all grounding electrode installations. Testing shall be conducted by the three (3) point fall-of-potential method in accordance with IEEE Standard No. 81-1983, Section 9.04. Ground tests shall be performed on each electrode before conductor connections are made. If measured resistance is below 5 ohms all conductors shall be connected and the entire grounding electrode system shall be tested. Submit all ground test readings in tabulated format within one week of ground test(s).
- C. Electrical Contractor shall engage an independent testing company to perform the ground testing. The Electrical Contractor shall not perform the ground testing.

END OF SECTION 260526

SECTION 260529 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Conduit and equipment supports.
- B. Anchors and fasteners.

1.2 REFERENCES

- A. NECA - National Electrical Contractors Association.
- B. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Submit under provisions of Section 260305.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- C. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Use precast insert system, expansion anchors and preset inserts.
 - 2. Steel Structural Elements: Use beam clamps, spring steel clips and welded fasteners.
 - 3. Concrete Surfaces: Use expansion anchors.

4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.
5. Solid Masonry Walls: Use expansion anchors and preset inserts.
6. Sheet Metal: Use sheet metal screws.
7. Wood Elements: Use wood screws.

2.2 STEEL CHANNEL

- A. Description: Galvanized steel in exterior locations, painted steel for interior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
- D. Do not use powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- G. Install surface-mounted cabinets and panelboards with minimum of four anchors.
- H. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.
- I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- J. Use galvanized steel channel to construct electrical equipment supports for all exterior mounted equipment that cannot be fastened to a building wall. Use a minimum of two (2) vertical channels with additional horizontal channels where multiple disconnects, starters or where a panelboard is installed. Set vertical members in concrete foundation or anchor to equipment slabs with galvanized angle brackets and 3/8 stainless steel bolts and expansion anchors, minimum of 2 per member.

END OF SECTION 260529

SECTION 260532 - CONDUIT

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Rigid metal conduit and fittings.
- B. Electrical metallic tubing and fittings.
- C. Electrical non-metallic conduit
- D. Flexible metal conduit and fittings.
- E. Liquidtight flexible metal conduit and fittings.
- F. Surface metal raceways.

1.2 REFERENCES

- A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
- B. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated.
- C. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- D. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
- E. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SUBMITTALS

- A. Submit under provisions of Section 260305.
- B. Product Data: Provide for all conduit types, fittings, conduit bodies, surface metal raceways and accessory fittings and device boxes.
- C. Submit product data for the following :
 - 1. Flexible metal conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. Flexible nonmetallic conduit.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Wireway.
 - 9. Pull and junction boxes.

10. Handholes.

PART 2 - PRODUCTS

2.1 RIGID METAL CONDUIT AND FITTINGS

- A. Rigid Steel Conduit: ANSI C80.1.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded type, material to match conduit.

2.2 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. EMT: ANSI C80.3. Galvanized tubing.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel or malleable iron, compression type.

2.3 FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: FS WW-C-566; steel.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

- A. Conduit: Flexible metal conduit with PVC jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1.

2.5 NONMETALLIC CONDUIT

- A. Description: NEMA TC 2; Schedule 40 PVC.
- B. Fittings and Conduit Bodies: NEMA TC 3.

2.6 CONDUIT SUPPORTS

- A. Conduit Clamps, Straps, and Supports: Steel or malleable iron.

2.7 SURFACE METAL RACEWAY

- A. Manufacturers:
 - 1. The Legrand Wiremold Co. Series 2000 metal raceway.
 - 2. Substitutions: Not Permitted.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Nominal Size: 1-1/4 x 3/4 inch.
- D. Finish: Buff enamel.

- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

PART 3 - EXECUTION

3.1 CONDUIT SIZING, ARRANGEMENT AND SUPPORT

- A. Install conduit in accordance with NECA "Standard of Installation."
- B. Install nonmetallic conduit in accordance with manufacturer's instructions.
- C. Size conduit for conductor type installed or for Type THWN conductors, whichever is larger; 1/2 inch minimum size.
- D. Arrange conduit to maintain headroom and present a neat appearance.
- E. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- F. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- G. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized straps, lay-in adjustable hangers, clevis hangers, or bolted split stamped galvanized hangers.
- H. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- I. Do not fasten conduit with wire or perforated pipe straps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
- J. Support conduit at a maximum of 7 feet on center.
- K. Do not use flexible conduit in lengths exceeding six feet.

3.2 CONDUIT INSTALLATION

- A. All conduit in finished spaces and normally occupied spaces shall be concealed where ever possible. Where conduit cannot be concealed, use surface metal raceway and manufacturer's standard accessory fittings and device boxes.
- B. Cut conduit square using a saw or pipecutter; de-burr cut ends.
- C. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- D. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to

cure for 20 minutes, minimum.

- E. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes, and for fastening conduit to sheet metal boxes in damp or wet locations.
- F. Install no more than the equivalent of three 90-degree bends between boxes.
- G. Use conduit bodies to make sharp changes in direction, as around beams.
- H. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.
- I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.
- J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- K. Provide No. 12 AWG insulated conductor or suitable pull string in empty conduit, except sleeves and nipples.
- L. Install expansion joints where conduit crosses building expansion joints.
- M. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.
- N. Route conduit through roof openings for piping and ductwork where possible; otherwise, route through roof jack with pitch pocket.
- O. Maximum Size Conduit in Slabs Above Grade: 1" inch. Do not route conduits to cross each other in slabs above grade.
- P. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

3.3 CONDUIT INSTALLATION SCHEDULE

- A. Underground Installations For Service Entrance and Building Feeder Conductors: Galvanized rigid steel conduit coated with asphaltum paint after fabrication/installation and prior to backfilling or PVC conduit encased in minimum 3" thickness concrete all around.
- B. Underground Installations and in Concrete Slabs: Schedule 40 PVC nonmetallic conduit. Convert PVC to metallic conduit including any elbows before rising through concrete slabs and continue metallic conduit to electrical enclosures.
- C. Exposed Outdoor Locations: Rigid steel conduit.
- D. Wet Interior Locations: Rigid steel conduit.
- E. Concealed Dry Interior Locations: Inside walls and above ceilings; Electrical metallic tubing.

- F. Exposed Dry Interior Locations: In mechanical and electrical rooms and similar utility spaces; Any conduit meeting NEC requirements.
In finished spaces and normally occupied spaces; Surface metal raceway.

3.4 PAINTING

- A. All conduit shall be field painted to match the adjacent wall color where walls are painted.
- B. Surface metal raceway shall be manufacturer's standard painted finish.
- C. All conduit containing fire alarm conductors shall be painted red.

END OF SECTION 260532

SECTION 260533 - BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Wall and ceiling outlet boxes.
- B. Pull and junction boxes.

1.2 RELATED SECTIONS

- A. Section 262726 - Wiring Devices: Wall plates in finished areas and access floor boxes.

1.3 REFERENCES

- A. NECA - Standard of Installation.
- B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
- C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Submit shop drawings and product data under the provisions of Section 260305.

1.5 SUBMITTALS FOR CLOSEOUT

- A. Section 017000 - Project Closeout : Operation and Maintenance Data submittals for Project closeout.
- B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
- C. Concrete Ceiling Boxes: Concrete type.
- D. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- E. Wall Plates for Finished Areas: As specified in Section 262726.

2.2 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify locations of floor boxes and outlets in offices, and work areas prior to rough-in.

3.2 INSTALLATION

- A. Install boxes in accordance with NECA "Standard of Installation."
- B. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- C. Set wall mounted boxes at elevations to accommodate mounting heights specified in section for outlet device.
- D. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box location up to 3 feet if required to accommodate intended purpose.
- E. Orient boxes to accommodate wiring devices oriented as specified in Section 262726.
- F. Maintain headroom and present neat mechanical appearance.
- G. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- H. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.
- I. Install boxes to preserve fire resistance rating of partitions and other elements.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- K. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

- L. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- M. Use flush mounting outlet box in finished areas.
- N. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- O. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches (150 mm) separation. Provide minimum 24 inches (600 mm) separation in acoustic rated walls.
- P. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- Q. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- R. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- S. Use adjustable steel channel fasteners for hung ceiling outlet box.
- T. Do not fasten boxes to ceiling support wires.
- U. Support boxes independently of conduit.
- V. Use gang box where more than one device is mounted together. Do not use sectional box.
- W. Use gang box with plaster ring for single device outlets.
- X. Use cast outlet box with gasket cover in exterior locations and wet locations.
- Y. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- Z. Set floor boxes level.
- AA. Large Pull Boxes: Use NEMA 1 hinged enclosure in interior dry locations, and NEMA 3R hinged enclosure in other locations.

3.3 ADJUSTING

- A. Adjust floor box flush with finish flooring material.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused box openings.

3.4 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.

- B. Clean exposed surfaces and restore finish.

3.5 PAINTING

- A. Paint all junction boxes to match adjacent wall color where walls are painted.
- B. Paint all junction boxes containing fire alarm conductors red.

END OF SECTION 260533

SECTION 260534 - FLOOR BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.
- B. Related Sections:
 - 1. Section 078413 - Penetration Firestopping.
 - 2. Section 260529 - Supporting Devices.
 - 3. Section 260533 - Boxes.
 - 4. Section 262726 - Wiring Devices: Receptacles for installation in floor boxes.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.3 SUBMITTALS

- A. Section 260305 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for floor boxes and service fittings.

1.4 CLOSEOUT SUBMITTALS

- A. Section 260305 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.5 QUALIFICATIONS

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

PART 2 - PRODUCTS

2.1 FLOOR BOXES

- A. Floor Boxes shall be of the concealed service type. Provide units with flush, hinged covers that conceal all wiring connections. Covers shall accept carpet or tile inserts. Exposed trim shall be metal, brushed aluminum or brass in color.
- B. Floor Boxes shall be sized to allow the installation of two (2) duplex, 120 volt convenience receptacles and two (2) duplex, telephone/data communications receptacles.
- C. Material: Cast metal.

- D. Shape: Rectangular.
- E. Service fittings and devices: As specified in Section 262726.
- F. Floor Boxes shall be Walker RFB Series or approved equal.

2.2 PEDESTAL-TYPE CONVENIENCE OUTLET SERVICE FITTING

- A. Housing: Satin aluminum.
- B. Device Plate: Stainless steel.
- C. Configuration: One duplex or two duplex, back-to-back as required.

PART 3 - PART EXECUTION

3.1 EXAMINATION

- A. Verify locations of floor boxes and outlets in all rooms with Architect prior to rough-in.

3.2 INSTALLATION

- A. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Scale drawings to determine locations. Adjust box location up to 12 inches to accommodate intended purpose. Verify all adjustments with Architect before placing floor boxes.
- B. Floor Box Requirements: Use cast floor boxes for installations in slab on grade.
- C. Set floor boxes level.
- D. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 260529.
- E. Install protective rings on active flush cover service fittings.

3.3 ADJUSTING

- A. Adjust floor box flush with finish flooring material.
- B. Install flooring material in all floor box recessed covers.

3.4 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION 260534

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Nameplates.
- B. Wire and cable markers.
- C. Conduit color coding.

1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 260305. Include schedule for nameplates and tape labels.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Nameplates: Engraved three-layer laminated plastic, White letters on a Black background, unless otherwise noted on the drawings.

2.2 MARKERS

- A. Wire and Cable Markers: Cloth markers, split sleeve or tubing type.

2.3 UNDERGROUND WARNING TAPE

- A. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates.
- B. Install nameplates parallel to equipment lines.
- C. Secure nameplates to equipment fronts using screws, rivets, or adhesive. Secure nameplate to inside face of recessed panelboard doors in finished locations.
- D. Embossed tape will not be permitted for any application.

3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each feeder conductor in panelboard gutters, pull boxes, and at load connection. Identify with feeder number for power and lighting circuits.

3.3 NAME PLATE ENGRAVING SCHEDULE

- A. Provide nameplates of minimum letter height as scheduled below.
- B. Panelboards and Switchboards: 1/4 inch; identify equipment designation. 1/8 inch; identify voltage rating and source.
- C. Individual Circuit Breakers, Enclosed Switches, and Motor Starters: 1/8 inch; identify load served.

3.4 Conduit Marker Installation:

- A. Paint conduit marker for each conduit longer than 6 feet.
 - 1. Conduit Marker Spacing: 20 feet on center.
 - 2. Raceway Painting: Identify conduit using field painting in accordance with Section 099123.
 - 3. Paint bands 20 feet on center.
 - a. Fire Alarm Color: Red.

END OF SECTION 260553

SECTION 262413 – SWITCHBOARD CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes main and distribution switchboard circuit breakers.
- B. Related Sections:
 - 1. Section 260526 - Secondary Grounding
 - 2. Section 260553 - Electrical Identification.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C12.1 - Code for Electricity Metering.
 - 2. ANSI C39.1 - Requirements, Electrical Analog Indicating Instruments.
- B. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
 - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- C. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
 - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- D. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 013000 - Submittals: Submittal procedures.
- B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.
- C. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

- D. Test Reports: Indicate results of factory production and field tests.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Project Closeout: Closeout procedures.
- B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.
- C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in 48 inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.
- B. Accept switchboards on site. Inspect for damage.
- C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Products, Materials and Equipment.
- B. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 SEQUENCING

- A. Section 011100 - Summary Of Work: Work sequence.
- B. Sequence Work to avoid interferences with building finishes and installation of other products.

1.10 MAINTENANCE MATERIALS

- A. Section 017000 - Project Closeout: Spare parts and maintenance products.

- B. Furnish two of each key.

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

- A. Product Description: NEMA AB 1, molded-case circuit breaker.
- B. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger shall have mechanism for adjusting long time, short time, continuous current, short time, long time, pickup current setting for automatic operation.
- C. Solid-State Circuit Breaker: Electronic sensing, timing, and tripping circuits for adjustable current settings; instantaneous trip; and adjustable short time trip.
- D. Accessories: As indicated on Drawings. Conform to NEMA AB 1.
 - 1. Shunt Trip Device: 120 volts, AC.
 - 2. Handle Lock: Provisions for padlocking.
 - 3. Grounding Lug: In each enclosure.

2.2 INSULATED CASE CIRCUIT BREAKER

- A. Product Description: NEMA AB 1, enclosed, insulated-case circuit breaker.
- B. Trip Unit: Electronic sensing, timing, and tripping circuits for adjustable current settings; instantaneous trip; and adjustable short time trip.
- C. Accessories: As indicated on Drawings. Conform to NEMA AB 1.
 - 1. Shunt Trip Device: 120 volts, AC.
 - 2. Handle Lock: Provisions for padlocking.
 - 3. Grounding Lug: In each enclosure.

2.3 GROUND FAULT DEVICES

- A. Ground Fault Sensor: Zero sequence type.
- B. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Furnish monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify surface is suitable for switchboard installation.

3.2 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- C. Install fuses in each switch and coordinate sizes with connected load.
- D. Install engraved plastic nameplates in accordance with Section 260553.
- E. Install breaker circuit directory.
- F. Ground and bond switchboards in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.1.

3.4 ADJUSTING

- A. Section 017000 - Project Closeout: Testing, adjusting, and balancing.
- B. Adjust operating mechanisms for free mechanical movement.
- C. Tighten bolted bus connections.
- D. Adjust circuit breaker trip and time delay settings to values as indicated on Drawings.

3.5 CLEANING

- A. Section 017000 - Project Closeout: Final cleaning.
- B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Distribution panelboards.
- B. Lighting and appliance branch circuit panelboards.

1.2 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers.
- B. NEMA PB 1 - Panelboards.
- C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- D. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.

1.3 SUBMITTALS

- A. Submit shop drawings and product data for equipment and component devices under provisions of Section 260305.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.4 SPARE PARTS

- A. Keys: Furnish 2 each to Owner, for each cabinet lock installed.

PART 2 - PRODUCTS

2.1 MAIN DISTRIBUTION PANELBOARDS AND PANELBOARDS FOR AIR CONDITIONING EQUIPMENT:

- A. Panelboards: NEMA PB 1; circuit breaker type. Rated for service entrance where used as main distribution panel.
- B. Enclosure: NEMA PB 1; Type 1. Cabinet size: 6 inches deep; 20 inches wide and NEMA type 3R for outdoor installation.
- C. Provide cabinet front, surface door-in-door type, fastened with hinged door with flush lock, with metal directory frame. Finish in manufacturer's standard gray enamel.

- D. Provide panelboards with copper bus, ratings as scheduled on Drawings. Provide copper ground bus in all panel boards.
- E. Minimum Integrated Short Circuit Rating: 22,000 amperes rms symmetrical for 208 volt and 25,000 amperes rms symmetrical for 480 volt. Select panelboards rated to meet maximum rms amperes symmetrical as required by the utility company service requirements.
- F. Molded Case Circuit Breakers: NEMA AB 1 provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Branch Circuit Panelboards: NEMA PB1; circuit breaker type.
- B. Enclosure: NEMA PB 1; Type 1 indoor, NEMA 3R outdoor.
- C. Cabinet Size: 6 inches deep; 20 inches wide.
- D. Provide flush or surface as cabinet front as indicated with hinged interior cover concealed trim clamps, concealed hinge and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copper bus, ratings as scheduled on Drawings. Provide copper ground bus in all panelboards.
- F. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical for 208 volt panelboards and 14,000 amperes rms symmetrical for 480 volt panelboards.
- G. Molded Case Circuit Breakers: NEMA AB 1; bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers for circuits indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1.
- B. Height: 6 ft.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- E. Stub 5 empty one inch conduits to accessible location above ceiling out of each recessed panelboard.

3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

3.3 PANELBOARD SCHEDULE

- A. Panelboards shall be as scheduled on the Drawings.

3.4 SURGE SUPPRESSION

- A. Provide transient voltage surge suppression protection according to Section 263555, "Transient Voltage Surge Suppression" on all new panelboards.

END OF SECTION 262416

SECTION 262418 - MOTOR CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Manual motor starters.
- B. Magnetic motor starters.
- C. Combination magnetic motor starters.

1.2 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- B. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- C. FS W-P-115 - Power Distribution Panel.
- D. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.
- E. NEMA AB 1 - Molded Case Circuit Breakers.
- F. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- G. NEMA KS 1 - Enclosed Switches.
- H. NEMA PB 1 - Panelboards.
- I. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260305.
- B. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and overcurrent protective devices.
- C. Submit manufacturers' instructions under provisions of Section 260305-1.9.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 260305-1.6.

- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 260 05-1.10.
- B. Store and protect products under provisions of Section 260305-1.10.

1.6 SPARE PARTS

- A. Keys: Furnish 2 each to Owner, for each cabinet lock installed.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR STARTERS

- A. Manual Motor Starter: NEMA ICS 2; size M-0 3 pole, AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, NO auxiliary contact, and push button operator.
- B. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, 2 pole, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- C. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated 2 pole, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, toggle operator.
- D. Enclosure: ANSI/NEMA ICS 6; Type 1, unless indicated otherwise.

2.2 MAGNETIC MOTOR STARTERS

- A. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- B. Full Voltage Starting: Non-reversing type.
- C. Coil Operating Voltage: 120 volts, 60 Hertz.
- D. Size: NEMA ICS 2; size as shown on Drawings.
- E. Overload Protection Device: NEMA ICS 2; melting alloy thermal . Electronic overload relays are not acceptable.
- F. Enclosure: NEMA ICS 6; Type 1. Unless indicated otherwise.

- G. Combination Motor Starters: Combine motor starters with motor circuit protector disconnect in common enclosure.
- H. Auxiliary Contacts: NEMA ICS 2; two and field convertible contacts in addition to seal-in contact.
- I. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- J. Indicating Lights: NEMA ICS 2; RUN: green in front cover.
- K. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO in front cover.
- L. Control Power Transformers: 120 volt secondary, capacity as required for control equipment.
- M. Transient Voltage Surge Suppressor: Manufacturer's standard coil transient suppressor, factory installed.
- N. Manufacturer: Magnetic motor starters shall be Square D, no substitutions.

2.3 CONTROLLER OVERCURRENT PROTECTION AND DISCONNECTING MEANS

- A. Motor Circuit Protector: NEMA AB 1; circuit breakers with integral instantaneous magnetic trip in each pole.
- B. Provide manufacturer's standard transient voltage surge suppressor, factory installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions.
- B. Select and install heater elements in motor starters to match installed motor characteristics.
- C. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION 262418

SECTION 262716 - CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hinged cover enclosures.
- B. Cabinets.
- C. Terminal blocks.
- D. Accessories.

1.2 RELATED SECTIONS

- A. Section 260529 - Supporting Devices.

1.3 REFERENCES

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.
- C. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 260305.
- B. Product Data: Provide manufacturer's standard data for enclosures and cabinets.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.6 EXTRA MATERIALS

- A. Provide two of each cabinet key.

PART 2 - PRODUCTS

2.1 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, Type 12 steel enclosure.
- B. Covers: Continuous hinge, held closed by flush latch operable by key.
- C. Provide interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.
- D. Enclosure Finish: White enamel. Stainless steel in manufacturing areas and laboratories.

2.2 CABINETS

- A. Boxes: Galvanized steel.
- B. Backboard: Provide interior metal panel for mounting terminals blocks and electrical components; finish with white enamel.
- C. Fronts: Steel, flush type with concealed trim clamps, concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel.
- D. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.
- E. Provide accessory feet for free-standing equipment.

2.3 TERMINAL BLOCKS

- A. Terminal Blocks: ANSI/NEMA ICS 4.
- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- D. Provide ground bus terminal block, with each connector bonded to enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.
- C. Install cabinet fronts plumb.

END OF SECTION 262716

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Wall switches.
- B. Receptacles.
- C. Floor mounted service fittings.
- D. Device plates and box covers.

1.2 REFERENCES

- A. NEMA WD 1 - General-Purpose Wiring Devices.
- B. NEMA WD 5 - Specific-Purpose Wiring Devices.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 260305.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

- A. Wall Switches for Lighting Circuits: NEMA WD 1. AC general use snap switch with toggle handle, rated 20 amperes at 277 volts AC. Handle: Ivory plastic.
- B. Pilot Light Type: Pilot strap in adjacent gang.

2.2 RECEPTACLES

- A. Convenience and Straight-blade Receptacles: NEMA WD 1.
- B. Locking-Blade Receptacles: NEMA WD 5.
- C. Convenience Receptacle Configuration: NEMA WD 1; Type 5- 20 R.
- D. Specific-use Receptacle Configuration: NEMA WD 1 or WD 5; type as indicated on Drawings.
- E. GFCI Receptacles: Duplex convenience receptacle with integral ground fault current interrupter.

2.3 WALL PLATES

- A. Decorative Cover Plate: Brushed stainless steel, jumbo size for all finished room locations.
- B. Device Plates for Surface Mounted Outlets: Galvanized surface outlet covers to fit 4 inch square boxes in unfinished utility rooms.
- C. Weatherproof Cover Plate: Gasketed cast metal with hinged gasketed device covers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wall switches 48 inches above floor, OFF position down.
- B. Install convenience receptacles 18 inches above floor, 6 inches above counters or backsplash if present, grounding pole on bottom.
- C. Install specific-use receptacles at heights shown on Contract Drawings.
- D. Corridor Convenience Receptacles: Hospital Grade.
- E. Install smooth stainless steel plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in all walls.
- F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- G. Install devices and wall plates flush and level.

END OF SECTION 262726

SECTION 262819 -DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Disconnect switches.
- B. Enclosures.

1.2 REFERENCES

- A. NEMA KS 1 - Enclosed Switches.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 260305.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Fused or Nonfusible Switch Assemblies: NEMA KS 1; Type HD; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- B. Enclosures: NEMA AB 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 4/4X 304 stainless steel..
- C. Fuse Rating/Size: As shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches where indicated on Drawings or as required in Division 23.

END OF SECTION 262819

SECTION 262823 - ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes molded-case and insulated-case circuit breakers in individual enclosures.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 260305 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.

1.4 CLOSEOUT SUBMITTALS

- A. Section 260305 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations and continuous current ratings of enclosed circuit breakers.

1.5 QUALIFICATIONS

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

PART 2 - PRODUCTS

2.1 MOLDED CASE CIRCUIT BREAKER

- A. Product Description: Enclosed, molded-case circuit breaker conforming to NEMA AB 1, suitable for use as service entrance equipment where applicable.
- B. Accessories: Conform to NEMA AB 1.
 - 1. Handle Lock: With provisions for padlocking.
 - 2. Grounding Lug: In each enclosure.

C. Enclosure: NEMA AB 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Locations: Type 1.
2. Exterior Locations: Type 4/4X 304 stainless steel.

D. Service Entrance: Switches identified for use as service equipment are to be labeled for this application. Furnish solid neutral assembly and equipment ground bar.

E. Minimum integrated short circuit rating: 22,000 amperes rms symmetrical for 208 volt breakers; 25,000 amperes rms symmetrical for 480 volt breakers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 260529.

B. Height: 5 feet to operating handle.

C. Locate and install engraved plastic nameplates in accordance with Section 260553.

3.2 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1.

END OF SECTION 262823

SECTION 262923 - VARIABLE FREQUENCY AC DRIVES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section provides specification requirements for AC inverter type adjustable frequency variable speed drives or herein identified as AC drives for use with NEMA B design, AC motors.
- B. The contractor shall furnish, test, install and place in satisfactory operation all AC drives, with spare parts as specified.
- C. Any exceptions to this specification shall be indicated in writing and submitted with the quotation.
- D. The manufacturer shall have a nationwide field service and technical support organization available 24 hours a day from an 800 telephone number. Capabilities shall include factory coordinated start-up service and on-site training of customer personnel.

1.2 SUBMITTALS

- A. Complete wiring diagrams and chassis outline drawings shall be furnished for review and approval before assembly of the AC drives shall commence. Drawings shall include front and side views with overall dimensions and weights shown.
- B. Two each standard operation and maintenance instruction manuals shall be furnished for each horsepower size of AC drive.
- C. Standard catalog sheets showing voltage, horsepower and current ratings; dimensions and enclosure details shall be furnished for each AC drive provided.
- D. A detailed list of replacement circuit cards, fuses and power components shall be provided with part numbers and pricing information for each drive horsepower size.

1.3 MANUFACTURERS' EXPERIENCE

- A. The manufacturer shall have been specialized in the production of this type of equipment for a period of at least 10 years.
- B. The AC drive(s) and other electrical gear herein specified, shall be supplied and manufactured by the AC drive manufacturer who shall coordinate and verify their operation.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 certified
- D. Substitute products that are in compliance with the specification and manufactured by others will be considered as "Approved Equal" only if pre-approved by the Engineer fourteen (14) days prior to bid date. Alternate suppliers shall submit documentation showing itemized compliance to the

specifications and experience specific to the proposed AC drive including a list showing details of the installation, application, location, contact name and telephone number of at least 10 users.

1.4 QUALITY ASSURANCE

- A. Every AC drive unit shall be designed, constructed and tested in accordance with NEMA, UL, NEC and IEEE recommendations.
- B. Every AC drive and all supplied options shall be UL approved and listed according to UL 50. The controller shall have a UL listed label attached inside the enclosure as verification.
- C. Every AC drive shall be tested with an actual motor load and temperature cycled within an environmental chamber at 104EF (40EC). The frequency output and voltage will be varied throughout the test. Documentation shall be furnished to verify successful completion at the request of the specifier.

1.5 WARRANTY

- A. A one-year warranty shall be provided on materials and workmanship from date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The AC drives supplied shall be Yaskawa, ABB, Danfoss/Trane or approved equal.
- B. Alternate adjustable frequency control drive techniques other than pulse width modulated (PWM) technology will not be considered.

2.2 GENERAL DESCRIPTION

- A. The AC drive shall convert the input AC mains power to an adjustable frequency and voltage. The output frequency and voltage of the AC drive shall be adjustable to maintain a constant V/Hz ratio throughout the operating range. The AC drive shall be designed to operate from 480v three phase, 60 Hz main supply that is within +10% , -10% of nominal line voltage.
- B. The rectifier stage shall convert fixed voltage, fixed frequency, ac line power to fixed dc voltage. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. Designs that incorporate silicon controlled rectifiers (SCRs) will not be allowed. The dc bus voltage shall be filtered. The rectifier shall be insensitive to the phase rotation of the AC line and shall not cause a displacement power factor of less than .95 lagging under any speed or load condition.
- C. The inverter shall change fixed dc voltage to variable frequency AC for application to a standard NEMA B motor. The inverter section shall utilize Gate Turn-Off Thyristor power devices or transistors as required by the current rating of the motor. Paralleling of inverter power devices to increase current rating is not acceptable.

- D. The AC drive shall be capable of operating into an open circuit without damage in order to facilitate start-up/maintenance.

2.3 INPUT CONTROLS AND SIGNALS

- A. The drive shall be capable of accepting the following inputs.
 1. 0-10 vdc speed control analog signal
 2. 4-20 ma speed control analog signal
 3. Forward run digital signal 24 vdc
 4. Three minute programmable digital speed inputs 0-100%, 24 vdc
 5. Logic input and output for interface with programmable logic controller

2.4 OUTPUT CONTROLS AND SIGNALS

- A. The drive shall be capable of the following outputs.
 1. Relay contact for "POWER ON"
 2. Relay contact for "FAULT"
 3. 24 vdc 100ma minimum power source for digital input convenience

2.5 MOTOR DATA

- A. The AC drive shall be designed to operate NEMA B electrical pump motors with a nameplate rating of 480v, three phase power, 1 through 2000 horsepower, Variable Torque (VT) and a 1.15 service factor.

2.6 RATINGS

- A. The AC drive shall be capable of supplying 120% of rated full load current for one minute at maximum ambient temperature.
- B. The AC drive unit and not just the fuses shall be rated for installation in a power system capable of delivering up to 65,000 RMS symmetrical amperes.
- C. The AC drive shall be capable of operating within -10% to +10% of nominal voltage rating
- D. The minimum displacement power factor shall be .95 throughout the entire speed range.
- E. The AC drive shall be capable of operating without damage with the motor disconnected.
- F. The AC drive efficiency shall be 98% at full speed.
- G. Storage temperature range shall be -4EF to 176EF (-20EC to +80EC).
- H. The AC drive shall be designed to operate in an ambient temperature of 32EF to 104EF (0EC to 40EC). For locations with temperatures greater than 104EF (40EC), the AC drive will be derated according to the manufacturers test information.
- I. Maximum relative humidity shall be 95%, non-condensing.

2.7 ADJUSTMENTS

- A. The acceleration and deceleration ramp rates shall be adjustable from 1 to 60 seconds.
- B. The overload trip shall be adjustable from 0 - 100% of rated output current.
- C. The current limit shall be adjustable from 60 - 120% of rated output current to maximize starting torque.
- D. The voltage boost shall be adjustable from 100 to 400% of nominal V/Hz ratio at 1 Hz tapering to 100% at 20 Hz.
- E. The AC drive shall be capable of providing a control for adjusting the minimum frequency setting up to 45 Hz and a maximum operating frequency adjustable over a range of 40 to 60 Hz.

2.8 PROTECTION

- A. A Non-adjustable instantaneous overcurrent trip shall be set to 250% of rated output current.
- B. Protection of the drive shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controller to any of the following conditions shall activate fuseless electronic protective circuits and eliminate component failure or the need for fuse replacement:
 - C. Short circuit at AC drive output
 - D. Ground fault at AC drive output
 - E. Open circuit at AC drive output
 - F. Input undervoltage
 - G. DC bus overvoltage
 - H. Loss of input phase
 - I. AC line switching transients
 - J. Instantaneous overload
 - K. Sustained overload exceeding 100% of controller rated current
 - L. Overtemperature

2.9 CONTROL OPTIONS

- A. All operator control options shall be mounted to the front panel which is integral to the AC drive.
- B. Start-stop push button.

- C. Manual speed potentiometer.
- D. Hand-Automatic selector switch. The controller shall accept an input signal of 0-10 vdc as an automatic speed reference signal when the controller is in the automatic mode of operation. The manual speed potentiometer will control the AC drive frequency when the switch is in manual mode.

2.10 OPERATION FEATURES

- A. The AC drive shall be factory set for manual reset after the first protective circuit trip for a malfunction (overcurrent, undervoltage, overvoltage or overtemperature) or an interruption of power. Automatic restart with two fault lockout shall provide a reset to allow the controller to restart automatically when configured in two wire start/stop control. Three wire control will require a manual restart signal; however, the number of restarts before lockout still applies if the AC drive is set for 2 fault lockout. The AC drive shall attempt to restart after a selected time delay. If the drive faults again within 33 seconds, a manual restart will be required.
- B. The number of allowed faults before the drive is disabled from automatically starting shall be programmable from 1 to 2.
- C. The AC drive shall be capable of restarting into a motor coasting in either forward or reverse direction without component failure or tripping off line.
- D. The AC drive shall include static reversing which shall change the output phase rotation to reverse the motor rotation.
- E. The AC drive shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

2.11 OPERATOR INTERFACE

- A. A Front panel mounted alphanumeric display with a keypad shall be provided to allow the operator access to drive modes, parameters and status conditions. Data will be edited via the keypad. Memory will consist of a main and a non-volatile, back-up memory. The back-up table is used to restore previous mode values without editing each mode individually.
- B. Pilot devices such as push buttons, selector switches and relay contacts shall be supported as an alternative method of control operation.
- C. Access to edit modes shall be restricted. There will be a fault reset that will not enable the AC drive to start unless the fault condition is corrected. Operator control and set-up functions will include the following:
 - 1. Frequency setpoint
 - 2. Acceleration/Deceleration Time
 - 3. Minimum/Maximum Output Frequencies
 - 4. Proportional Gain
 - 5. Integral Gain
 - 6. Set point
 - 7. Drive Reset

8. Elapsed Time
9. Enable PI (Set point) Control
10. Auto Reference Source Select
11. Operating status information will consist of the following:
12. Frequency Output
13. Output Current
14. Output Voltage
15. Axle/Decel Ramp Time
16. Forward/Reverse Direction
17. Hand/Auto Local Indicator
18. Elapsed Time

- D. The diagnostic and fault conditions available via the operator interface will include the following:
1. Output Frequency
 2. Output Current
 3. Output Voltage
 4. Shutdown Reference Status
 5. Jog Status
 6. Mode of Operation
 7. Input Signal Levels
 8. Faults
 9. Overload Timer Activated
 10. Motor Current Limit

2.12 CONTROL REQUIREMENTS

A. Control Functions

1. Frequently accessed AC drive programmable parameters shall be adjustable from a digital operator keypad located on the front of the AC drive. The AC drive shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
2. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
3. The keypad shall have copy / paste capability.
4. Upon initial power up of the AC drive, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
5. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the AC drive RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood

instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section. Provide one copy of the advanced programming software.

6. The operator shall be able to scroll through the keypad menu to choose between the following:
 - a. Monitor
 - b. Operate
 - c. Parameter setup
 - d. Actual parameter values
 - e. Active faults
 - f. Fault history
 - g. LCD contrast adjustment
 - h. Information to indicate the standard software and optional features software loaded.

7. The following setups and adjustments, at a minimum, are to be available:
 - a. Start command from keypad, remote or communications port
 - b. Speed command from keypad, remote or communications port
 - c. Motor direction selection
 - d. Maximum and minimum speed limits
 - e. Acceleration and deceleration times, two settable ranges
 - f. Critical (skip) frequency avoidance
 - g. Torque limit
 - h. Multiple attempt restart function
 - i. Multiple preset speeds adjustment
 - j. Catch a spinning motor start or normal start selection
 - k. Programmable analog output
 - l. DC brake current magnitude and time
 - m. PID process controller

8. The AC drive shall have the following system interfaces:
 - a. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:
 - (1) Remote manual/auto
 - (2) Remote start/stop
 - (3) Remote forward/reverse
 - (4) Remote preset speeds
 - (5) Remote external trip
 - (6) Remote fault reset
 - (7) Process control speed reference interface, 4-20mA DC
 - (8) Potentiometer and 1-10VDC speed reference interface
 - (9) RS-232 programming and operation interface port
 - (10) Serial communications port

2.13 Communications

- A. The drive shall be equipped with Embedded BACnet communications (BTL Certified), along with Modbus/Memobus, Metasys and Apogee FLN.

2.14 Outputs

- A. A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.
 - 1. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
 - 2. Fault
 - 3. Run
 - 4. Ready
 - 5. Reversed
 - 6. Jogging
 - 7. At speed
 - 8. Torque Limit Supervision
 - 9. Motor rotation direction opposite of commanded
 - 10. Over-temperature
- B. Programmable open collector output with available 24VDC power supply and selectable with the following available at minimum:
 - 1. Fault
 - 2. Run
 - 3. Ready
 - 4. Reversed
 - 5. Jogging
 - 6. At speed
 - 7. Torque Limit Supervision
 - 8. Motor rotation direction opposite of commanded
 - 9. Over-temperature
- C. Programmable analog output signal, selectable with the following available at minimum:
 - 1. Motor current
 - 2. Output frequency
 - 3. Frequency reference
 - 4. Motor speed
 - 5. Motor torque
 - 6. Motor power
 - 7. Motor voltage
 - 8. DC-bus voltage
 - 9. AI1 (Analog Input 1)
 - 10. AI2 (Analog Input 2)
 - 11. PT100 temperature
 - 12. FB digital input 4 (Field Bus Input)

2.15 Load Reactor

- A. Line reactor: Input line reactor shall be 1.5 to 3% impedance and rated to coordinate with the drive.

- B. Reactor shall be model # KDR by Trans-Coil Inc., 7878 North 86th St., Milwaukee, WI. 53224, (800)824-8282, (www.transcoil.com) or approved equal.

2.16 ENCLOSURE

- A. The AC drive shall be available in NEMA 1 construction for installation in a separate NEMA rated enclosure. This configuration shall be a factory standard offering, and shall allow mounting of the AC drive(s) in approved electrical enclosures.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide ac drives as indicated on drawings.
- B. Provide line side load reactors.
- C. Install in accordance with NEMA ICS 7.1.
- D. Tighten accessible connections and mechanical fasteners after placing controller.
- E. Install fuses in fusible switches.
- F. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- G. Install engraved plastic nameplates in accordance with Section 260553.
- H. Neatly type label inside controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.
- I. Ground and bond controller in accordance with Section 260526.

3.2 FACTORY TESTS

- A. Each AC drive unit shall be completely functionally tested under actual motor load. Motor speeds will be varied by computer control throughout the test.
- B. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 - 2. After all tests have been performed, each AC DRIVE shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 - 3. After the burn-in cycle is complete, each AC DRIVE shall be put through a motor load test before inspection and shipping.
 - 4. The manufacturer shall provide three (3) certified copies of factory test reports.

- C. The test shall be in a 40E Centigrade temperature controlled environment.
- D. Inspect and test in accordance with NETA ATS, except Section 4.
- E. Perform inspections and tests listed in NETA ATS, Section 7.16 and NEMA ICS 7.1.

3.3 FIELD QUALITY CONTROL

- A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of AC DRIVE on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper AC DRIVE operation.
- B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.
 - 1. Inspection and final adjustments.
 - 2. Operational and functional checks of AC drives.

END OF SECTION 262923

SECTION 263555 - TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes the materials and installation requirements for transient voltage surge suppressors (TVSS) for the protection of all AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.
- B. This section includes materials and installation of Transient Voltage Surge Suppressors (TVSS) for the protection of electronic circuits and equipment.

1.2 RELATED WORK

- A. Section 260305, "General Electrical Requirements"
- B. Section 260532, "Conduit"
- C. Section 260519, "Wire and Cable"
- D. Section 260533, "Boxes"
- E. Section 260526, "Secondary Grounding"
- F. Section 262418, "Motor control"

1.3 REFERENCES

- A. UL 1449 Edition 4, 2014 Revision (effective 8/20/2014).
- B. UL 1283.
- C. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- D. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
- E. IEEE 1100 Emerald Book.
- F. NEMA LS-1, 1992-(R2000) Low-Voltage Surge Protection Devices.
- G. National Fire Protection Association (NFPA 70: National Electrical Code).

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 260305. Include shop drawings, product data and manufacturer's installation instructions.

- B. The surge suppression submittals shall also include:
1. Copies of Manufacturer's catalog data, technical information and specifications on equipment proposed for use.
 2. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc.) and are tested and multi-listed to UL 1449 and UL 1283.
 3. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category 3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C62.45.
 4. Copies of Noise Rejection testing as outlined in NEMA LS1-1993 (R2000) Section 3.11. Noise rejection is to be measured between 50kHz and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.
 5. Copies of Surge Fuse Testing. Each unit shall be surge tested with fusing in series to verify that a transient of maximum surge current capacity/magnitude is fully suppressed without fuse failure, operation or degradation per NEMA LS1-1992 (R2000) Section 3.9.
 6. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.
 7. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

1.5 WARRANTY

- A. All TVSS units shall be guaranteed to be free of defects in materials and workmanship for a period of five years from the date of installation.
- B. Any suppressor which fails or operates improperly, even as a result of a direct lightning strike, will be replaced by the manufacturer at no expense to the owner.

1.6 QUALITY ASSURANCE

- A. All suppressors shall be manufactured in the United States by a company normally engaged in the design, development, and manufacture of such devices for electrical and electronics systems equipment for a minimum period of five years.
- B. All manufacturers will provide products which do not interrupt power to the protected system in the event of a suppressor failure, for life safety applications, i.e., fire alarm. Written certification of this parameter shall be provided by the suppressor manufacturer.
- C. The suppressors listed in this specification shall not impair the performance of the protected systems, including, but not limited to, the following parameters: degradation of signal quality or levels, attenuation, and distortion. The suppressors shall not initiate conditions which jeopardize the life safety features of fire alarms, communications, energy management, and other code related protection.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE AND MAIN DISTRIBUTION PANEL SUPPRESSORS

- A. Suppressors shall be listed in accordance with UL 1449, "Standard for Safety, Transient Voltage Surge Suppressors", and UL 1283, "Electromagnetic Interference Filters".
- B. Suppressors shall be independently tested with the category C3 high exposure waveform (20 kV, 10kA, 8/20 micro-second waveform) clamp voltage test results.
- C. Suppressors shall incorporate copper bus bars for the surge current path. Small round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
- D. The unit shall include an engineered solid-state high performance suppression filter system, utilizing metal oxide varistors, and polypropylene capacitors. Units may contain selenium cells to achieve higher ratings.
- E. The unit shall contain 200,000 AIC fuses on each phase.
- F. The status of each phase shall be monitored on the front of the suppressor's enclosure.
- G. For three phase, four wire plus ground configurations, the unit shall provide protection in all modes, Line to Neutral, Line to Ground, Line to Line and Neutral to Ground.
- H. Suppressors shall be equipped with an audible alarm which shall activate upon device failure. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. The switches and alarm shall be located on the front cover of the suppressor's enclosure.
- I. Suppressor shall meet or exceed the following criteria:
 - 1. Tested maximum single impulse surge current rating per mode shall be:

Line to Line	100,000A
Line to Neutral	100,000A
Line to Ground	100,000A
Neutral to Ground	100,000A
 - 2. Pulse life test: Capable of protecting against and surviving 3500 ANSI/IEEE C62.41 Category C3(20kV, 10 kA) transients without failure or degradation of UL 1449 suppression rating by more than 10%.
 - 3. The UL 1449 suppression rating shall be listed with an integral disconnect switch, where applicable, and shall not exceed the following:

For units with an integral disconnect switch:				
VOLTAGE	L-N	L-G	N-G	L-L
120/208	400V	500V	500V	700V
277/480	800V	1000V	900V	1500V
- J. The suppressor shall have a response time no greater than five nanoseconds for any of the individual protection modes.
- K. The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 listed as an

electromagnetic interference filter. The filter shall reduce fast rise-time, high frequency, error producing transients. The filter shall provide minimum noise attenuation as follows:

Attenuation Frequency	100KHz	1 MHz	10MHz	100MHz
Attenuation dB	41	31	35	53

- L. Suppressors shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 125% of nominal RMS voltage for 120 volt systems.
- M. The unit shall incorporate solid state, long life, externally mounted LED visual status indicators that indicate the on line status of each phase of the unit.
- N. The unit shall incorporate an integral test point allowing easy off line diagnostic testing which verifies the operational integrity of the unit's suppression filter system.
- O. The unit shall include mechanical lugs for each phase, neutral and ground. The lugs shall accommodate up to #4 AWG copper conductor with integral fused disconnect switch, and up to 1/0 AWG copper conductor without an integral fused disconnect switch.
- P. Suppressor manufacturer shall provide certified test data confirming a "fail-short" failure mode.
- Q. Suppressors shall be equipped with the following optional items:
 - 1. Integral Disconnect. The unit shall include an integral disconnect switch located in the unit enclosure with an externally mounted manual operator. The switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and maintenance without interruption of power to the facility. The switch shall be rated 600 volt AC. The unit shall be UL 1449 listed with the integral disconnect switch and the UL 1449 suppression rating for this configuration shall be provided.
 - 2. Disturbance Counter. A transient voltage surge counter shall be located on the front cover of the suppressor. The counter shall be equipped with a manual reset and a battery to retain memory upon loss of AC power.
- R. Acceptable manufacturers:
 - Current Technology
 - Eaton Innovative Technology
 - Square D Surge Logic

2.2 208 VOLT AND 480 VOLT SUB PANEL SUPPRESSORS

- A. Suppressors shall be listed in accordance with UL 1449, "Standard for Safety, Transient Voltage Surge Suppressors", and UL 1283, "Electromagnetic Interference Filters".
- B. Suppressors shall be independently tested with the category C3 high exposure waveform (20 kV, 10kA, 8/20 micro-second waveform) clamp voltage test results.
- C. Suppressors shall incorporate copper bus bars for the surge current path. Small round wiring or plug-in connections shall not be used in the path for surge current diversion. Surge current diversion modules

shall use bolted connections to the bus bars for reliable low impedance connections.

- D. The unit shall include an engineered solid-state high performance suppression filter system, utilizing metal oxide varistors, and polypropylene capacitors.
- E. The unit shall contain 200,000 AIC fuses on each phase.
- F. The status of each phase shall be monitored on the front of the suppressor's enclosure.
- G. For three phase, four wire plus ground configurations, the unit shall provide protection in all modes, Line to Neutral, Line to Ground, and Neutral to Ground.
- H. Suppressors shall be equipped with an audible alarm which shall activate upon device failure. An alarm on/off switch shall be provided to silence the alarm and an alarm push-to-test switch shall be provided to test the alarm. The switches and alarm shall be located on the front cover of the suppressor's enclosure.
- I. Suppressor shall meet or exceed the following criteria:

- 1. Tested maximum single impulse surge current rating per mode shall be;

Line to Line	80,000A
Line to Neutral	80,000A
Line to Ground	80,000A
Neutral to Ground	80,000A

- 2. Pulse life test: Capable of protecting against and surviving 2500 ANSI/IEEE C62.41 Category C3(20kV, 10 kA) transients without failure or degradation of UL 1449 suppression rating by more than 10%.
- 3. The UL 1449 suppression rating shall be listed with an integral disconnect switch, where applicable, and shall not exceed the following:

For units without an integral fused disconnect switch:

VOLTAGE	L-N	L-G	N-G	L-L
120/208	400V	500V	500V	700V
277/480	900V	1000V	800V	4800V

- J. The suppressor shall have a response time no greater than five nanoseconds for any of the individual protection modes.
- K. The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 listed as an electromagnetic interference filter. The filter shall reduce fast rise-time, high frequency, error producing transients. The filter shall provide minimum noise attenuation as follows:

Attenuation Frequency	100KHz	1 MHz	10MHz	100MHz
Attenuation dB	41	31	35	53

- L. Suppressors shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 125% of nominal RMS voltage for 120 volt systems.

- M. The unit shall incorporate solid state, long life, externally mounted LED visual status indicators that indicate the on line status of each phase of the unit.
- N. The unit shall incorporate an integral test point allowing easy off line diagnostic testing which verifies the operational integrity of the unit's suppression filter system.
- O. The unit shall include mechanical lugs for each phase, neutral and ground. The lugs shall accommodate up to #4 AWG copper conductor with integral fused disconnect switch, and up to 1/0 AWG copper conductor without an integral fused disconnect switch.
- P. Suppressor manufacturer shall provide certified test data confirming a "fail-short" failure mode.
- Q. Acceptable manufacturers:
 - Current Technology
 - Eaton Innovative Technology
 - Square D Surge Logic

2.3 TERMINAL STRIP HARD-WIRED (120 VAC) SUPPRESSORS

- A. Suppressors shall be listed in accordance with UL 1449, "Standard for Safety, Transient Voltage" "Surge Suppressors".
- B. Suppressors shall consist of a three stage hybrid design: first stage - MOV, second stage - inductor, third stage - silicon avalanche diode or MOV.
- C. Suppressors shall be internally fused in such a manner that power to protected equipment is not interrupted in the event of a suppressor failure.
- D. Suppressors shall provide three suppression paths: line to neutral, line to ground, and neutral to ground.
- E. Suppressors shall provide a maximum single impulse current rating of 25 kA (8/20 micro-second waveform) per mode.
- F. Pulse life rating: Capable of protecting against and surviving 500 Category B3 transients (6 kV - 1.2/50 micro-second, 3 kA - 8/20 micro-second waveform).
- G. Suppressors' maximum clamping voltage when subjected to Category B3 transients shall not exceed 350 V peak.
- H. Visible indication of proper suppressor connection and operation shall be provided.
- I. The suppressor shall have a two year warranty.
- J. Acceptable manufacturers: Advanced Protection Technologies, Inc., Model TE/AC03UL, or approved equal.

2.4 INTERCOM CIRCUIT SUPPRESSORS

- A. Suppressors shall meet the following requirements:

1. UL 497B listed and labeled.
2. Utilize a multi-stage hybrid protection circuit.
3. Consist of a plug-in replaceable modular design or individually mounted units.
4. Designed for a fail-short mode of failure.

B. Electrical Requirements

1. Maximum single impulse current: 200 A (10/1000 micro-second waveform).
2. Clamp voltage: not to exceed 150% of circuit peak operating voltage (100 A, 10/1000 micro-second waveform).
3. Maximum continuous operating voltage: 125% of peak operating voltage, minimum.
4. Capacitance for DC or low frequency lines shall not exceed 2000 pF (measured line to ground at the rated diode breakdown voltage).
5. Pulse life: 200 impulses of 50 A (10/1000 micro-second waveform)

C. Acceptable manufacturers: Advanced Protection Technologies, DA Series

2.5 SECURITY SYSTEMS

A. Suppressors shall meet the following requirements:

1. UL 497B listed and labeled.
2. Utilize a multi-stage hybrid protection circuit.
3. Consist of a plug-in replaceable modular design or individually mounted units.
4. Designed for a fail-short mode of failure.

B. Electrical Requirements

1. Maximum single impulse current: 200 A (10/1000 micro-second waveform).
2. Clamp voltage: not to exceed 150% of circuit peak operating voltage (100 A, 10/1000 micro-second waveform).
3. Maximum continuous operating voltage: 125% of peak operating voltage, minimum.
4. Capacitance for DC or low frequency lines shall not exceed 2000 pF (measured line to ground at the rated diode breakdown voltage).
5. Pulse life: 200 impulses of 50 A (10/1000 micro-second waveform)

C. Acceptable manufacturers: Advanced Protection Technologies, DA Series, or approved equal.

2.6 COAXIAL CABLE SUPPRESSORS

A. Suppressors shall be installed on each generic or unspecified system coaxial cable on points of entry to or exit from separate buildings, and at roof mounted and other locations where direct exposure to lightning occurs. Suppressors shall meet the following criteria.

1. Shunt clamping elements: gas tubes and high energy bipolar silicon avalanche diodes separated by a series resistance.
2. Electrical Parameters:
 - a. Impedance: match the system being protected.
 - b. Capacitance: 10 pF.
 - c. Maximum single impulse current: 10 KA (8/20 micro-second waveform), minimum.
 - d. Clamping voltage: not to exceed 200% of normal peak operating voltage.
3. Response time: less than one nanosecond.

B. Acceptable manufacturers: Advanced Protection Technologies; TE9025, or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install TVSS equipment according to manufacturer's recommendations.
- B. Contractor shall properly match TVSS equipment to equipment being protected, including wire sizes, operating voltages and currents.
- C. Contractor shall coordinate with providers of all equipment being protected and provide TVSS equipment which meets these specifications.
- D. Provide required NEMA 1 (indoor) or NEMA 3R (outdoor) enclosures for suppressors adjacent to each electronic system cabinet, or coordinate with each electronic system supplier to provide oversized cabinets to incorporate suppressors into electronic systems cabinet.
- E. Electronic system equipment shall be protected by treating groups of related devices as a "cluster" and protecting all hard wire circuits which enter and leave the cluster. All equipment chassis within a protected cluster shall be bonded to a ground bar at the "window" location for the cluster, the window being the common point where all hard wire circuits enter or leave the cluster.

3.2 SERVICE ENTRANCE AND MAIN DISTRIBUTION PANELS AND MCC'S

- A. Install one primary suppressor at each utility service entrance to the facility, according to manufacturer's recommendations.
- B. Install one primary suppressor at each main distribution panel for each voltage in use at the facility, according to manufacturer's recommendations.
- C. Install one primary suppressor at each motor control center for each voltage in use at the facility, according to manufacturer's recommendations.
- D. The suppressor shall be installed on the load side of the service entrance.
- E. Conductors between suppressor and point of attachment shall be kept short and straight.
- F. Suppressor's ground shall be bonded to the service entrance ground.

3.3 208 VOLT AND 480 VOLT SUB PANELS

- A. Install one secondary suppressor at each sub panel location, according to manufacturer's recommendations.
- B. Conductors between suppressor and point of attachment shall be kept short and straight.
- C. Neutral and ground shall not be bonded together at secondary panelboard locations.
- D. Provide suitable three pole breaker in all panels as recommended by suppression manufacturer to connect unit.

3.4 ELECTRONIC EQUIPMENT (120 VAC) POWER SUPPLY

- A. Install one each hard-wired branch circuit suppressor between each of the following equipment items and its power supply conductors.
 - 1. Each Building Fire alarm control panel.
 - 2. Master Intercom panel.
 - 3. Each Building Energy Management and Control system panel.
- B. Install suppressor according to manufacturer's recommendations.

3.5 COAXIAL CABLE SYSTEMS

- A. Suppressors shall be installed on each cable TV coaxial cable system on points of entry to or exit from separate buildings, and at roof mounted equipment and other locations where direct exposure to lightning occurs.

3.6 GROUND INSTALLATION

- A. Ground Bus Connections
 - 1. Provide local ground bus in each terminal cabinet housing surge protection equipment (with other materials as required).
 - 2. Bond local ground bus to terminal cabinet with minimum #6 copper wire.
 - 3. Connect terminal cabinet local ground bus to systems ground bus with minimum #6 copper insulated wire (unless otherwise noted) in conduit.
 - 4. Note that the systems ground bar is also to be used for power transformation ground (480 V to 208 V) where applicable.
- B. Surge Suppression Equipment Grounding
 - 1. Connect each suppressor to local ground bus in terminal cabinet with wire sized as recommended by manufacturer. Where M block type terminations/suppressors are used, bond ground rail to local ground bar with wire as recommended by manufacturer.
 - 2. Ensure that 120 VAC power source/supply suppressor is also grounded to same local ground bus as suppressors provided in this section for same system (i.e., fire alarm, intercom, television, etc.).
- C. Grounding Conductors
 - 1. Conductors shall be a minimum size of #12 THWN (in conduit, insulated) unless otherwise noted or otherwise recommended by the manufacturer.
 - 2. Conductors shall be as short as possible.
 - 3. No bend radius shall be less than 6 inches or more than 90 degrees.
 - 4. Conductors shall be secured at 12 inch intervals with an approved copper clamp.
 - 5. Grounding conductors shall be properly connected to the building service ground by approved clamps.
 - 6. Do not bundle unprotected conductors with protected conductors.
- D. Grounding Connectors
 - 1. Connectors, splicers, and other fittings used to interconnect grounding conductors, or bond to equipment or grounding bars, shall be approved by UL or NEC for the purpose.
 - 2. All connectors and fittings shall be of the one time crimp or compression set-screw type solderless connection.
 - 3. Special treatment to fittings, lugs, or other connectors of dissimilar material shall be applied to

prevent electrogalvanic action.

END OF SECTION 263555

SECTION 265110 - LED LIGHTING FIXTURES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Interior luminaries and accessories.
- B. Exterior luminaries and accessories.
- C. LED Modules.
- D. LED Drivers.

1.2 REFERENCES

- A. UL Standard 8750 "Light Emitting Diode Equipment for Use in Lighting Products".
- B. IES Standard LM-79 "Electrical and Photometric Measurements of Solid-State Lighting Products".
- C. IES Standard LM-80 "Measuring Lumen Maintenance of LED Light Sources".
- D. IES Standard TM-21 "Projecting Long Term Lumen Maintenance of LED Light Sources".
- E. ANSI C78.377 "Specifications for the Chromaticity of Solid State Lighting products" with LEDs binned within a maximum three-step MacAdam Ellipse to ensure color consistency amongst luminaries of the same type.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 260305.
- B. Include outline drawings, LED module and driver data, support points, weights, and accessory information for each luminaire type.

1.4 DEFINITIONS

- A. BF: Ballast Factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 260305-110.
- B. Store and protect products under provision of Section 260305-1.10.

1.6 QUALITY ASSURANCE

- A. Lighting fixtures shall be of specification grade and listed or labeled by Underwriters Laboratories (UL) or an approved Nationally Recognized Testing Laboratory (NRTL).

1.7 WARRANTY

- A. For LED fixtures, lamps, drivers, and components, provide a complete warranty for parts and labor for a minimum of five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LED LUMINARIES AND ACCESSORIES

- A. Luminaries shall be as scheduled on the drawings.
- B. Catalog numbers indicated in the Luminaire Schedule are a design reference. Provide complete luminaires as scheduled to correspond with the features, accessories, number of lamps, wattage and/or size defined by the manufacturer's catalog number listed.
- C. Submit all substitutions for approval by the Architect and Engineer prior to bid.
- D. LED fixtures shall be modular and allow for separate replacement of LED lamps and drivers. User serviceable LED lamps and drivers shall be replaceable from the room side.

2.2 LEDS

- A. LED modules shall have a color temperature of 4000 degrees K, a CRI of 80 minimum, and a lumen maintenance L70 rating of 50,000 hours minimum.
- B. Retrofit LED lamps shall comply with NEMA SSL 4 "SSL Retrofit Lamps: Suggested Minimum Performance Requirements".

2.3 DRIVERS

- A. LED drivers shall be electronic-type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, and comply with NEMA SSL 1 "Electronic Drivers for LED Devices, Arrays, or Systems". LED drivers shall have a sound rating of "A", have a minimum efficiency of 85%, and be rated for a THD of less than 20 percent at all input voltages.
- B. Drivers shall be solid state and accept 120 through 277 VAC at 60 Hz input.
- C. Dimmable LED drivers shall be 0-10V type. Dimmable LED drivers shall be capable of dimming without

LED strobing or flicker across their full dimming range.

- D. Drivers shall be rated for the ambient temperatures in which they are located. Outdoor fixtures shall be equipped with ballasts or drivers rated for reliable starting to -20 degrees F. Indoor fixtures located in areas with direct sunlight or above normal ambient temperatures shall have ballasts or drivers rated at 65 degrees C minimum.

2.4 EMERGENCY LIGHTING

- A. Emergency lighting shall consist of normal lighting fixtures with generator system backup.

2.5 EXIT SIGNS

- A. Exit signs shall be of the LED type, connected to the emergency generator system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lamps in luminaires and lamp holders.
- B. Support surface-mounted luminaires directly from building structure or fasten to T grid using bolts, screws, rivets, or approved ceiling framing member clips.
- C. Support recessed troffers independently of the ceiling grid system by using two safety wires minimum on diagonally opposite corners of the fixtures. Removable T-bar clips shall not be used to attach fixtures to the ceiling grid system.
- D. Support recessed downlights by using safety wires or by rigidly attaching the fixtures to the building structure or ceiling grid system.
- E. Install fixtures level, with no gaps between adjacent fixtures or between fixtures and surrounding surfaces. Lenses, reflectors, and trims of fixtures shall be properly and uniformly aligned.
- F. Install recessed luminaires to permit removal from below.
- G. Provide an individual feed with ground conductor from a junction box to each group of switched lighting fixtures. Lighting fixtures may be daisy-chained.
- H. Drops to recessed fixtures may be flexible metallic conduit, or manufactured wiring systems may be used where accessible. Fixtures shall be provided with sufficient length to permit removal and lowering of the fixtures 12" below the ceiling.
- I. Provide green grounding conductors back to the panel ground for lighting circuits. Raceways shall not be used as grounding conductors.
- J. Aim all adjustable luminaires to provide intended lighting and uniform lighting levels within space.

3.2 EXTERIOR LUMINAIRES

- A. Install exterior luminaires in accordance with manufacturer's installation instructions.
- B. Support from four inch square outlet box with plaster ring and from wall at non-feed ends with expansion anchors and bolts or toggle bolts. Don not use plastic anchor inserts.
- C. Provide clear silicone sealant at tops of wall mounted fixtures, around wall outlet boxes and on unused openings in fixture housings to create waterproof seal and eliminate water intrusion into fixture.

3.3 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Adjust all occupancy controls to shut off lights in Code required time after room is vacated.
- C. Adjust day lighting controls to dim controlled lights to maintain minimum classroom lighting level of 50 foot candles.

3.4 TRAINING

- A. Train Owner's maintenance personnel on equipment operation, startup and shutdown, trouble-shooting, servicing, and preventative maintenance procedures. Demonstrate operation of all lighting fixtures on occupancy sensor switches, day lighting controllers and dimmers. and dimming. Review the data contained in the Operating and Maintenance Manuals with Owner's personnel. Training shall occur separate from startup activities.

3.5 LUMINAIRE SCHEDULE

- A. Luminaries as scheduled on the Drawings are the basis for the lighting design.
- B. Substitutions may be made according to specifications sections 002113, "Instructions to Bidders" and 016010, "Product Substitutions."

END OF SECTION 265110

SECTION 271343 - COMMUNICATIONS CIRCUIT PATHWAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes arrangement with Telecommunications Utility Company for telecommunication service; payment of Utility Company charges for service installation; and backboards, cabinets, cable tray, raceways, and boxes.
- B. Related Sections:
 - 1. Section 099000 - Painting: Painting backboards.
 - 2. Section 099000 - Painting and Coating: Painting backboards.
 - 3. Section 260534 - Floor Boxes for Electrical Systems.
 - 4. Section 262726 - Wiring Devices: Wall plates.
 - 5. Section 260526 - Secondary Grounding and Bonding
 - 6. Section 270533 - Conduits and Backboxes for Communications Systems.

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. Telecommunications Industry Association/Electronic Industries Alliance:
 - 1. TIA/EIA 568 - Commercial Building Telecommunications Cabling Standard.
 - 2. TIA/EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. American Society for Testing and Materials:
 - 1. ASTM A123 - Specification for Zinc (hot dipped galvanized coatings on iron and steel).
 - 2. ASTM A510 - Specification for general requirements for wire rods and course round wire, carbon steel.
 - 3. ASTM B633 - Specification for electro-deposited coatings of zinc on iron and steel.
- D. National Electrical Manufacturers Association:
 - 1. NEMA VE2-2000 - Cable tray installation guidelines.

1.3 SYSTEM DESCRIPTION

- A. Service entrance from Telecommunications Utility Company.
- B. Service Entrance Pathway: Empty ducts and raceway from point of Telecommunications Utility Company connection at property line to building service terminal backboard.
- C. Entrance Wiring: By Telecommunications Utility Company.
- D. Backbone Wiring: By Contractor. See sections 271346, Local Area Network Fiber Optic Cabling and 271348, Local Area Network Premise Distribution System.

- E. Horizontal Wiring: By Contractor. See sections 271346, Local Area Network Fiber Optic Cabling and 271348, Local Area Network Premise Distribution System.

1.4 SUBMITTALS

- A. Section 260305 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for cable tray, raceways and boxes.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.6 COORDINATION

- A. Contact utility company regarding charges related to service installation. Include utility charges in this contract.

PART 2 - PRODUCTS

2.1 TELEPHONE TERMINATION BACKBOARDS

- A. Material: Fire retardant painted Plywood.
- B. Size: As indicated on Drawings, 3/4 inch thick.

2.2 TELECOMMUNICATION GROUND BUS BAR

- A. Busbar Material:
 - 1. 1/4" thick copper
 - 2. ASTM B187-C11000
 - 3. Electro-tin plated
- B. Insulators:
 - 1. Manufactured of rugged polyamide, halogen-free nylon material reinforced with glass fiber
 - 2. 2" standoff height
 - 3. Meet requirements of UL 94 VO for self-extinguishing materials
- C. Brackets:
 - 1. Type 304 Stainless Steel
 - 2. 1/8" thick
- D. Fasteners:
 - 1. Type 304 Stainless Steel

2.3 TELEPHONE/DATA OUTLETS

- A. Provide telephone/data outlets consisting of 4 inch square X 1-1/2 inch deep box with single gang plaster rings where shown.

- B. Provide 3/4 inch conduit from box to above ceiling and turned out perpendicular to wall, 6 inches from wall with plastic bushing attached to conduit or connector.
- C. Provide a pull string in all conduits.

2.4 TELEPHONE/DATA FLOOR OUTLETS

- A. Provide conduit underfloor from communication section of floor boxes to telephone terminal boards. Conduits shall extend above finished floor 12 inches.
- B. Provide plastic bushing on all underfloor conduits.
- C. Provide pull string in all conduits.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install pathways in accordance with TIA/EIA 569.
- B. Finish paint termination backboards with durable class A flame retardant finish material prior to installation of any equipment.
- C. Install termination backboards and cabinets plumb, and attach securely to building wall at each corner.
- D. Install a telecommunication ground bus (TGB) bar at each backboard with a #2 awg copper green insulated conductor in 1/2" conduit to the main electrical grounding system in the building electrical room.
- E. Install polyethylene pulling string in each empty telephone conduit over.
- F. Install engraved plastic nameplates in accordance with Section 260553. Mark backboards and cabinets with legend "TELEPHONE" or "DATA" as appropriate.
- G. Ground and bond pathways, cable shields, and equipment in accordance with Section 260526.

END OF SECTION 271343

SECTION 271346 - LOCAL AREA NETWORK FIBER OPTIC CABLING

PART 1 - GENERAL

1.1 GENERAL

- A. Furnish and install complete with all accessories an EIA/TIA Category 6 Fiber Optic cable backbone to be used for but not limited to IEEE 802.3 10 Base-T Ethernet, EMCS intra-building communications, Networked Intercom Communications and Networked Fire Alarm Communications

1.2 REFERENCES

- A. EIA/TIA-568 - Commercial Building Telecommunications Wiring Standard. Horizontal Cable Section.
- B. NEMA.
- C. National Electric Code.
- D. IEEE 802.3, 10 Base-T Ethernet.
- E. ANSI X3T9.5 Requirements for UTP at 100 Mbps.

1.3 SUBMITTALS

- A. Submit under provisions of Section 16011.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, technical information, and configurations. Provide data for the following:
 - 1. Fiber optic cable.
 - 2. Fiber optic connectors.
 - 3. Fiber optic patch panels.
 - 4. Fiber optic patch cords.

1.4 Manufacturer's Instructions:

- A. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
- B. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three (3) years experience.
- B. Contractor: The contractor shall be experienced in all aspects of the work to be performed.

1.6 WARRANTY

- A. Provide preventive maintenance for a period of 1 years from Date of Final Acceptance. Service shall include full replacement cost including material and labor required to replace any failed component. Include annual inspection of entire system.

PART 2 - PRODUCTS

2.1 CABLES

A. Exterior Fiber Optic Cable

1. Fiber optic cable for underground use shall be used to interconnect the MDF and IDF's between buildings. The cable shall be a multimode, loose tube, single jacket cable rated for indoor/outdoor use. The cable shall have a central core with strength members located outside the central core tube containing the optical fibers. Cable shall be plenum rated type OFNP.
2. Optical fibers. Each cable shall contain 24 fibers as shown on the drawings. Fibers shall be dual coated to protect against microbending, provide mechanical protection and color retention, improve fatigue resistance, and enhance stripability. Coating shall consist of a low modulus inner layer and a high modulus outer diameter.
3. Fiber strength. Fiber strength shall have a minimum proof test level of 50,000 psi, tested per method EIA-TIA-455-31b, "Fiber Tensile Proof Test Method.
4. Multimode Fiber Specifications. (62.5/125)
 - a. Fiber Core 62.5 +/- 3 micron
 - b. Cladding Diameter 125 +/- 2 micron
 - c. Attenuation (dB/Km at 850 nm) Max. 3.75 dB/Km
 - d. Attenuation (dB/Km at 1300nm) Max. 1.00 dB/Km
 - e. Bandwidth (Mhz-Km at 850 nm) Min. 160 Mhz-Km
 - f. Bandwidth (Mhz-Km at 1300 nm) Min. 500 MHz-Km
 - g. Core Non-Circularity Less than 6%
 - h. Cladding Non-Circularity Less than 2%
 - i. Concentricity error Less than 6%
 - j. Primary Coating Material UV curable acrylate
 - k. Primary Coating Diameter Nom. 250 micron
5. Cable Core. The cable core shall consist of groups of six fibers with two helically applied opposing binders. The fibers and binders shall be color coded to facilitate positive fiber identification. The cable core shall consists of an extruded high density polyethylene(HDPE) jacket covering the fiber bundle.
6. Cable Sheath. The overall cable jacket shall cover the central core, strength members and rip cords. The jacket shall be plenum rated type PVDF.

2.2 FIBER OPTIC DISTRIBUTION CENTERS (FDC'S)

- A. All MDF and IDF fiber optic cabling shall be terminated in rack mount SC Fiber Distribution Enclosures. Provide a new FDC at each IDF to terminate new cables. Each FDC shall contain two (2) 12 port type SC connector panels. All FDC's shall be provided with rack mounting hardware allowing the unit to be placed in a standard EIA 19" rack. Provide sufficient port quantity using SC connector panels to allow termination of all fiber optic strands.
- B. Provide blanking modules in all unused connection ports.
- C. Labeling for fiber cabling shall be by IDF number, plus the color suffix designating which fiber is terminated. Die cut acetate labels or Kroy labels shall be considered acceptable for the purpose.
- D. FDC's shall be constructed of minimum 16 gauge steel and shall have cable tie down bars and grounding clamps. FDC's shall be painted with light blue enamel paint.
- E. Manufacturers: AMP, Ortronics, Siecor.

2.3 FIBER OPTIC PATCH CORDS

- A. Distribution Frame Fiber Optic Patch Cords: Pre-assembled, multimode, 62.5/125 micron, duplex fiber optic cable with two (2) SC style connectors at one end and two (~~LC~~) (2) LC style connectors at the opposite end and plenum rated outer jacket. Cable shall be ten (10) feet total length. Cable ends shall be labeled with transmit and receive markers. Provide one (1) patch cord for every pair of fibers terminated at each distribution frame plus 50% spares.
- B. Building Systems Fiber Optic Patch Cords: Fiber optic patch cords for the Intercom, Fire Alarm and EMCS building systems, used to connect the systems communication hardware to the fiber optic backbone, shall be provided as specified in the specific section covering the individual building system. Patch cords shall have type SC style connectors at the MDF or IDF end and the style of connectors required to connect to the various systems equipment at the opposite end. See sections 275115, 283100 and 230923.

2.4 FIBER OPTIC CONNECTORS

- A. Fiber optic connectors shall be type SC, of the hot melt installation type. Crimp type connectors are not acceptable. Connectors shall be preloaded with all necessary adhesive to achieve a permanent connection. Adhesive shall be reheatable to allow fiber repositioning. Connector boot shall be Thermoplastic Elastomer. Connector Housing and Body shall be Engineered Resin Material. Connector Ferrule shall be Zirconia Ceramic. Insertion Loss Typical Field Mount (one mated pair) @ 1300 nm: <0.2dB. Reflection Typical Field Mount: -25dB
- B. Manufacturers: 3M or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect wire and cable for physical damage and proper connection. Replace damaged cables.

3.2 INSTALLATION

- A. Install all cable between buildings in conduit as specified in Section 260532 "Conduit". Bending radii shall not be less than the cable manufacturer's minimum bending radius for the installed cable.
- B. Cables in communications rooms shall be neatly routed from entry conduit to LAN rack using wire management devices secured to the communication room backboards. Free hanging cables shall not be allowed.
- C. Fiber Optic Cable shall be terminated on a rack mounted patch panel.
- D. Cables shall be installed unbroken from originating point to end use point. Terminate all cables using specified connectors. Spare conductors shall be suitably marked at each end to identify individual components for future use.
- E. Splices: Splices shall not be permitted. All fiber optic conductors shall be terminated at a fiber optic patch panel.
- F. Metallic Component Grounding: Fiber optic cable system metallic components including tube routing panels and fiber termination patch panels shall have the metallic components grounded at the cable termination points.
- G. Deliver Fiber Optic Patch Cords, as specified in Part 2 Products, to Owner.

3.3 TESTING

- A. Fiber Optic Cable Test: Verify complete operation of data transmission system during field testing. Perform test on 100 percent of the fibers. Field tests shall include as a minimum:
 - B. Optical time domain reflectometer (OTDR) test at 850 and 1300 nanometers. Calibrate OTDR to show anomalies of 0.2 dB as a minimum. Reterminate cable or replace and reterminate cable which has power loss in excess of 1 dB at 1300 nanometers. Test new segment of cable to demonstrate acceptability. Record maximum power loss of each fiber exceeding 0.5 dB.
 - C. Perform power attenuation test at light wavelength of the transmitter to be used on the circuit being tested. Measure flux at the Fiber Optic receiver end and compare to the flux injected at the transmitter end. Provide a jumper at each end of the circuit under test to validate end connector loss. Rotational optimization of the connectors will not be permitted. Circuit loss shall not exceed the calculated circuit loss by more than 2 dB. When test is unsatisfactory, examine circuit to determine the problem.
- D. Provide a typed test report with results of all tests indicated.

3.4 LABELING

- A. Pathways shall be labeled at all endpoints located in telecommunication closets, equipment rooms, and other facilities. Additional labeling may be desirable at intermediate locations, or regularly spaced throughout the length of the pathway.
- B. Labeling must withstand the performance requirements of UL 969 as outlined in TIA standard.
- C. Station labeling shall be visible and distinguishable from a distance of 4 feet.

END OF SECTION 271346

SECTION 271348 - LOCAL AREA NETWORK PREMISE DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01 and Division 26 Specification Sections apply to this Section.
- B. Standards - Conform to the requirements of the following:
 - 1. TIA/EIA-568-B.1 "Commercial Building Telecommunications Cabling Standard", CSA T529.
 - 2. TIA/EIA-568-B.2-1 "Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling".
 - 3. TIA/EIA-569 "Commercial Building Standard for Telecommunications Pathways and Spaces", CSA T530.
 - 4. TIA/EIA-606 "Administration Standard for Telecommunications Infrastructure of Commercial Buildings", CSA T528.
 - 5. TIA/EIA-607 "Commercial Building Grounding/Bonding Requirements".
 - 6. TSB-67 "Transmission Performance Specification for Field Testing of Unshielded Twisted Pair Cabling Systems".
 - 7. TIA/EIA TSB-72 "Centralized Optical Fiber Cabling Guidelines".
 - 8. TIA/EIA PN-3398 TSB-75 "Additional Horizontal Cabling Practices for Open Offices".
 - 9. ANSI/NFPA 70 National Electrical Code, CSA C22.1.
 - 10. BICSI Telecommunications Distribution Methods Manuals
 - 11. BICSI Telecommunications Installation Manuals
 - 12. County Codes and Regulations.
 - 13. Underwriters Laboratories (UL)
 - 14. FCC -Federal Communications Commission
 - 15. ADA Requirements
 - 16. Occupational Safety and Health Regulations (OSHA)
 - 17. National Fire Protection Association (NFPA)
 - 18. Florida Statutes and Administrative Rules
 - 19. Cabling System Certified Cabling Catalog
 - 20. American Society for Testing and Materials (ASTM)
 - 21. EIA/TIA-492AAAA - Detail Specification for 62.5 Micrometer Core Diameter/125 Micrometer Cladding Diameter Class 1a Multimode, Graded Index Optical Waveguide Fibers.
 - 22. EIA/TIA TSB-36 - Technical Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted Pair Cables.

23. EIA/TIA TSB-40-A - Technical Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware.
24. Florida DMS/DOC - General Facility Requirements for Telecommunications Systems
25. LPC - Lightning Protection Code (NFPA-780).
26. UL Certified - UL's LAN Cable Certification Program. UL 910 - Test for Flame Propagation and Smoke Density Values for Electrical and Optical Fiber Cables Used in Spaces Transporting Environmental Air.
27. UL 1666 - Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts.
28. UL 1449, 3rd Edition – Standard for Safety for Surge Protective Devices
29. UL 497, UL 497A, UL 497B
30. ANSI - American National Standards Institute
31. NEMA - National Electrical Manufacturers Association
32. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

1.2 PERFORMANCE REQUIREMENTS

- A. General: Provide for a complete (furnish and install) EIA/TIA 568-B.2-1 Category 6 Premise Distribution System (PDS) with all accessories and a minimum 20-year LINK AND CHANNEL WARRANTY for the entire system. The goal is to provide an enhanced PDS system that will serve as a vehicle for transport of data, video and voice telephony signals throughout the building and from building to building from a designated demarcation point to outlets located at various desks, workstations and other locations.
- B. Support analog and digital voice applications, data, local area networks (LAN), video and low voltage devices for building controls and management on a common cabling platform. The applications supported include, but are not limited to:
 1. Data Processing – EIA-232-D, EIA-422A, EIA-43-A, RS-485, Star LAN, Fiber Distributed Data Interface (FDDI), Ethernet 10Base-T (IEEE 802.3i), 10Base-F (IEEE 802.3j), and TP-PMD. In addition, these links/channels shall be capable of supporting high-end applications such as 100Base-T (IEEE 802.3u), 1000Base-T (IEEE 802.3z, ab), and 1000 base TX.
 2. Voice Applications – Lucent, Northern Telecom, NEC, SIEMENS.
 3. Video – Broadband and base band Analog Video, Digital Video, and Video Conferencing.
 4. WLAN applications, cabling for Wireless Access Points (WAP), shall be compliant with applicable EIA/TIA standards, as well as the IEEE 802.3af standard for providing PoE, (Power over Ethernet) for Data Terminal Equipment (DTE) over Category rated UTP cable.
 5. Other Applications: ISDN, ATM, ADSL, VoIP
- C. Provide a network of unshielded twisted pair cables (UTP) and fiber optic cables (FO) for horizontal cabling, backbone cabling, riser cabling, tie cabling, and patch cords. Provide and locate terminations and quantities on contract drawings. Terminate FO Cables on rack mounted Fiber Distribution Centers (FDC's),

and UTP cables on rack mounted modular patch panels. Identify all cables and terminations in accordance with EIA/TIA 606 using an alphanumeric sequence.

- D. At a minimum provide all terminations and testing in accordance with EIA/TIA 568.2-1, Category 6, with at least a 20-year warranty.
 - 1. Provide an installation that requires horizontal cable supporting data applications must meet at a minimum the Category 6 performance requirements as listed by EIA/TIA standards for the link and channel. (Field testing for LINK only, 100% factory patch cord testing required).
- E. Data communications is to originate at Owner provided switches and routers located at individual IDF'S.
- F. Wiring, terminations and patch bays between designated demarcation points and outlet locations is to be considered part of the contract. Outlets (jacks) shall be furnished, wired, and installed by the Structured Cable Systems (SCS) Contractor.
- G. Nassau County School District has standardized on the following color code for category 6 components.
 - 1. All category 6 cable shall be green in color

1.3 QUALITY ASSURANCE

A. Installer Qualifications:

- 1. Any contractor who chooses to bid on this project must show current certification as an installer of the specified connectivity manufacturer.
- 2. Provide that the Contractor responsible for the work is a "Premise Distribution Wiring Contractor" who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years, holds a valid Florida Certified Limited Energy System Specialty license (ES 069) and possess either a Panduit Certified Installer or AMP Netconnect Design & Installation and Corning Extended Warranty Program Certifications in order to provide the level of warranty for the product sets required.. Also, any sub-Contractor, who will assist the PDW Contractor in performance of this work, is to have the same training and certification as the PDW Contractor. A copy of the sub-contractors connectivity manufacturer certification shall be submitted to Nassau County School District prior to the commencement of work.
- 3. BICSI Accreditation: Provide that the Contractor's Project Manager be a member in good standing with and possess a current BICSI Registered Communications Distribution Designer (RCDD) certificate.
- 4. Experienced: Provide that the Contractor be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Contractor is to own and maintain tools and equipment necessary for successful installation and testing of optical fiber and Category 6 copper premise distribution systems and have personnel who are adequately trained in the use of such tools and equipment.

1.4 SUBMITTALS DURING CONSTRUCTION

- A. Adherence to Specifications: Manufacturers and/or products are listed in no order of preference and only referenced as acceptable. Single manufacturer names means that no other manufacturer's product is accepted without written approval from Nassau County School District and the Engineer. These manufacturers represent major components and are not intended to be comprehensive. Shop drawings and/or samples for all products not listed must be submitted to Nassau County School District for approval. Also, an explanation in detail giving the reason(s) why and how the proposed items will meet the specifications and will not be considered an exception, and submit adequate information to support this

claim. Nassau County School District reserves the right to be the sole judge of what is equal or equivalent. These changes, if approved by the OWNER and the ENGINEER, must be issued in a WRITTEN ADDENDUM not later than seven (7) days prior to bid opening date.

- B. Required to be submitted with the bid:
 - 1. Copy of the Contractor's current Certification by the specific connectivity manufacturer.
- C. Submittals required prior to the commencement of work: Include manufacturers' cut sheets for all proposed equipment including, but not limited to, the following:
 - 1. All wire and cable as specified by the contract documents.
 - 2. All connectors and required tooling.
 - 3. All terminations system components for each cable type.
 - 4. All IDF equipment frame types, hardware and surge strips.
 - 5. All cable suspension J-hooks, cable fasteners, CAT 6 cable suspension components.
 - 6. All grounding and surge suppression system components for the system portion of the project.
 - 7. AC Grade, Plywood Backboards painted with UL Classified fire retardant paint.
 - 8. All CAT 6 patch cords.
- D. As-Built Documentation
 - 1. Provide as-built documentation in accordance with Division 01.
 - 2. As part of the as-built documentation provide all cable routings (trunk lines) and elevations of each IDF or MDF indication outlet, tie, and riser cable terminations.
 - 3. Provide EXCEL software spreadsheet that defines the telecommunications outlet number, location, and number of voice, data and special jacks. This database is to also include outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs.
- E. Warranty Requirements:
 - 1. Cabling system warranties are to be supplied by the manufacturer of the connectivity, (jacks, patch panels and patch cords). The warranty program shall include coverage for both Link and Channel configuration as specified in the connectivity manufacturer's warranty. The patch cords and workstations cords shall be manufactured by the same manufacturer as the jacks and patch panels. The patch cords shall be 100% factory tested for compliance to the Category 6 standard. The warranty shall provide for guaranteed system performance, provide for material replacement and the labor to re-install defective products.

PART 2- PRODUCTS

2.1 MATERIALS, PRODUCTS, EQUIPMENT, MANUFACTURED UNITS

- A. Fiber Optic Cabling: See Section 271346 Local Area Network Fiber Optic Cabling.
- B. Category 6 Horizontal Cable
 - 1. General: Data pairs are to be extended between the outlet location and its associated IDF. The cable is to consist of 4 pair 23 gauge, solid copper conductors, certified to the Category 6

standards. ETL or UL verified for EIA/TIA electrical performance and comply with FCC part 68. Cables are to be terminated on each of the 8-position modular jacks provided at each outlet. Voice is to utilize this same cable type. Only virgin materials are to be used.

- a) Cable selection is to be based upon meeting an end-to-end channel performance and be shown to have been tested with the proposed component manufacturer's products and warranted as a complete permanent link and channel solution by the connectivity Manufacturer.
 - b) The Cabling System Warranty shall be issued by the connectivity manufacturer. (Jacks, patch panels, patch cords, etc.). A Warranty from the cable manufacturer or the Contractor shall not be accepted.
2. Cable Insulation and Jacket: Cable jacket is to comply with Article 800 of the NEC for the environment in which the cable will be installed. All cables are to bear the UL and NEC, CMR or MPR markings. (All cable is to be RISER rated unless otherwise specified or required by code). All PLENUM cables are to bear the UL and NEC, CMP or MPP markings.
 3. Horizontal cable drops from IDF or MDF to specified outlet locations are to be without splices.
 4. Properties: Electrical Characteristics for horizontal cable tested on 100 m length are to be as follows:

	TIA/EIA CAT 6
Frequency	500MHz
Characteristic Impedance	100 ± 15%
NEXT (dB) Minimum	39.2dB
PSNEXT (dB) Minimum	37.2dB
ELFEXT Minimum	12.3dB
PSELFEXT Minimum	11.3dB
Return Loss Minimum	18dB
Maximum Attenuation (dB/100m)	54.5dB

1. Horizontal Cable Specified: In addition to meeting listed requirements cable is also required to meet a 20 year or greater total PDW warranty. The cable selected must be one of those listed below and be approved cable for use in a warranted system from the connectivity manufacturer.
 - a) Approved horizontal copper cabling manufacturers:
 1. Amp, Belden, Berk-Tek
- B. Category 6 Modular Copper Patch Cords

1. Category 6 Modular Copper Patch Cord assemblies shall be constructed using modular plugs with 50µm gold-plated contacts, and shall be wired to the T568A wiring pattern. Cable assemblies shall utilize colored cable and "snagless" cable boots that match the color of the cable.
 2. Conductors shall be 24 AWG, 7/32 stranded copper. Insulation shall be Flame Retardant Polyethylene. Jacket shall be PVC (Riser Rated), .210 nominal diameter. Boot shall be Elastomer Polyolefin. Plug Housing shall be Clear Polycarbonate. Terminals shall be Phosphor bronze with 50µm gold plating on selected area, gold flash over the remainder, over 100µm nickel underplate.
 3. Provide Category 6 Modular Patch Cords for each patch panel port, 7'-0" length.
 4. Provide Additional Category 6 Modular Patch Cords for each work station outlet jack plus an additional 50% of the total workstation outlet jacks (total workstation jacks x 1.5).
 5. Twenty-five percent (25%) of all workstation jack patch cords shall be 5'-0" in length. Fifty percent (50%) of all workstation jack patch cords shall be 7'-0" in length. Twenty-five percent (25%) of all workstation jack patch cords shall be 10'-0" in length.
 6. All patch cords shall be green in color.
- C. Copper Tie Cabling
1. Where required copper tie cabling is to be provided between IDF's and MDF. All voice grade wire and cable placed underground is to be solid twisted pair, multi-conductor, ASP-filled core cable. Cable jacket is to be aluminum steel polyethylene (ASP) dual insulated with foam skin and plastic, and surrounded by filling compound. Cable is to be resistant to mechanical damage, lightning damage or damage from wildlife.
 2. Multi-pair backbone copper cables are to meet the following specifications:
 - a) Gauge: 24 AWG
 - b) DC Resistance: 27.3Ω/1000 ft (8.96Ω/100m), maximum
 - c) Mutual Capacitance (at 1khz)
 - d) Impedance: 100Ω (25pair)
 - e) Buried/Underground Cable Attenuation (dB/1000 ft [305m]): at 1.0MHz: 6.4 (25 pair), maximum
 - f) Aerial Cable Attenuation (dB/1000 ft [305m]): at 1.0 MHz: 6.7 (25 pair), maximum
 3. Design Selection:
 - a) Amp
 - b) Belden
 - c) Berk-Tek
- D. Site Copper Cable Protection Units
1. Entrance Protection (Analog or Digital Phone Systems): All site copper circuits are to be provided with protection between each building with an entrance cable protector chassis. All building-to-building circuits are to be routed through this protector. Protector is to be connected with a #6 AWG copper bonding conductor between the protector ground lug and the IDF ground point. Each protector chassis is to be provided with 5-pin plug-in protector modules for each pair terminated on the chassis.
 - a) Design Selection:
 1. Porta Systems, #24100-1100-M110C w/1155CN-240 modules (Analog phones), or #1155CN-75 (75 volt) modules for (Digital phones).

2. Or equal by Circa or Systimax.
2. VoIP Entrance Protection (Cisco or other VoIP Phones): All site copper circuits that are intended to distribute voice over IP (VoIP) are to be provided with protection between each building with data rated primary protectors. All copper data grade building-to-building circuits are to be routed through this protector.
 - a) Design Selection:
 1. Porta Systems #606-27 (non-PoE circuits)
 2. Porta Systems #606-65 (for circuits providing PoE power)
 3. Portable Classrooms: Site Cat 6 copper circuits from building or portable (modular) IDF's to portables (modular) are to be provided protection on both ends. At the IDF rack, multi-port rack mounted protector patch panels are to be used for the outgoing Cat 6 cable. Cable is to be run in conduit to the portables where they will terminate in 3-port and 4-port Wall Plate protector units directly without splice.
 - a) Design Selection:
 1. CoreTEK Industries, Inc.: CTI-R12, CTI-W3, and CTII-W4 respectively. Requires "Red" CoreTEK protectors.
- E. Equipment Racks
 1. General: Each MTR and ITR is to be equipped with 19 inch EIA rack(s), floor mounted, to house owner-provided equipment and contractor provided termination bays for multiple cable types. Floor mounted racks are to be mounted on an isolation pad and utilize non-conductive washers to secure the rack to the floor. Floor mounted open racks are to be secured from the top rail to the backboard in the room with a length of cable tray to prevent movement. Wall racks are to be securely fastened to the wall studs with at least 1/4" hardware. All racks are to be bonded to the TR ground bar using a standard ground lug and #6 AWG insulated green cable.
 2. Equipment Mounting Selections:
 - a) Floor Rack: Panduit # CMR19X84S; or owner approved equal
 - b) Isolation Pad: Chatsworth, Hubbell, B-Line, or Pathways & Spaces, Inc.
 3. Rack Accessories: Each equipment rack is to be provided with the following accessories:
 - a) Horizontal Cable Organizer: Premise wiring Organizer, Front/rear 19" rack mount, 2U high, 3.5" tall, w/3.5" deep rings on the front (with cover), and 4.6" deep rings on the rear (no cover).
 1. Panduit #WMPH2E
 - b) Power Plug Strip: 120V, 15 Amp surge protected, 10 outlet, 19 inch rack mounted w/switch and 5-15P plug, 10 foot cord length, steel housing (black).
 1. Panduit #CMRPSH15
 4. Cable Routing: Ensure that station cables will be routed into the rear station Cable Manager, neatly organized and terminated onto the patch panel following TIA/EIA-568-B, 569 termination guidelines. Require that a horizontal cable manager be installed above and below any patch panel installed on the rack. Patch panels and front/rear cable managers are to be installed in alternating order on the rack. Also, ensure that on 48 port patch panels, the cables terminated on the top 24 ports is neatly routed through the cable manager mounted above the patch panel and conversely those terminated

on the lower 24 ports are routed through the cable manager mounted below the patch panel. This routing method allows easier moves, adds and changes at a later date.

5. Vertical Cable Management: Free standing relay racks are to have vertical cable management installed on each side of the rack. If more than one rack is installed then each rack will be separated by a vertical, duct style cable manager. Black, 6" channels with covers.

- a) Panduit #WMPVHC45E

NOTE: This part number provides vertical cable management for one side of the rack only.

- F. Plywood Backboards: Backboards are to be installed in each MTR and ITR on all four (4) walls from 12" AFF to a height of 9'-0" AFF. Rooms are to have walls covered with $\frac{3}{4}$ " A/C Grade plywood with the "A" side out. Imperfections and voids are to be filled, sealed and sanded prior to being primed and painted with two coats of UL Classified, fire retardant intumescent paint on the front, back and all four sides of the plywood. Fire retardant coating is to be tested to UL723, "Test for Surface Burning Characteristics of Building Materials"; backboards are to be clearly labeled with the name of the backboard manufacturer, UL Classification of the Fire Retardant Coating, NFPA 255 Coating Flame Spread Index Class and the APA Grade of the plywood.

- G. Category 6 Patch Panels

1. General: Equipment Racks: Provide with 19" rack mount, 8-position modular jacks (RJ45), non-keyed, factory configured, patch panels for termination of all copper horizontal cables.
2. Work Area Outlet Patch Panels: Test to meet the Category 6 standard for component and channel performance and are to be modular-to-110, wired for T568B pin outs for the cables serving the Work Area Outlets.

- a) Category 6 patch panel component values:

- | | | |
|------------------------|------------|-------------------|
| 1. NEXT (dB) | at 250 MHz | 46.0 dB or exceed |
| 2. Insertion Loss (dB) | at 250 MHz | 0.32 dB or less |
| 3. FEXT (dB) | at 250 MHz | 35.1 dB or exceed |

- b) Patch panels are to be provided in 24 and 48 port configurations.

1. Design Selection:

- a) Panduit #CPP24FMWBL (24 port); #CPP48FMWBL (48 port)
- b) AMP #1116749-1 (24 port); #1375119-1 (48 port)

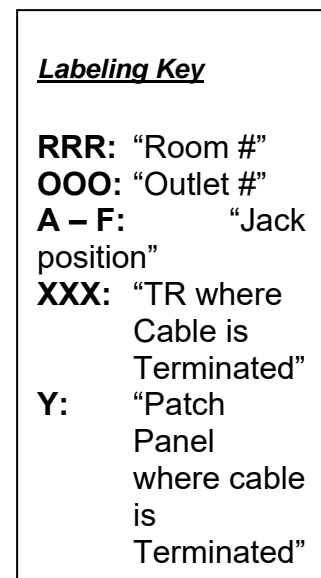
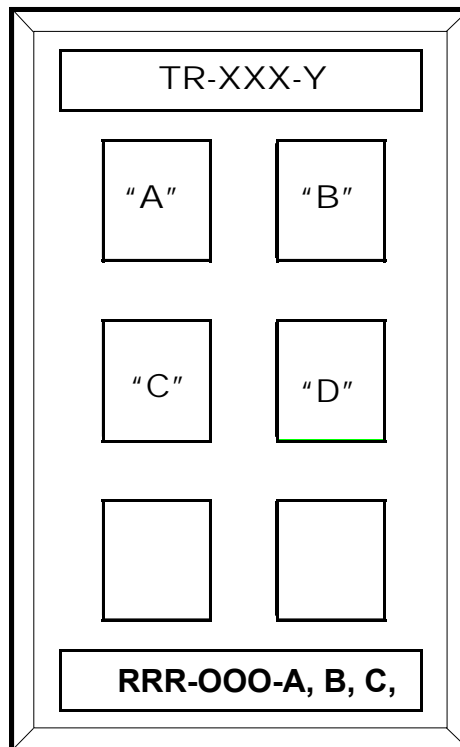
3. Voice Site Patch Panels: Provide for the distribution of the voice pairs to the work area patch panels via patch cords. Terminate the site copper tie cables, 25 or 50 pair, via the protector units to voice patch panels. These patch panels are to be configured with one voice pair per port (blue pair) via the 110-connector side of the panel. The panels are to be configured as 8-position modular jack-to-110 termination panels in the required quantities.
4. Identification: Each jack on all patch panels is to be identified with permanent machine generated labels, meeting the EIA/TIA 606 requirements, matching the Nassau County School District numbering plan as shown (re: para. 2.1.M.6.3.(b)) on the faceplate. All labeling is to be permanent. All labeling is to be 12 point in size. Engineer is to approve labeling prior to fabrication.

- H. Cable Support System

1. General: Horizontal cables are to be suspended by pre-manufactured CAT 6 rated J-hooks and Hilti "ECH" hangers in closets where J-hooks, ladder tray or rack management is not available. All supports are to be permanently attached to the structure using all-thread suspension, beam clamps, or wall mount to the structural metal or wooden members. The J-hooks are to feature a wide base loop with smooth curves to eliminate snag potential and cable deformation.
 2. Use of cable ties within the Telecommunications room is strictly prohibited. Velcro cable ties or Velcro wraps are to be used instead of cable ties in all rooms where Category 6 cable and fiber optic cable is terminated. Including all Data Centers, MC's (MDF), TC's or IDF's.
 3. J-hooks are to be in accordance with the NEC, EIA/TIA requirements for structured cabling systems. All cable supports are to be UL listed.
 - a) Design Selection:
 1. Erico Caddy
 2. Generic J-hook
 4. Ladder Rack: Ladder Rack for equipment rack tie to wall is to be 12 inches wide with a 6 inch rung spacing, have a minimum of 24 square inches of cable pathway and minimum 24 inch radius. Adjustable splice connectors are acceptable where needed to accommodate non-standard vertical and horizontal bends. Each straight section, and fitting, is to be provided with two "heavy duty" splice connectors and appurtenant hardware. The splice, when bolted together to form a tray joint, is to be designed to have the same strength (or better) than the tray when placed mid-span. The tray system is to be capable of carrying 50 lb/linear foot without exceeding a 1.5 inch mid-span deflection (in accordance with NEMA Class 8A) when supported every 4 foot. Support the tray system from wall studs or suspend from the structure above the ceiling, do not suspend the tray system from the roof deck.
 - a) Design Selection: Ladder Tray manufacturer is to be Chatsworth Products, Inc. Cable Runway® and Radd Bends® or owner approved equal.
- I. Outlets
1. General: Communications outlets that contain copper services are to be equipped with ANSI/TIA/EIA-568-B.2-1 Category 6, 8-position modular jacks (RJ45 type) utilizing T568B wiring. Terminate all outlet cabling on appropriate termination blocks at their associated IDF. Outlets are to be certified to operate at 1000 Mbps data speed with twisted pair horizontal cabling as verified by ETL or UL. Faceplates are to be able to accommodate up to 6, 8-position modular jacks each.
 2. Wall Outlets: Wall outlets are to consist of single gang wall plates with blank module inserts for all unused module locations.
 3. Modular Furniture Outlets: Furniture outlets are to consist of a modular furniture faceplate capable of housing up to four (4) 8-position modular connectors with blank module inserts for all unused module locations.
 4. House Wall Phone: Wall phone outlets are to consist of a SE630 type wall plate with Category 6 minimum cable to each, terminating in an 8-position modular jack.
- J. Outlet Placement:
1. Standard PDS Wall Plate locations shall be installed where shown on the project drawings.
 2. Wireless LAN - (WAP) Wall Plates shall be as follows:

- a) Classroom Placement: Ceiling mount, one (1) per classroom. The outlet shall be located on the ceiling close to the center of the room. Mounting of the low voltage faceplate shall comply with all applicable codes and standards.
 - b) Common Area Placement: (locations such as the Cafeteria, Library, Study Halls, etc.). Shall be designed to for higher density usage of the WLAN system. All areas designated as “WLAN Common Areas,” shall have WAP Wall plates located on each wall (one per wall minimum). For larger rooms, the WAP wall plates shall be located no more than 10’ to 12’ from the floor.
 - c) Administration Area: (Areas such as the Teachers’ Dining Room, Reception Area, etc.) one (1) outlet shall be wall mounted, between 10’ to 12’ high from the finished floor.
 - d) All WAP wall plates shall be compliant with IEEE 802.3af, PoE power for Data Terminal Equipment (DTE).
 - e) All WAP wall plates shall utilize the same wall boxes and conduit stub-up installation as standard PDS wall plates.
3. 8-position Modular Jack: Category 6 jacks are to meet or exceed the following electrical and mechanical specifications:
- a) Electrical Specifications:
 1. Insulation Resistance: 500 M minimum.
 2. Dielectric withstand voltage 1000 VAC RMS, 60 Hz minimum, contact-to-contact and 1500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
 3. Contact Resistance: 20 m maximum.
 4. Current Rating: 1.5 A at 68 F (20 C) per IEC Publication 512-3, Test 5b.
 5. ISO 9001 Certified Manufacturer.
 6. UL Verified for EIA/TIA electrical performance.
 7. Comply with FCC Part 68.
 - b) Mechanical Performance:
 1. Plug Insertion Life: 750 insertions
 2. Contact Force: 3.5 oz (99.2 g) minimum using FCC Approved modular plug.
 3. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
 4. Temperature Range: -40 °F to 150 °F (-40 °C to 66 °C).
4. Channel Performance: All Enhanced Category 6 jacks are to be utilized in a channel configuration meeting or exceeding the following specifications at 250 MHz:
- a) NEXT (dB) at 250 MHz 46.0 dB or exceed
 - b) Insertion Loss (dB) at 250 MHz 0.32 dB or less
 - c) FEXT (dB) at 250 MHz 35.1 dB or exceed
 - d) Return Loss (dB) at 250 MHz 16.0 dB or exceed
5. WLAN faceplates for Wireless Access Points (WAP) locations.

- a) Wall Faceplate (office white)
 - b) Data and Voice Jacks (blue): Panduit # CJ6E88TGBU; AMP # 1375187-6
6. Standard PDS Wall Plate Design Selection: these wall plates are to be located throughout each classroom or office location.
- 1. Wall Faceplate (office white) w/sloped modules: Panduit # CFPSE4EIY; AMP # 1339118-X
 - 2. PDS Jacks (yellow): Panduit # CJ6E88TGYL; AMP # 1375187-8
 - 3. Miscellaneous Building Systems, security, fire, A/V, and BMS/EMS (white): Panduit # CJ6X88TGIW; AMP # 1375055-3
 - 4. Voice (green): Panduit # CJ6E88TGGR; AMP # 1375187-9
 - 5. Blanks (office white)
 - (a) Provide blank module inserts for all unused module locations.
 - (b) Outlet Labeling: Each jack on all outlets is to be identified with permanent machine generated labels, meeting the EIA/TIA 606 requirements, matching the Nassau County School District numbering plan on the faceplate. All labeling is to be permanent. All labeling is to be 12 point in size. Engineer is to approve labeling prior to fabrication.
 - (c)



- A. Unspecified Equipment and Materials
 - 1. Ensure that the Contractor understands that any item of equipment or material not specifically addressed on the contract drawings and required to provide a complete and functional SCS installation is to be provided at a level of quality consistent with other specified items.
- B. Grounding System and Conductors
 - 1. Communications bonding and grounding is to be in accordance with the National Electrical Code (NEC) and NFPA as well as EIA/TIA grounding and bonding standards. Backbone and entrance cables are to be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
 - 2. A #6 AWG stranded copper wire cable is to be extended between new ground bars located at each IDF and the building main electrical service ground point or secondary transformer ground point. The building steel, the equipment racks, and all surge suppressors, Protectors and metallic cabinets are to be bonded to the ground bar via a #6 AWG stranded copper cable and UL approved connecting hardware.

PART 3 - EXECUTION

3.1 INSTALLATION STANDARDS AND TOLERANCES

- C. General: Cable routing and Installation practices shall be in accordance with BICSI's Telecommunications Distribution Methods Manual (TDMM) and Telecommunications Installation Manual.
- D. T568B wiring pin out configuration is to be used for all jack and patch panel terminations. T568B is to be the standard for all twisted pair wiring.
- E. All cable runs are to contain a service slack prior to the termination point. Provide for a 12-inch service slack in the ceiling above each outlet. Service slack at IDF is to consist of a 10-foot slack section for all station cables located and placed neatly in the cable ladder above the equipment rack.
- F. Plenum Spaces and cable routing: The majority of PDW wiring is installed above ceilings. All communications cabling used throughout is to meet the requirements as outlined in the National Electrical Code (NEC) article 800. In ducted "air return" applications, and cable run in conduit the cable is to bear CMR, MPR or OFNR (RISER) and/or appropriate marking. In non-ducted return air applications or as required by local and/or state code requirements cable is to bear CMP, MPP or OFNP (plenum) markings. Verify with state and local code enforcement officers where plenum and non-plenum cables are required. All cables are to bear the appropriate markings of the environment in which they are installed.
- G. Cable Pathways:
 - 1. Above ceilings:
 - a) All primary cable pathways Utilize J-Hooks.
 - b) Use of ceiling tiles, grid or hanger wires for the support of PDW cables is to be prohibited.
 - c) Horizontal cables used in the system are to be installed within the ceiling spaces. Cables routed in these spaces are to be at right angles to electrical power circuits and supported only from the structure. Tie cables between MDF and IDF's are to utilize conduit.
- H. Category 6 Cable
 - 1. Provide for Category 6 UTP cables are installed in accordance with EIA/TIA guidelines for Category 6. Contractor will replace cable installation and terminations that do not comply.

- a) Maximum pulling tension is not to exceed 25 pounds.
 - b) Minimum bending radius of the cable is not to be less than 4 times the diameter of the cable.
 - c) The cable is to be installed without kinks or twists and the application of cable ties is not to deform the cable bundle.
 - d) Require the Contractor to only strip back only as much cable jacket as required to terminate the cable and the amount of untwisting in a pair as a result of the termination is not to exceed 0.5 inch.
- I. In suspended ceiling and raised floor areas where duct, cable trays, or conduits are not available, bundle Category 6 cables in bundles of 40 or less, horizontal wiring above the ceiling is to be secured with cable ties, the cable ties are to be installed loosely. Cables are to be loose enough to be rotated easily by hand. Cable ties used in plenum areas are to be plenum rated. Ensure ties are not tightened to a point where they will deform the cable geometry.
 - J. Provide a minimum of two hangers at any corners or 90 degree turns. Attachment shall be to the building structure and framework at a maximum of five (5) foot intervals. Ceiling suspension wire or independent tie wires are not to be allowed for cable support. Where cable is routed above the ceiling in areas where there are no walls, all-thread is to be used (minimum 1/4", however sized to support the intended weight) with the appropriate CAT 6 hanger for cross-room support. Support rods are to be level and plumb after cable installation. Manufacturers' requirements for bending radius and pulling tension of all cables are to be adhered to.
 - K. Fire Stopping Protection: All fire stopping of openings through rated fire and smoke walls existing or created by the premise wiring contractor are to be sealed under Division 7 Section Firestopping.
 - L. Damage: Repair of surfaces including painting and ceiling tile replacement is to be the responsibility of the premise wiring contractor.
 - M. Avoiding EMI: To avoid EMI provide clearances of at least four (4) feet (1.2 meters) from motors or transformers; 1 foot (12 inches) from conduit and cables used for electrical power distribution; and 1 foot (12 inches) from fluorescent lighting. Pathways are to cross fluorescent lighting and electrical power cables and conduit perpendicularly.
 - N. Work External to the Building
 - 1. General: The same requirements are to apply to exterior installations as do those within the confines of the building, with code required adjustments.

3.2 FIELD QUALITY CONTROL

- A. Field Testing:
 - 1. Testing of Wiring Accuracy
 - a) Ensure the Premise Distribution Cabling Contractor tests wiring setting tester for channel configuration which includes the patch cord, patch panel, UTP Cable, work-area jack and work-area cord.
 - b) Testing Equipment: Agilent Technologies, Fluke, Microtest or Ideal are approved manufacturers of test equipment. Testers are to be 100% Level III compliant with TIA/EIS 568.2-1 specifications for testing of CAT 6 cabling. No testers will be approved without meeting these requirements.
 - c) Testing Guidelines: Each jack in each outlet is to be tested at a minimum of Category 6 compliance. Tests are to be done in a LINK configuration to verify the integrity of all

conductors and correctness of the termination sequence. The manufacturer is to provide 100% factory testing of the patch cords. It is not acceptable practice for patch cords to be unpackaged for use in certification testing. The cords shall remain boxed and stored for installation by the owner or as otherwise indicated by the scope of work. Perform testing between the outlets and the patch panel at the equipment rack, prior to testing UTP runs the tester shall be calibrated per manufacturer's guidelines. The correct cable NVP shall be entered into the tester to assure proper length and attenuation readings.

- d) The Contractor must verify that this testing method is acceptable to the manufacturer that will be providing the LINK AND CHANNEL warranty for the project.
 - 1) 250 MHz sweep tests, Wire map, Attenuation, NEXT, PSNEXT, ELFEXT, PSELFEXT, ACR, PSACR, Return Loss, Delay, Delay Skew, and the installed length for Category 6 cables.
 - 2) Cables not complying with ANSI.TIA.EIA-568-B.1 and B.2-1 Category 6 tests are to be identified to the engineer for corrective action which may include replacement at no additional expense to the Owner.
 - 3) Documentation of cable testing is required.

2. Testing of Fiber Optic Cable

- a) Provide that each strand in fiber optic cables is tested for correctness of termination, overall transmission loss, and defects using an approved Optical Time Domain Reflectometer (OTDR) and a power meter. The Engineer, with one week prior notice, is to be present for all tests.
- b) Testing Equipment: Agilent Technologies, Fluke, Microtest, Noyes or Ideal are acceptable manufacturers of test equipment.
- c) Testing of multimode fiber is to be in accordance with TIA/EIA-526-14 method B. System loss measurements (both calculated and measured) are to be provided at 850 and 1300 nanometers in both directions for multimode cables (1310 and 1550 nanometers for single-mode) for each strand. Per IEEE 802.3z, maximum fiber strand attenuation is not to exceed 2.38 dB @ 850 nm with a modal bandwidth of 160 MHz/km and 2.35 dB @ 1310 nm with a modal bandwidth of 500 MHz/km. Test as follows:
 - 1) Measure and record normalized fiber loss at operating wavelength in dB/km.
 - 2) Detect and record point faults or discontinuities.
 - 3) Measure and record overall length of cable.
- d) Certification report is to be provided listing both the calculated and measured loss for each fiber optic circuit and submitted with the test results as called for above.
 - 1) Wavelength, fiber type, fiber manufacturer and cable model number, cable manufacturer's attenuation specifications, cable manufacturers' bandwidth specifications, measurement direction, test equipment and serial numbers (with last date of calibration), date of each test, reference setup, name of technician(s) performing testing.
 - 2) OTDR trace(s) is to be submitted with request for substantial completion

3.3 DEMONSTRATION

- A. Provide one 2-hour training session to familiarize the owner with the locations of all IDF's, cable and jack labeling and number systems, data and voice connections.

END OF SECTION 271348

SECTION 275115 - INTERCOM, PUBLIC ADDRESS AND MUSIC SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDES

- A. Provision of New Dukane Carehawk Life Safety Communication System with intercom and public address added into new additions. Include provision of new speakers, call buttons and wiring in all buildings. Include all necessary modifications to existing building(s) systems and head-in equipment, raceways, outlet boxes and conductors where indicated on drawings.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION

- A. The equipment specified herein shall as a system provide a modular communications system capable of two way communications between classrooms and the main office with public address or all call capability and bell scheduling.

1.4 SUBMITTALS

- A. Submit under provisions of Section 260305.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.
- C. Product Data: Provide showing electrical characteristics and connection requirements for each component. Include data for the following:
 - 1. Classroom Speakers.
 - 2. Exterior Horn Speakers.
 - 3. Call Buttons.
 - 4. Wire and Cable.
 - 5. Equipment Panels.
- D. Test Reports: Indicate satisfactory completion of each test recommended by the manufacturer.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260305.

- B. Record actual locations of speakers, control equipment, and outlets for input/output connectors.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Section 260305.
- B. Operation Data: Include instructions for adjusting, operating, and extending the system.
- C. Maintenance Data: Include repair procedures and spare parts documentation.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience, and with service facilities within a 2 hour response time of project.
- B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.
- C. Installer: Authorized installer of specified manufacturer with service facilities within a 2 hour response time of Project.

1.8 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.
- C. Conform to requirements of Federal Communications Commission.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of public address and music system for three years from Date of Final Acceptance.

1.10 WARRANTY

- A. The Contractor shall warrant the equipment to be new and free from defects in material and workmanship and will, within five years from Date of Final Acceptance, repair or replace all or any part of the equipment found to be defective. Damage by lightning shall be included in the warranty. This warranty shall not apply if damage is caused by abuse, accident, improper operation, or negligence. Warranty maintenance shall be provided by the Contractor during his normal working hours at no expense to the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The Design Basis Intercom System is comprised of products of Carehawk Safety Communications 1985

Corporate Square, Longwood, FL 32750. The Design Basis System is a Carehawk model CH1000 Life safety Communication System.

- B. Substitutions: Not allowed.

2.2 INTERCOM COMMUNICATIONS SYSTEMS

- A. Provide a Carehawk model CH1000 Life safety Communication System.

2.3 LIFE SAFETY SYSTEM DESIGN:

- A. Only systems designed primarily as a LIFE SAFETY SYSTEM shall be considered. Life safety features shall include but not be limited to; priority based access to voice functions, emergency paging, emergency call-in, covert PC based call-in, pre-recorded emergency announcements, external and internal telephone access, integrated video surveillance, and optional district wide communication functions. Paging systems, traditional school intercom systems, or any system that does not include the above minimum features shall not be considered.
- B. The LIFE SAFETY SYSTEM shall be of a core design vintage dating from the year 2000 or later. LIFE SAFETY SYSTEMS that use designs dating from before the year 2000 shall not be considered.
- C. The LIFE SAFETY SYSTEM shall be an event driven design. LIFE SAFETY SYSTEMS using a polling method design shall not be considered.
- D. Microcontroller
 - 1. The LIFE SAFETY SYSTEM shall contain a central microcontroller capable of a minimum of 500 MHz processing speed to allow for the addition of future features. LIFE SAFETY SYSTEMS with microcontrollers that run less than 500 MHz shall not be considered.
 - 2. The LIFE SAFETY SYSTEM shall have flash based removable storage media of a size no smaller than 1 gigabyte. It shall be possible to remove the storage media from one system to another like system with no need to adjust the configuration files. LIFE SAFETY SYSTEMS that do not use removable flash based media or do not have at least 1 gigabyte of storage shall not be considered.
 - 3. The LIFE SAFETY SYSTEM shall have at least 512 Megabytes of system ram. Said RAM shall be removable and upgradable. LIFE SAFETY SYSTEMS that do not use removable RAM or cannot be upgraded not be considered.
- E. Central Cabinet
 - 1. The LIFE SAFETY SYSTEM shall contain natively RS232, RS485, USB, and Ethernet ports for communication to any third party system. LIFE SAFETY SYSTEMS that do not contain all of the above communication ports or require additional equipment shall not be considered.
 - 2. The LIFE SAFETY SYSTEM shall contain five open collectors, three dry contacts, and six general purpose inputs for third party system integration or for general panic buttons. It shall be possible to expand inputs or outputs to any number needed. LIFE SAFETY SYSTEMS not supporting the

minimum inputs and outputs or able to expand to any number shall not be considered.

3. The LIFE SAFETY SYSTEM central cabinet shall be a wall mounted. Total weight of the central cabinet shall not exceed 35 lbs. LIFE SAFETY SYSTEMS requiring floor racks or that weigh more than 35 lbs shall not be considered.
4. The LIFE SAFETY SYSTEM shall contain no moving parts that suffer from wear or that require maintenance. LIFE SAFETY SYSTEMS that contain moving parts shall not be considered.
5. The LIFE SAFETY SYSTEM shall draw no more than 3.5A of current at full load including all system accessories. LIFE SAFETY SYSTEMS that draw more than 3.5A of current at full load shall not be considered.
6. The LIFE SAFETY SYSTEM shall have integrated surge protection for all audio ports and switching/line card ports. Said surge protection shall be replaceable in the field with no need to return parts for repair. LIFE SAFETY SYSTEMS that require external surge protection shall not be considered.

F. Amplifiers

1. The LIFE SAFETY SYSTEM shall use Class D digital amplifier with at least 250 Watts RMS and 300 Watts peak output. Amplifier distortion shall not exceed 0.2% at 90% load. LIFE SAFETY SYSTEMS using Class B amplifiers or amplifiers not capable of 0.2% maximum distortion shall not be considered.
2. The Class D amplifier shall be direct drive 25V constant voltage type. LIFE SAFETY SYSTEMS using transformer based amplifiers shall not be considered.
3. The LIFE SAFETY SYSTEM shall filter all voice signals through a Digital Signal Processor (DSP) to maximize voice intelligibility. LIFE SAFETY SYSTEMS not using a DSP shall not be considered.
4. The LIFE SAFETY SYSTEM shall have 45 Ohm conversion modules available on a switching/line cards basis to convert the 25V audio signal to 45 Ohm for use with 45 Ohm speakers. LIFE SAFETY SYSTEMS not capable of conversion to 45 Ohm audio on a switching/line card basis shall not be considered.
5. The LIFE SAFETY SYSTEM amplifiers shall go to sleep thus reducing their current draw when not in use. LIFE SAFETY SYSTEMS that use amplifiers that do not reduce their current draw when not in use shall not be considered.
6. The LIFE SAFETY SYSTEM amplifiers shall have a built in pink noise generator for testing speaker quality and audio levels. LIFE SAFETY SYSTEMS that do not contain a pink noise generator shall not be considered.
7. A remote amplifier shall be provided, if required, to drive large groups of speakers or horns for paging purposes. The remote amplifier shall be model # DAF100-25 and/or DAF100-70 (25V and 70V models). The remote amplifier shall be interfaced to the SS16/SS32 using the CareHawk AT1.

G. Tones

1. The LIFE SAFETY SYSTEM shall have at least 25 tones available for bells, reminders, and other events. LIFE SAFETY SYSTEMS with less than 25 tones shall not be considered.
2. The LIFE SAFETY SYSTEM shall support WAV type audio files. The user shall be able to add 25+ custom WAV files for use as pre-recorded announcements, bells, reminders, pre-announce tones, or any other system tone. LIFE SAFETY SYSTEMS not allowing users to add WAV files or do not allow for the use of WAV files for any system tone shall not be considered.

H. Switching/Line Cards

1. The LIFE SAFETY SYSTEM shall support remote switching/line cards with 16 and 32 audio ports sizes available. A single central cabinet shall support up to eight 32 port cards. The switching/line card shall be powered from the central cabinet out to 2700 feet away from the central cabinet. LIFE SAFETY SYSTEMS that do not use remote switching/line cards or require additional power supplies shall not be considered. Provide SS16/SS32 Security Switching Cards in the quantities as required for the project.

I. Telephone Integration

1. The LIFE SAFETY SYSTEM shall support up to eight FXS Caller-ID enabled telephone ports. FXS ports shall be added as needed in single port configurations. FXS ports shall be used to interface with system Administrative phones, standard telephones, and PBX/KSU/iPBX/VoIP telephone systems. LIFE SAFETY SYSTEMS that use proprietary telephone ports for Administrative phones or cannot provide eight FXS ports for PBX/KSU/iPBX/VoIP telephone system integration shall not be considered.

J. Master Clock

1. The LIFE SAFETY SYSTEM shall contain an integral master clock. LIFE SAFETY SYSTEMS that do not have an integral master clock shall not be considered.
2. The LIFE SAFETY SYSTEM master clock shall correct Sapling, Dukane, Rauland, National time & Signal, American Time & Signal, Simplex, and Latham secondary clocks, analog or digital or both. LIFE SAFETY SYSTEM that do not correct all of the above clock systems shall not be considered.
3. The LIFE SAFETY SYSTEM master clock shall be capable of being synchronized by a Network Time Server (NTP). LIFE SAFETY SYSTEMS that do not synchronize to a NTP server shall not be considered.
4. The LIFE SAFETY SYSTEM master clock shall provide for automatic daylight saving time adjustment with leap year programming. LIFE SAFETY SYSTEMS that require user intervention for daylight savings events shall not be considered.
5. The LIFE SAFETY SYSTEM master clock shall support unlimited schedules with unlimited events on said schedules. LIFE SAFETY SYSTEMS that do not support unlimited schedules and events shall not be considered.

6. The LIFE SAFETY SYSTEM master clock shall be calendar based capable of future event programming at least 30 years in the future. LIFE SAFETY SYSTEMS not using a calendar shall not be considered.
7. The LIFE SAFETY SYSTEM master clock shall allow for scheduling tone events, output events, program source events, and video camera events. LIFE SAFETY SYSTEMS not capable of scheduling all of the above event types shall not be considered.

K. Security Integration

1. The LIFE SAFETY SYSTEM shall allow for the integration of motion sensors, glass break sensors, and door contacts in parallel with call buttons. Events from these sensors shall be capable of being programmed to activate pre-recorded WAV files, outputs, and cameras. LIFE SAFETY SYSTEMS that do not support integration of security sensors shall not be considered.

L. Video Surveillance

1. The LIFE SAFETY SYSTEM shall provide eight transmission paths and control of closed-circuit television (CCTV) UTP type cameras. LIFE SAFETY SYSTEMS that do not provide camera transmission paths shall not be considered.
2. The LIFE SAFETY SYSTEM shall support cameras connected on the same cable as speaker/call button ports. LIFE SAFETY SYSTEMS that require additional cabling for cameras shall not be considered.

2.4 LIFE SAFETY SYSTEM OPERATION

- A. The LIFE SAFETY SYSTEM shall allow for user-programmable room number assignment in the form of 3, 4, 5 or 6-digit alphanumeric format for architectural room numbering and a 60 character alphanumeric caller ID description associated with each audio port. LIFE SAFETY SYSTEMS that do not support caller-ID on all ports or require additional equipment to support caller-ID shall not be considered.
- B. The LIFE SAFETY SYSTEM shall allow for a minimum of 64 page/time/program zones that can be assigned and configured as desired. LIFE SAFETY SYSTEMS with less than 64 zones shall not be considered.
- C. The LIFE SAFETY SYSTEM shall allow for the assigning of each call-in button to one or more of 32 distinct call-in destination groups. LIFE SAFETY SYSTEMS with less than 32 call-in groups shall not be considered.
- D. The LIFE SAFETY SYSTEM administrative telephone shall allow for the user to view the alphanumeric room address and the caller-ID information of the calling station and the call priority (e.g., emergency, normal) on the display. The administrative telephone shall use distinctive ringing patterns to annunciate the type of call. LIFE SAFETY SYSTEMS that do not support caller-ID or call priority shall not be considered.
- E. The LIFE SAFETY SYSTEM shall be capable of receiving 2048 call-ins simultaneously without data collisions or loss of any call-ins. Call-ins shall remain in the system call queue until answered. Emergency Call-ins shall automatically move to the top of the call-in queue and annunciated in the in-

- use telephone earpiece to notify the user of an emergency call. LIFE SAFETY SYSTEMS that do not maintain a system call queue or do not prioritize call-ins shall not be considered.
- F. The LIFE SAFETY SYSTEM shall communicate with each classroom loudspeaker hands-free. The staff member or occupant in the classroom need not operate any buttons to reply to a call. The Administrative telephone operator shall be able to use the hands-free speaker phone or handset on an Administrative telephone. LIFE SAFETY SYSTEMS requiring “push to talk” shall not be considered.
 - G. The LIFE SAFETY SYSTEM shall communicate with each classroom phone. The classroom phone shall be integrated with the classroom speaker. If the staff member or occupant in the classroom lifts the classroom phone while in communication over the classroom loud speaker classroom audio will automatically be transferred to the classroom phone. LIFE SAFETY SYSTEMS that do not have loudspeaker-classroom phone integration shall not be considered.
 - H. The LIFE SAFETY SYSTEM shall be capable of classroom phones that can dial emergency personnel in case of an emergency. The classroom phone shall have an integrated dial pad. LIFE SAFETY SYSTEMS that do not support classroom phones with dial pads shall not be considered.
 - I. The LIFE SAFETY SYSTEM shall operate under the following audio priority scheme. LIFE SAFETY SYSTEMS not following the audio priority scheme listed below shall not be considered.
 - 1. An emergency page suspends all other audio
 - 2. An emergency tone suspends all other audio except the above
 - 3. A normal page suspends all other audio except the above
 - 4. A tone suspends all other audio except the above
 - 5. A program source audio event suspends nothing
 - 6. Interrupted lower priority functions shall be restored after conclusion of the higher priority function.
 - J. The LIFE SAFETY SYSTEM shall allow a call-in to be escalated from a normal call-in to an emergency call-in at any time by pressing the call button twice within 2 seconds. LIFE SAFETY SYSTEMS that do not allow for call escalation shall not be considered.
 - K. The LIFE SAFETY SYSTEM shall allow for any connected telephone to place an emergency voice paging announcement. LIFE SAFETY SYSTEM that restricts access to emergency paging shall not be considered.
 - L. The LIFE SAFETY SYSYEM shall allow the activation of connected dormant cameras based on an emergency call-in, security sensor activation, or telephone code. LIFE SAFETY SYSTEMS not allowing for integrated emergency camera functions shall not be considered.
 - M. The LIFE SAFETY SYSTEM shall allow for operation via a GUI based PC based application. The PC application shall allow for emergency paging, normal paging, intercom, activation of any system/user tone, schedule changes, program distribution, call-in management, and on the fly room exclusion. LIFE SAFETY SYSTEMS that do not support PC based control shall not be considered.

- N. The LIFE SAFETY SYSTEM shall use a PC based GUI scheduling tool for schedules and tone management. This tool shall not allow access to any system configuration controls. This tool shall not prevent the LIFE SAFETY SYSTEM from operating when being used. This tool shall allow the user to schedule events and manage tones over the local LAN/WAN and the Internet. It shall not be required to be directly connected to the central system to use this tool. LIFE SAFETY SYSTEMS that do not separate scheduling and tone functions from any other configuration functions or cannot be used over LAN/WANs or the Internet shall not be considered.
- O. The LIFE SAFETY SYSTEM shall have a built in 30 day log of every system function and access. LIFE SAFETY SYSTEMS not having a 30 day log shall not be considered.
- P. The LIFE SAFETY SYSTEM shall have a built in real time system diagnostics application. LIFE SAFETY SYSTEMS that do not have any real time system diagnostics shall not be considered.
- Q. The LIFE SAFETY SYSTEM shall allow for system diagnostics, system log access firmware updates, and programming over the local LAN/WAN or over the Internet. LIFE SAFETY SYSTEMS not providing all of the above functions shall not be considered.

2.5 LOUDSPEAKERS

- A. Each classroom and other designated room shall be provided with a room loudspeaker. Eight (8) inch loudspeakers shall be provided in each classroom, staff area, administration area, hallways, common areas and as designated on plans.
- B. Classroom loudspeaker shall be Quam Model SOLUTION 1 or approved equal. The loudspeaker shall be an interior grade, ceiling tile mount, complete loudspeaker assembly consisting of a 22 gage perforated steel baffle, fastened to a Factory installed loudspeaker and transformer, steel support bridge and steel UL Listed back can. Finish of the baffle shall be white baked epoxy hybrid. The loudspeaker shall be 8" O.D., the transducer voice coil shall be 19 mm (0.75 in) O.D.; the loudspeaker cone shall be constructed of molded paper fiber. The loudspeaker assembly shall be equipped with an integral dual voltage line transformer for either 25V or 70.7V systems. Five tap levels shall be available at 5W, 2.5W, 1.25W, 0.63W and 0.31W. Tap selection is by selecting and energizing color coded wire pigtail leads on the rear of the enclosure. Performance measurement and specification of a typical production unit shall conform to EIA 426A standards: Sensitivity (SPL at 1m [3.3 ft] with 2.83V input, averaged from 100 Hz to 10 kHz) shall be at least 92 dB-SPL. Usable frequency response shall extend from 65 Hz to 17 kHz (10 dB below rated sensitivity) with no external equalization. Rated power for nominal 8-Ohm unit shall be at least 12 W continuous pink noise. The loudspeaker assembly shall have a nominal conical polar coverage pattern of 90 degrees (at -6 dB point), averaged 500 Hz to 10 kHz. The complete loudspeaker assembly, shall weigh no more than 5 kg (11 lb). Packaging: Two complete loudspeaker assemblies in one shipping carton.
- C. Weatherproof Loudspeakers shall be Quam Model QH16T or approved equal. The loudspeaker shall be a double re-entrant trumpet type, consisting of a single compression-type transducer, installed in Factory assembled integral metal enclosure with integral metal projector bell. The loudspeaker will be furnished complete with adjustable, universal metal mounting flange. Finish: Tan enamel. The transducer voice coil shall be 25 mm (1.0 in) in diameter; the diaphragm shall be weather resistant phenolic composite. The loudspeaker assembly shall be equipped with an integral dual voltage line transformer for either 25V or 70.7V systems. Tap selection is by selector switch; four tap levels shall be

available for 70.7V operation at 16W, 8W, 4W and 2W. Five tap levels shall be available for 25V operation at 16W, 8W, 4W and 2W and 1W. Audio connection to the loudspeaker is by binding head screw in an integral weather-resistant compartment. Performance measurement and specification of a typical production unit shall conform to EIA 426A standards:

1. Sensitivity (SPL at 1m [3.3 ft] with 2.83V input, averaged from 100 Hz to 10 kHz) shall be at least 110 dB-SPL. Usable frequency response shall extend from 300 Hz to 15 kHz (10 dB below rated sensitivity) with no external equalization.
2. Rated power for nominal 8 ohm unit shall be at least 16 W continuous pink noise.
3. The loudspeaker shall have a nominal conical polar coverage pattern of 110 degrees (at -6 dB point), averaged 500 Hz to 10 kHz. Overall trumpet bell diameter shall not exceed 225 mm (8.88 in), front to rear dimension shall not exceed 235 mm (9.19 in), the integral mounting flange shall be no smaller than 80mm (3.13 in). The loudspeaker shall weigh no more than 4.5 kg (10 lb).

- D. Attenuators shall be Quam Model QC10 or approved equal. The QC10 is a UL listed, single gang, 20W, ten-step, continuous rotary, audio level attenuator with an OFF position. Brushed, stainless steel faceplate with embossed positions and a black knob with white indicator mark.

2.6 CLASSROOM CALL-IN BUTTON

- A. The LIFE SAFETY SYSTEM shall allow for the use of normally open, normally closed, wireless, and virtual call buttons. LIFE SAFETY SYSTEMS not capable of using all of the above call button types shall not be considered.
- B. The LIFE SAFETY SYSTEM shall allow for the use of virtual call buttons installed on local PC computers. LIFE SAFETY SYSTEMS that do not support virtual call buttons shall not be considered.

2.7 MATCHING TRANSFORMERS

- A. Description: Tapped at ½, 1 and 2 watts with primary/secondary ratio to match amplifier to speaker impedances.

2.8 VOLUME PADS

- A. Description: Transformer type rated 10 watts.

2.9 WIRE AND CABLE

- A. The LIFE SAFETY SYSTEM shall use CAT-6 unshielded cabling.
- B. The LIFE SAFETY SYSTEM shall be capable of using two wire conductors for a speaker and call button referred from herein as a 2-wire circuit. It shall be possible to mix 2-wire and standard 4-wire circuits on the same switching/line card. LIFE SAFETY SYSTEMS that cannot mix 2-wire and 4-wire circuits on the same switching/line card shall not be considered. LIFE SAFETY SYSTEMS that require more than two conductors or require shielded cable shall not be considered.
- C. It shall be possible to distribute the switching/line cards of the LIFE SAFETY SYSTEM up to 2700 feet using a single home run eight conductor cable. LIFE SAFETY SYSTEMS that require networking of multiple central systems to be distributed shall not be considered. LIFE SAFETY SYSTEMS that require the use of Ethernet components to bridge the 2700 foot distance shall not be considered.

- D. It shall be possible to network the LIFE SAFETY SYSTEM with additional systems using copper wire, single mode fiber optic and multimode fiber optic cables. LIFE SAFETY SYSTEMS that do not allow for the use of fiber optic cable shall not be considered.
- E. Interior cabling shall be CAT-6 unshielded 22 awg cable.
- F. Exterior cabling shall be fiber optic conductors between buildings provided as a part of the Fiber Optic Cable System. Provide all necessary hardware in the LIFE SAFETY SYSTEM necessary to use fiber optic cable to communicate between buildings.
- G. Provide fiber optic patch cords to connect the LIFE SAFETY SYSTEM equipment to the Fiber Optic Cable System. Patch cords shall be multimode, 62.5/125 micron, duplex fiber optic cable with two (2) SC style connectors at one end. Connectors at the opposite end shall be selected as required to connect to the LIFE SAFETY SYSTEM equipment. Provide Cord length as required to connect LIFE SAFETY SYSTEM equipment to the Fiber Optic Cable System using conduit routed above Systems room ceilings.

2.10 TERMINAL BLOCKS

- A. All intercom cables shall be terminated using CAT-6 RJ45 jacks and connected to CAT-6 RJ 45 patch panels. located in an Intercom Panel.

2.11 TERMINAL BLOCK ENCLOSURES

- A. NEMA 250, Type 1 steel enclosure.
- B. Continuous hinge cover with flush latch and key lock.
- C. Interior metal panel, for terminal block mounting, painted with white enamel.
- D. Enclosure finish: Manufacturer's standard gray enamel.
- E. Minimum size: 12"W x 18"H x 6"D.

PART 3 -EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mounting Heights: Coordinate locations of outlet boxes specified in Section 260533 to obtain mounting heights indicated.
- C. Wall-mounted Speaker: 7 feet above finished floor.
- D. Call-in Switches: 4 feet above finished floor.
- E. Terminal Block Enclosures: 5 feet - 6 inches above finished floor to top of cabinet.

- F. Terminate all cable only at terminal block enclosures and end use equipment. Do not splice conductors.
- G. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
- H. Install input circuits in separate cables and raceways from output circuits.
- I. Leave 18 inches excess cable at each termination at microphone, volume pad, speaker, and other system outlet.
- J. Leave 6 feet excess cable at each termination at system cabinet
- K. Provide protection for exposed cables where subject to damage.
- L. Connect reproducers to amplifier with matching transformers.
- M. Install equipment racks in location shown; arrange to provide adequate ventilation and access.
- N. Ground and bond equipment and circuits in accordance with Section 260526.
- O. Install all wiring in conduit. Conduit shall be adequate size for cables installed therein.
- P. Install fiber optic patch cords in conduit.
- Q. Install antenna on roof where not visible from ground level . Wall mount antenna above roof and above column line 7 near mid point between column line CC and DD. Provide conduit and RG-6 cable from wall outlet box to LIFE SAFETY SYSTEM equipment.

3.2 ADJUSTING

- A. Adjust transformer taps for appropriate sound level.
- B. Adjust devices and wall plates to be flush and level.

3.3 TESTING

- A. Upon completion of the installation, the system must be tested by the manufacturer's representative and all necessary modifications and/or adjustments must be made to assure compliance with this specification.

3.4 SURGE SUPPRESSION

- A. Provide transient voltage surge suppression protection according to Section 263555, "Transient Voltage Surge Suppression" on all TV cables between buildings and at all buildings.

3.5 DEMONSTRATION

- A. Conduct walking tour of Project. Briefly describe function, operation, and maintenance of each

component.

- B. Use submitted operation and maintenance manual as reference during demonstration.

END OF SECTION 275115

SECTION 283100 - FIRE ALARM AND SMOKE DETECTION SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm and smoke detection systems.

1.2 WORK INCLUDES

- A. Section includes complete new fire alarm system with, addressable control panel, fire alarm terminal cabinets, manual fire alarm stations, automatic smoke and heat detectors, fire alarm signaling appliances, and auxiliary fire alarm equipment and power and signal wire and cable.

1.3 REFERENCES

- A. NFPA 72 - 2013 National Fire Alarm Code.
- B. NFPA 101 - 2015 Life Safety Code.
- C. Florida Fire Prevention Code - Sixth edition.

1.4 REGULATORY REQUIREMENTS

- A. System: UL and FM listed.
- B. Conform to requirements of NFPA 101.

1.5 SYSTEM DESCRIPTION

- A. Make new connections to the existing EST EST3X Life Safety Control System main control panel, with voice evacuation, in the school EHPA Office, located in Building 2, with all new devices and wiring.
- B. Provide EST EST3X Life Safety Control System fire alarm remote panels in Buildings 7 and 8.
- C. Fire Alarm System: NFPA 72, manual and automatic local fire alarm system.
 - 1. The system supplied under this specification shall be a new UL Listed modular fire alarm network that uses independently addressed fire detection devices, input/output control modules, amplifiers and speakers.

The network shall utilize token ring, peer-to-peer communications. The network shall consist of a main panel and remote control panels. To enhance survivability, each panel shall be an equal, active functional member of the network, capable of making all local decisions and initiating network tasks for other panels. In the event of a panel failure or communications failure between panels, panels shall be capable of forming sub-networks and remain operational between communicating panels. Master/slave system configurations shall not be considered as equal.

The system shall be fully field programmable such that virtually any combination of system output

functions may be correlated to any type of input event(s). Inputs may be combined using Boolean logic, be time dependent or under manual control, as defined by required system operation. All software operations are to be stored in a non-volatile programmable memory within the fire alarm control panels. There shall be no limit, other than maximum system capacity, as to the number of addressable devices which may be in alarm simultaneously.

Addressable smoke detector sensitivity settings for both pre-alarm and alarm activation shall be automatically individually configurable for both daytime and nighttime operation. Addressable smoke detectors shall be UL listed for automatic sensitivity testing.

Ease of maintenance shall be facilitated by the use of panel based and PC based system diagnostics.

1. The system shall automatically test smoke detector sensitivity, eliminating the need for manual sensitivity testing.
2. Ground fault detection and annunciation shall be by individual module address for supervised input and output devices.
3. System test operation shall be configurable by individual addressable devices, and not disable entire circuits.
4. The system shall be capable of generating a graphical map of connected all addressable devices to aide in circuit troubleshooting.
5. Placement supervision of addressable devices shall couple a device's location (not its address) to the programmed system response.

The system shall provide a one-way multi-channel emergency communication sub-system for the distribution of emergency messages to facility occupants.

The system shall support CO and security detection devices with appropriate independent annunciation and signal processing.

System panels and annunciators shall utilize configurable message routing and selective event messaging to direct event information only to the required system displays and printers as determined by the event type and location.

D. Fire Alarm Performance:

1. The system shall identify all off normal conditions and log each condition into the system as an event.
 - a. The system shall automatically display on the control panel Liquid Crystal Display (LCD) the first (oldest) event of the highest priority by type and the most recent event. The event priority shall be alarm, supervisory, trouble, and monitor.
 - b. The system shall utilize four sequential event queues.
 - c. For each event, the display shall include the event number, the type of event, a 40 character custom user description, and acknowledgement status.
 - d. The user shall be able to review the event queue using the rotary controller.
 - e. New alarm, supervisory, or trouble events shall sound a distinct, silenceable audible signal at the control panel.
 - f. The LCD shall show the system time and the number of active and disabled points in the system, and the number of events in the alarm, supervisory, trouble and monitor queues.
 - g. Specific input/output devices shall operate in accordance with the alarm, supervisory, trouble, monitor sections that follow and the input/output matrix.
2. All critical systems, sub-systems and circuits shall be monitored for integrity. System faults shall be

- annunciated.
3. Strobes shall be synchronized on each floor.
 4. Batteries shall be sized to support the system for 24 Hrs. of standby operation followed by 15 minutes of alarm operation at the end of the 24 Hour period.
 5. Off premises reporting of the loss of AC mains power to any system component shall be automatically delayed for a period of time acceptable to the AHJ to reduce traffic at the central monitoring station due to wide-area power failures.
 6. The system shall provide configurable service groups to facilitate "one man" testing of the system based on the physical layout of the building. Each service group shall be capable of supporting any combination of system devices, independent of the circuit on which they are installed. Systems that disable entire circuits, circuits serving multiple floors or fire zones for testing shall not be considered as equal. Activated devices on a service group shall be capable of initiating alternative system test responses to facilitate system maintenance and minimizing occupant disturbances while in test mode.
 7. Event processing and display shall be prioritized as follows:
 - a. Fire alarms
 - b. Supervisory events
 - c. Trouble events
 - d. Monitor events
 8. The system supplied under this specification shall be a new UL Listed modular fire alarm network that uses independently addressed fire detection devices, input/output control modules, amplifiers and speakers.
 9. The network shall utilize token ring, peer-to-peer communications. The network shall consist of a main panel and remote control panels. To enhance survivability, each panel shall be an equal, active functional member of the network, capable of making all local decisions and initiating network tasks for other panels. In the event of a panel failure or communications failure between panels, panels shall be capable of forming sub-networks and remain operational between communicating panels. Master/slave system configurations shall not be considered as equal.
 10. The system shall be fully field programmable such that virtually any combination of system output functions may be correlated to any type of input event(s). Inputs may be combined using Boolean logic, be time dependent or under manual control, as defined by required system operation. All software operations are to be stored in a non-volatile programmable memory within the fire alarm control panels. There shall be no limit, other than maximum system capacity, as to the number of addressable devices which may be in alarm simultaneously.
 11. Addressable smoke detector sensitivity settings for both pre-alarm and alarm activation shall be automatically individually configurable for both daytime and nighttime operation. Addressable smoke detectors shall be UL listed for automatic sensitivity testing.
 12. Ease of maintenance shall be facilitated by the use of panel based and PC based system diagnostics.
 - a. The system shall automatically test smoke detector sensitivity, eliminating the need for manual sensitivity testing.
 - b. Ground fault detection and annunciation shall be by individual module address for supervised input and output devices.
 - c. System test operation shall be configurable by individual addressable devices, and not disable entire circuits.
 - d. The system shall be capable of generating a graphical map of connected all addressable devices to aide in circuit troubleshooting.
 - e. Placement supervision of addressable devices shall couple a device's location (not its address) to the programmed system response.

13. The system shall provide a one-way multi-channel emergency communication sub-system for the distribution of emergency messages to facility occupants.
 14. The system shall support CO and security detection devices with appropriate independent annunciation and signal processing.
 15. System panels and annunciators shall utilize configurable message routing and selective event messaging to direct event information only to the required system displays and printers as determined by the event type and location.
- E. Supervisory Operation: Upon supervisory activation of any sprinkler valve supervisory switch, waterflow switch, duct smoke detector, smoke damper smoke detector, clean agent fire suppression system trouble, the following functions shall automatically occur:
1. The internal supervisory event audible device shall sound at the control panel.
 2. Display the event on the graphical workstation and display a pictorial image.
 3. The LCD display shall indicate all applicable information associated with the supervisory condition including; zone, device type, device location and time/date.
 4. All system activity/events shall be documented on the system printer and logged to system history.
 5. Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.
 6. Transmit signal to the central monitoring station with point identification.
- F. Alarm Sequence of Operation: Actuation of initiating device causes the following system operations:
1. Local fire alarm signaling devices sound and display signal.
 2. Location of alarm device indicates on fire alarm control panel.
 3. Signal transmits to building mechanical controls, shutting down fans and operating dampers in all Buildings.
- G. Duct Smoke Detector Operation: Activation of a duct smoke detector at any AHU causes the following system operations:
1. Initiate all operations listed in paragraph F. above.
 2. Initiate signal to shut down the AHU containing the alarming duct detector and all other AHUs in the same building.
- H. Smoke Damper Smoke Detector Operation: Activation of a smoke damper smoke detector causes the following system operations:
1. Initiate all operations listed in paragraph F. above.
 2. Initiate signal to shut down the specific AHU supplying air to the smoke damper and all other AHUs in the same building.
 3. Initiate signal to close all smoke dampers in the building housing AHUs.
- I. Drill Sequence of Operation: Manual drill function causes alarm mode sequence of operation.
- J. Trouble Sequence of Operation: Upon activation of a trouble condition or signal from any device or internal system integrity monitoring function on the system, the following functions shall automatically occur:
1. The internal panel audible device shall sound at the control panel.
 2. Display the event on the graphical workstation and display a pictorial image.
 3. The LCD keypad display shall indicate all applicable information associated with the trouble condition including; zone, device type, device location and time/date.

4. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not prevent the logging of trouble events to the historical file.
 5. All system activity/events shall be documented on the system printer and logged to system history.
 6. Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated.
 7. Transmit a trouble signal to the central monitoring station with point identification.
- K. Monitor Operation: Upon activation of any device connected to a monitor circuit, the following functions shall automatically occur:
1. The internal panel audible device shall sound at the control panel.
 2. The LCD display shall indicate all applicable information associated with the status condition including; zone, device type, device location and time/date.
 3. Any remote or local annunciator LCD/LED's associated with the monitor circuit shall be illuminated.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with five years documented experience.
- B. Installer: Company specializing in smoke detection and fire alarm systems with 2 years documented experience, certified as fire alarm installing contractor.

1.7 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260305. Submit Manufacturer's catalog data, to include material description, agency approvals, operating characteristics, electrical characteristics, dimensions, mounting requirements and accessories. Product data sheets for system components shall be highlighted to indicate the specific products, features, or functions required to meet this specification.
- B. Alternate or as-equal products submitted under this contract shall provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
- C. Provide wiring diagrams, data sheets, and equipment ratings, layout, dimensions, and finishes. Provide device floor plans for all areas served by the fire alarm system. Floor plans shall indicate accurate locations for all control and peripheral devices. Drawings shall be NO LESS THAN 1/8-INCH SCALE. If individual floors need to be segmented to accommodate the 1/8" scale requirements, KEY PLANS and BREAK-LINES shall be provided on the plans in an orderly and professional manner.
 1. All addressable devices shall be shown. Coordinate the device address with the same device shown on the riser diagram.
 2. Identify all notification appliances with a circuit and item number. Coordinate the circuit and item number with the same device shown on the riser diagram.
 3. Show all raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.

Include a device riser diagram, Control panel drawing(s) and typical device wiring diagrams that show all system components, and the respective field wiring. Wire type, gauge, and jacket shall be indicated. When an addressable module is used in multiple configurations for monitoring or controlling equipment, provide a drawing for each application. End-of-line resistors (and values) shall be shown.

- D. Submit manufacturer's installation instructions under provisions of Section 260305. Manufacturer's product installation sheets: A copy of the documentation that is required to be shipped with all listed products by UL.
- E. Submit manufacturer's certificate under provisions of Section 260305, that system meets or exceeds specified requirements.
- F. Calculations:
 - 1. Battery Capacity: Provide battery capacity calculations for each power supply that uses batteries for secondary power. Identify all loads. Identify any loads shed during alarm operation. Use the manufacturer's recommended methods and/or forms.
 - 2. For each 24VDC NAC, provide worst case voltage drop calculations. The load shall be treated as a lump sum at the end of the circuit. Worst case power supply terminal voltage shall include all applicable internal power supply losses. Using 85% of nominal circuit voltage (20.4VDC) shall not be accepted as lowest terminal voltage without manufacturer's published documentation stating there are no internal losses in the power supply.
 - 3. Audio (Speaker) Notification Appliance Circuits - Interior: The system shall be designed for interior building audibility level of 15 dBA-fast over ambient condition and intelligibility. Intelligibility shall be designed to maintain Common Intelligibility Standard (CIS) rating of 0.7 or Sound Transmission Index of 0.5 in all areas designated on the drawings to have intelligible audio. Provide dB loss calculations for all audio (speaker) notification appliance circuits. Circuits shall be designed for no more than 0.5 db loss based on lump-sum load method. All areas required to meet intelligibility requirements shall be modeled in a recognized computer modeling program such as EASE by Renkus-Hienz. All modeling output data shall be part of the submittal.
 - 4. High Power Speaker Arrays - Exterior: HPSAs shall be designed for an audibility level of 15 dBA-fast over ambient condition and intelligibility. Intelligibility shall be designed to maintain Common Intelligibility Standard (CIS) rating of 0.7 or Sound Transmission Index of 0.5 in outdoor areas during normal weather conditions. Intelligibility may be less than 0.7 CIS in areas of the zone if it can be determined that a voice signal is being broadcast and an individual could walk less than 164 feet to find a location in the zone with at least 0.7 CIS. Values of 0.65 through 0.74 shall be rounded to 0.7.

1.8 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 260305.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include manufacturer representative's letter stating that system is operational.

1.9 CLOSEOUT

Two (2) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance.

- A. Project specific operating and maintenance manuals covering the system as installed. The manuals shall contain a description of the system architecture, inputs, notification signaling, auxiliary functions, annunciation, sequence of operations, expansion capability, application considerations and limitations. A generic instruction and operation manual shall not be acceptable.

- B. Technical literature (manufacturer's data sheets and installation manuals/instructions) for all parts of the system, including control panels, smoke detectors, batteries, manual stations, alarm notification appliances, power supplies, and remote alarm transmission means.
- C. Software and Firmware Operational Documentation:
THE END-USER SHALL RETAIN COMPLETE RIGHTS AND OWNERSHIP TO ALL SITE-SPECIFIC SOFTWARE RUNNING IN THE SYSTEM. The fire alarm equipment supplier shall provide hard and soft copies of the software database to the end-user at the end of the warranty period. The database provided shall be useable by any authorized and certified distributor of the product line, and shall include all applicable passwords necessary for total and unrestricted use and modification of the database.
- D. Drawings
Provide "As Built" drawings of record of all the shop drawings used in the installation of the system. Refer to the Submittals - Shop Drawings section of this specification for drawing requirements.
- E. Record of Completion
System supplier and contractor shall provide a certified test report to verify that the system and all components functioned properly and as intended.
A filled out Record of Completion similar to NFPA 72, 2007 edition figure 4.5.2.1 shall be provided.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site and store and protect products from adverse weather.

1.11 EXTRA MATERIALS

- A. Provide the following spare parts:
- B. Provide two keys of each type.

1.12 WARRANTY

- A. The Contractor shall warrant the equipment to be new and free from defects in material and workmanship and will, within five years from Date of Final Acceptance, repair or replace all or any part of the equipment found to be defective. Damage by lightning shall be included in the warranty. This warranty shall not apply if damage is caused by abuse, accident, improper operation, or negligence. Warranty maintenance shall be provided by the Contractor during his normal working hours at no expense to the Owner.
- B. Provide copies of the warranty documentation as detailed in the Warranty section of this specification.
- C. Provide the name, address and telephone of the authorized factory representative.

1.13 TRAINING

- A. Provide 16 hours of training in multiple sessions, each not to exceed 8 hours in length.
- B. Use approved shop drawings and operation and maintenance data to detail normal and emergency operation and repair procedures.

PART 2 - PRODUCTS

2.1 Acceptable Manufacturers

- A. The catalog numbers used are those of Edwards Systems Technologies, or approved equal, and constitute the type and quality of equipment to be furnished.
- B. Acceptable manufacturers are Edward Systems Technologies and Silent Knight.
- C. If equipment of another manufacturer is to be submitted for approval as equal, the contractor shall, at the time of bid, list all exceptions taken to these specifications, all variances from these Specifications and all substitutions of operating capabilities or equipment called for in these specifications and forward said list to the engineer. Any such exceptions, variances or substitutions not listed at the time of bid and are subsequently identified in the submittal, shall be grounds for immediate disapproval without comment. Final determination of compliance with these specifications shall rest with the engineer, who, at his discretion, may require proof of performance.
- D. Alternate product submissions shall provide proof of no less than three (3) factory authorized and certified manufacturer's distributors within 50 miles of the project job site. These distributors shall provide installation support, shall have a service organization capable of 24 hour emergency call service and SHALL HAVE BEEN CONTRACTED AND DELIVERED NO LESS THAN FIVE (5) SIMILIAR PROJECTS USING THE SUBMITTED PRODUCT OVER THE PAST YEAR. Alternate submissions without the required references shall be rejected.
- E. Alternate product submissions based upon use of a product line considered proprietary in its distribution, design, application software, or ongoing maintenance and repair shall not acceptable. Proof of a product's non-proprietary nature shall be the burden of the contractor at the time of bid, and shall be in the form of written documentation. The determination of a product's compliance to this requirement shall be exclusively that of the engineer.
All products used shall be of a single manufacturer. All products shall be listed by the manufacturer for their intended purpose. Submission of notification appliances, auxiliary relays, or documentation from other than a single manufacturer shall not be acceptable and will be grounds for immediate disapproval without comment.

2.2 Fire Alarm Panel

A. General - Fire3X

1. Overview

All materials, equipment, accessories, devices and other facilities and appurtenances covered by these specifications or noted on the drawings shall be new, best suited for the intended use and shall conform to applicable and recognized standards for their use, and supplied by a single manufacturer. Should any equipment provided under this specification be supplied by a different manufacturer, that equipment shall be recognized compatible by BOTH manufacturers and listed as such as required by Underwriters' Laboratories.

The fire alarm control panel(s) shall be a multi-processor based networked system designed specifically for fire, one-way emergency audio communications, smoke control, extinguishing agent

releasing system, and guard patrol applications. The control panel shall be listed and approved for the application standard(s) as listed in the References section of this specification.

The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured, and modified using software provided by the manufacturer. The control panel(s) operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The operating controls shall be located in a steel enclosure behind a locked door with viewing window. All control modules shall be labeled, and all zone locations shall be identified. All panel modules shall be placement supervised for and signal a trouble if damaged or removed.

2. System Features

Each control panel shall include the following capabilities:

- Supervision of the system electronics, wiring, detection devices and software
- Up to 1500 analog/addressable input/output points
- Network connections with up to 8 other control panels.
- Support multiple dialers (DACTs) and modems
- An RS-232 serial communication port
- An internal audible signal with different patterns to distinguish between alarm, supervisory, trouble and monitor events
- Support four 24 VDC and eight channel Audio NACs
- NACs
- User configurable switches and LED indicators to support auxiliary functions
- Log up to 1100 chronological events
- The ability to download all applications and firmware from the configuration computer at a single location on the fire network
- A real-time clock for time stamps and timed event control
- Electronic addressing of intelligent addressable devices
- Provide an independent hardware watchdog to supervise software and CPU operation
- “Dry” alarm, trouble and supervisory relay contacts
- An optional 10/100 Base-T Ethernet port for network programming, diagnostics and monitoring.
- Control panel modules shall plug in to a chassis assembly for ease of maintenance
- Field wiring shall connect to the panel using removable connectors

3. User Oriented Features

Each control panel shall include the following user oriented features:

- An LCD user interface control/display that shall annunciate and control system functions.
- Provide discreet system control switches for reset, alarm silence, panel silence, and acknowledge.
- A Rotary Control shall be provided to simplify scrolling through the display and entering data.
- A “lamp test” feature shall verify operation of all visual indicators on the panel.
- An authorized user shall have the ability to operate or modify system functions including system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
- An authorized user shall have the ability to disable/enable devices, zones, actions, timers and sequences.
- An authorized user shall have the ability to activate/restore outputs, actions, sequences, and simulate detector smoke levels.

An authorized user shall have the ability to enter time and date, reconfigure an external port for download programming, initiate programming and change passwords.

An authorized user shall have the ability to test the functions of the installed system.

Service groups shall facilitate one-man walk testing. Service/test groups shall be capable of being configured with any combination of addressable devices, independent of SLC wiring. It shall be possible to program alternate device responses when the device's service group is active. Devices not in an active service group shall process all events normally.

Provide internal system diagnostics and maintenance user interface controls to display/report the power, communication, and general status of specific panel components, detectors, and modules.

SLC loop controller diagnostics shall identify common alarm, trouble, ground fault, Class A fault, and map faults. Map faults include wire changes, device type changes by location, device additions/deletions and conventional open, short, and ground conditions. Ground faults on the supervised circuit wiring of remote addressable modules shall be identified by device address.

An authorized user shall have the ability to generate a report history for alarm, supervisory, monitor, trouble, smoke verification, watchdog, and restore activity.

System reports shall provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.

An authorized user shall have the ability to display/report the condition of addressable analog detectors. Reports shall include device address, device type, percent obscuration, and maintenance indication. The maintenance indication shall provide the user with a measure of contamination of a device upon which cleaning decisions can be made.

4. Programmability

A Windows-based Configuration Utility (CU) shall be used to create the site-specific system programming. The utility shall facilitate programming of any input point to any output point. The utility shall allow customization of fundamental system operations using initiating events to start actions, timers, sequences and logical algorithms.

- Zoning of initiation devices.
- Initiation of events by time of day, day of week, day of year.
- Initiation of events by matrix groups (X-Y coordinate relationships) for releasing systems.
- Initiation of events using OR, AND, NOT and counting functions.
- Prioritizing system events.
- Programmable activation of detector sounder bases by detector, groups of bases, or all bases.
- Directing selected device messages to specific panel annunciators
- Detector sensitivity selection by time of day
- Support of 256 Central Monitoring Station accounts and directing selected device messages to any one of ten Central Monitoring Stations.

The configuration utility shall time and date stamp all changes to the site-specific program, and shall facilitate program versioning and shall store all previous program version data. The utility shall provide a compare feature to identify the differences between different versions of the site-specific program.

The configuration utility shall be capable of generating reports which detail the configurations of all fire alarm panels, addressable devices and their configuration settings including generating electrical maps of the addressable device SLCs.

The configuration utility shall support the use of bar code readers to expedite electronic addressing and custom programming functions.

The fire alarm control panel shall be an Edwards EST3X or Approved Equal.

2.3 Power Supply3X

- A. System power supply(s) shall be a high efficiency switched mode design providing four (4) supervised power limited 24 VDC output circuits as required by the panel and external loads fed by the panel. Initial power supply loading shall not exceed 80% of power supply capacity in order to allow for future system expansion.
- B. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
- C. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system functionality. When powered from batteries, the power supply shall employ "Voltage Boost" technology to insure that output voltage never drops below 22.5 VDC regardless of battery voltage.
- D. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
- E. All standby batteries shall be continuously monitored by the power supply. The power supply shall be able to perform an automatic test of batteries and indicate a trouble condition if the batteries fall outside a predetermined range. Power supplies shall incorporate the ability to adjust the charge rate of batteries based on ambient temperatures. The power supply shall automatically disconnect the battery before low voltage damages the battery. Low battery and disconnection of battery power supply conditions shall immediately annunciated as battery trouble.
- F. Batteries shall utilize sealed lead acid chemistry. Initial battery capacity shall provide 125% of calculated capacity requirements in order to allow for future system expansion.
- G. All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of NFPA 70 and NFPA 72. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel the disconnect serves.
- H. The power supply shall be an Edwards PS10-4B or Approved Equal.

2.4 User Interface

- A. Panel LCD and Common Controls3X

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the facility.

Each fire alarm control panel (system node) shall be capable of supporting a backlit LCD display. The display on each system node shall be configurable to *display* the status of any and/or all combinations of all alarm, supervisory, trouble, monitor, or service group event messages on the network. Each LCD display on the system shall be capable of being programmed to allow *control* functions of any combination of nodes on the entire network.

The LCD display shall provide separate alarm, trouble, supervisory, and monitor event queues of to minimize operator confusion. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 dBA at 10 feet.

The LCD display shall contain the following system status indicators:

- System Power Indicator
- System CPU Fail Indicator
- Ground Fault Indicator
- Disabled Points Indicator
- System Common Alarm Indicator
- System Common Trouble Indicator
- System Common Supervisory Indicator

The LCD display shall contain the following system switch/indicators:

- System Reset Switch with Indicator
- System Alarm Silence Switch with Indicator
- System Panel Silence Switch with Indicator
- Acknowledge Switch with Indicator

The LCD display shall contain the following system function control:

- Rotary Controller/Switch - to scroll through the display and enter data.

960 Character Backlit Liquid Crystal Text Display

The user interface shall provide a backlit LCD that will allow custom event messages of up to 42 characters. The interface shall provide a minimum of 24 lines by 40 characters and provide the emergency user hands free viewing of the first seven (7) and last highest priority events. The last highest priority event shall always display and update automatically. Events shall be automatically placed in one of four queues: alarm, trouble, supervisory and monitor. The total number of active events by type shall be displayed. Visual indication shall be provided of any event type that has not been acknowledged. It shall be possible to customize the designation of all user interface LEDs and Switches for local language requirements.

Instructional text messages support a maximum of 2,000 characters each.

The system 960 character LCD display shall be an Edwards 4X-LCD or Approved Equal.

B. LEDs and Switches

A modular series of switches and LED indicators shall be available to customize the fire alarm control panel operation in accordance with this specification. All LED and switch functions shall be software

programmable. Switches shall be configurable for momentary, maintained, toggle, or "exclusive or" operation as required by the application. LEDs shall be configurable for slow flash, fast flash or steady operation. LED/Switch modules shall be capable of mounting in any available fire panel module position. All LED/Switch modules shall be supervised. LEDs shall be available in a variety of colors to facilitate identification from a distance. The LED/Switch modules shall provide ample room for custom function text labels under a protective membrane.

The LED/Switch modules shall be Edwards 3-24x series, 3-12xx series, and 3-6/3S1xxx series devices or Approved Equal.

C. Audio Annunciation and Control3X

Provide a master one-way emergency audio control unit as part of the main fire alarm control panel. The emergency audio control shall contain a paging microphone and shall be capable of generating and delivering multi-channel audio messages simultaneously over copper and/or fiber media to remote parts of the facility.

All audio messages and live pages shall originate at the one-way audio control unit. The one-way audio control unit shall store up to two (2) minutes of pre-recorded audio messages digitally as WAV files. These messages shall be automatically directed to various areas in a facility under program control. The unit shall have the capacity to store up to 200 individual audio messages and to simultaneously play back seven (7) different messages in addition to live page message.

During non-alarm conditions, the control unit shall continuously distribute a default audio message to all amplifiers, providing total audio path supervision. To enhance system survivability, each remote FACP cabinet containing an amplifier shall play the default audio message in the event of a fire AND a control network system failure.

The one-way emergency audio control shall provide control switches to direct live paging messages as follows:

- "All Call" to direct the page messages to all areas in the facility, overriding all other messages and tones.
- "Page to Evacuation Area" to direct the message to the evacuation area(s), overriding all other messages and tones.
- "Page to Alert Area" to direct page messages to the area(s) receiving the alert message and tones, overriding all other messages and tones.
- "Page to Balance Building" to direct page messages to the areas) in the facility NOT receiving either the evacuation area or alert area messages.

The system shall automatically deliver a preannounce tone of 1000 Hz for three seconds when the emergency operator presses the microphone PTT key. A 'ready to page' LED shall flash during the preannounce phase, and turn steady when the system is ready for the user's page delivery. The system shall include a page deactivation timer which activates for 3 seconds when the emergency user release the microphone talk key. Should the user subsequently press the microphone key during the deactivation period a page can be delivered immediately. Should the timer complete its cycle the system shall

automatically restore emergency signaling and any subsequent paging will be preceded by the pre-announce tone. A VU display shall indicate voice level to the emergency operator.

The one-way audio control unit shall be capable of supporting up to 64 remote microphone inputs and a line level audio input.

The fire alarm control panels shall support remote cabinets with zoned amplifiers to receive, amplify and distribute messages through speakers over supervised circuits.

The master one-way emergency audio control unit shall be an Edwards 3X-PMI.

D. System Printer

The event and status printer shall be a 9-pin, impact, dot matrix printer with a minimum print speed of 232 characters per second. The printer shall be capable of serial or parallel communications protocol. The communications speed for RS-232 communications protocol shall be adjustable from 300 to 9600 Baud.

The printer output shall include the type of event, the circuit or device reporting including address, date, and event time. Event restoral conditions shall also be printed, including address, date, and event time.

In the event that the printer is off-line when an event is received, a panel buffer shall retain the data and it shall be printed when the printer is restored to service.

The system printer shall be an Edwards PT-1S or Approved Equal.

E. Reports

The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD, and shall be capable of being printed on any system printer.

The system shall provide a report that gives a sensitivity listing of all detectors that have less than 80% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.

The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.

The system shall provide a report that gives a chronological listing of at least the last 1000 system events.

The system shall provide a listing of all of the firmware revision listings for all of the installed components in the system.

2.5 Signaling Line Circuits

A. Fire Network Wiring

The network inter panel wiring shall be Class A. The network media shall be fiber optic cable as indicated on the drawings.

The system supplied under this specification shall utilize node to node, direct wired peer-to-peer network operations. The system shall utilize independently addressed, smoke detectors, heat detectors and

input/output modules <intrusion detection> as described in this specification. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, LCD/LED annunciation nodes, and workstations. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes.

When a network is wired in a Class B configuration, a single break or short on the network wiring isolates the system into two groups of panels. Each group continues to function as a peer-to-peer network working with their combined databases. When wired using a Class A configuration, a single break or short on the network wiring causes the system to isolate the fault, and network communication continues uninterrupted, without any loss of function. Should multiple wiring faults occur, the network re-configures into many sub-networks and continues to respond to alarm events from every panel that can transmit and receive network messages.

The copper network interface shall be an Edwards 3X-NET(8) series or Approved Equal.
The fiber optic network interface shall be an Edwards 3X-FIB8 with multi-mode fiber optic transceivers or Approved Equal.

B. EST3X System

The signaling line circuit connecting panels/nodes to intelligent addressable devices including, detectors, monitor modules, control modules, isolation modules and notification circuit modules shall be Class B (style 4). All signaling line circuits shall be supervised and power limited.

When the addressable devices on a signaling line circuit cover more than one designated fire/smoke compartment, a wire-to-wire short on the circuit shall not affect the operation of the addressable devices in other fire/smoke compartments.

Each SLC shall support 125 addressable detector addresses and 125 module addresses. The SLC shall support 100% of all addressable devices in alarm and provide support for a 100% compliment of detector isolator bases. Initial circuit loading shall not exceed 80% in order to allow for future system expansion.

T-taps (branching) shall be permitted on Class B circuits. Where possible, the devices installed at the end of each branch should be easily accessible for troubleshooting, e.g. a pull station at normal mounting height.

The addressable device SLC module shall be UL Listed for use with code compliant, electrically sound existing wiring.

Each intelligent addressable device shall transmit information about its location with respect to other devices on the circuit. This information shall be used to create an "As-Built" wiring diagram as well as provide enhanced supervision of a device's physical location. The device message and programmed system output function shall be associated with the device's location on the SLC circuit location and not a device address.

The SLC module shall allow replacement of "same type" devices without the need to address and reload the "location" parameters on replacement device.

The SLC/Panels shall notify the user when programmed devices are detected on the SLC circuit. The SLC/Panels shall notify the user when the wrong device type is installed at a location configured for a different device type on the SLC circuit.

The addressable device signaling line circuit module shall be an Edwards XAL250 series or Approved Equal.

2.6 Notification Appliance Circuits

- A. Notification Appliance Circuits3X: All notification circuits shall be supervised and power limited. Non-power limited circuits are not acceptable. All notification appliance circuits shall be Class B (Style "Y"). Initial circuit loading shall not exceed 80% in order to allow for future system expansion.

1. 24 VDC Notification Appliance circuits

Notification appliance circuits shall utilize a "voltage boost" circuit to insure FACP terminal voltage never drops below 22.5VDC even under low battery conditions.

Notification appliance circuits shall have a minimum circuit output rating of 3 amps @ 24 VDC

2. 24VDC NACs shall be polarized and provide both strobe synchronization and a horn silence signals on a single pair of wires.

3. Audio Notification Appliance Circuits

Audio notification appliance circuits shall be polarized and have a minimum circuit output rating of 50 watts @ 25V audio, and 35 watts @ 70V audio.

B. Audio Amplifiers

Each audio power amplifier shall have integral audio signal de-multiplexers, allowing the amplifier to select any one of eight digitized audio channels as directed by system programming.

Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall provide a selectable 25/70 Vrms output, suitable for connection to emergency speakers.

To enhance system survivability in the event of a total loss of audio data communications, all amplifiers shall default to the local "EVAC" tone generator channel. If the local panel has an alarm condition, then all amplifiers will sound the EVAC message on their speaker circuits. In the event of a loss of the fully digitized, multiplexed audio riser data, the audio amplifiers shall automatically default to an internally generated alarm tone which shall sound a 3-3-3 temporal pattern.

Amplifiers shall also include a 24 VDC notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable.

Provide as minimum, one twenty (20) watt audio amplifier per paging zone. Initial amplifier loading shall not exceed 80% in order to allow for future system expansion. Calculations shall assume each speaker is connected at one (1) watt.

Audio amplifiers shall be Edwards 3-ZA series devices or Approved Equal.

2.7 Initiating Device Circuits

- A. Conventional (2-wire) initiating device circuits monitoring manual fire alarm stations, smoke and heat detectors, waterflow switches, valve supervisory switches, Class B (Style "A" or "B").
- B. Initiating device circuits shall be configurable for latched or non-latched operation and configurable to initiate alarm, supervisory or monitor events.
- C. End-of-line resistors for conventional initiating device circuits shall be covered with insulated tubing, terminated with ring lugs and display a UL label.

2.8 Off Premises Communications

A. DACT

The system shall provide off premises communications capability using a Digital Alarm Communications Transmitter (DACT) for sending system events to multiple Central Monitoring Station (CMS) receivers over conventional telephone lines.

The system shall provide the CMS(s) with point identification of system events using 4/2, Contact ID ID (SIA DC-05) or SIA DCS protocols. <The system shall also transmit an alphanumeric system activity message, by event, to a commercial paging system provided by the owner, using TAP Pager protocol and an internal V.32BIS or greater 14.4Kbaud modem.>

The dialer shall support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system design.

In the event of a fire alarm panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.

The owner shall arrange for two (2) dedicated loop-start phone lines to be terminated using two RJ31X jacks within 5 ft of the main fire alarm control panel.

- B. The DACT shall be an Edwards 3-MODCOM(P) or Approved Equal.

2.9 Remote Booster Power Supply

- A. Install Remote NAC Power Supplies (boosters) at the locations shown on the drawings, as required, to minimize NAC voltage drops. Remote NAC power supplies shall be treated as peripheral NAC devices and shall not be considered fire alarm control units.

The NAC power supplies shall be fully enclosed in a surface mounted steel enclosure with hinged door and cylinder lock, and finished in red enamel. Door keys shall be the identical to FACP enclosure keys. The enclosure shall have factory installed mounting brackets for additional UL listed fire alarm equipment within its cabinet. Enclosures shall be sized to allow ample space for interconnection of all components and field wiring, and up to 10AH batteries. The enclosure shall have provisions for an optional tamper switch. All FACP addressable control modules required to initiate the required NAC power supply output functions shall be installed within the NAC power supply enclosure

Remote NAC power supply *input* circuits shall be configurable as Class B supervised inputs or for connection to any 6 to 45 VDC initiation source.

Remote booster power supplies shall provide four (4) synchronized Class B supervised or two (2) Class A, power limited, 24VDC filtered and regulated Notification Appliance Circuits (NACs). Each NAC output shall be configurable as a continuous 24Vdc auxiliary power output circuit. The booster power supply shall be capable of a total output of <6> 10 amps.

The power supply NACs shall be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. It shall be possible to configure the NACs to follow the main FACP NAC or activate from intelligent addressable synchronized modules. All visible <audible> NACs within the facility shall be synchronized.

Upon failure of primary AC power, the remote power supply shall automatically switch over to secondary battery power without losing any system functions. It shall be possible to delay reporting of an AC power failure for up to 6 hours. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately be announced as locally as battery trouble. All power supply trouble conditions (DC power failure, ground faults, low batteries, and IDC/NAC circuit faults) shall identify the specific remote power supply affected at the main FACP. All power supply trouble conditions except loss of AC power shall report immediately. Interconnecting NAC Booster power supplies in a manner which prevents identification of an individual power supply trouble shall not be considered as an equal.

The remote booster power supply shall be capable of recharging up to 24AH batteries to 70% capacity in 24 hours maximum. Batteries provided shall be sized to meet the same power supply performance requirements as the main FACP, as detailed elsewhere in this specification.

All AC power connections shall be to the building's designated dedicated emergency electrical power circuit. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each remote NAC power supply the disconnect serves.

- B. The remote NAC power supplies shall be Edwards model BPS/APS series devices or Approved Equal.

2.10 Peripheral Components

A. Addressable Detectors

- 1. General Requirements for Intelligent Addressable Heat, Smoke and Duct Detectors

Each detector shall contain an integral microprocessor which shall determine if the device is normal, in alarm, or has an internal trouble. The microprocessor's non-volatile memory shall permanently store the detector's serial number, device type and system address. It shall be possible to address each intelligent device without the use of switches. Devices requiring switches for addressing shall not be considered as equal. Memory shall automatically be updated with the hours of operation, last maintenance date, number of alarms and troubles, time of last alarm, and analog signal patterns for each sensing element just before the last alarm.

Each detector shall be capable of identifying up to 32 diagnostic codes. This information shall be available for system maintenance. The diagnostic code shall be stored at the detector.

Each addressable detector on the Signaling Line Circuit (SLC) shall transmit information regarding its location with respect to other intelligent devices on the signaling line circuit to the control panel, creating an "As-Built" circuit map. The circuit mapping function shall provide location supervision of all intelligent devices on the signaling line circuit. An intelligent detector's programmed system response functions shall be associated with the detector's actual *location* on the signaling line circuit and *not with the detector's address*. After system commissioning, detectors improperly installed in the wrong location shall function according to the mapped programmed response for its *location* on the circuit, not its detector's address.

Two status LEDs shall be provided on each detector. A flashing green LED shall indicate normal operation; flashing RED shall indicate the alarm state. A steady RED and steady GREEN shall indicate alarm state when in the stand-alone mode. LEDs shall be visible from any direction.

The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced, without the need for reprogramming. System shall display an off-normal condition until the proper detector type is installed or a change in the device type profile has been made.

Detectors shall be rated for operation in the following environment unless specifically noted:

- Temperature: 32°F to 120°F (0°C to 49°C)
- Humidity: 0-93% RH, non-condensing

Detectors with addressing components in the base shall not be considered as equal.

B. Photoelectric Smoke

Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings.

When mounted in a sounder base, the detector shall initiate a temporal 3-3-3 when smoke is detected.

The photoelectric smoke detector shall be suitable for direct insertion into air ducts up to 3 ft (0.91m) high and 3 ft (0.91m) wide with air velocities up to 5,000 ft/min. (0-25.39 m/sec) without requiring specific duct detector housings or supply tubes.

Each smoke detector shall be individually programmable to operate at any one of five (5) sensitivity settings. The detector shall also store pre-alarm and alternate pre-alarm sensitivity settings. Pre alarm sensitivity values shall be configurable in 5% increments of the alarm and alternate alarm sensitivity settings respectively. The detector shall be able to differentiate between a long term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel. It shall be possible to automatically change the sensitivity of individual intelligent addressable smoke detectors for day and night (alternate) periods.

Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide

a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

The photoelectric smoke detector shall be an Edwards SIGA-PS or Approved Equal.

C. Duct Smoke

Provide intelligent low profile photoelectric duct smoke detectors / remote test switches at the locations shown on the drawings.

The intelligent duct smoke detector shall operate in ducts having from 100ft/min to 4,000ft/min air velocity. The detector shall be suitable for operation over a temperature range of -20 to 158F° and offer a harsh environment gasket option. The detector shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten (10) feet. Design of the detector shall permit sampling tube installation from either side of the detector and permit sampling tube installation in 45- degree increments to ensure proper alignment with duct airflow. Drilling templates and gaskets to facilitate locating and mounting the housing shall be provided.

The intelligent duct smoke detector shall obtain information from a photoelectric sensing element. The detector shall be able to differentiate between a long term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel

Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.

The intelligent duct smoke detector shall provide a form "C" auxiliary alarm relay rated at 2amps @ 30Vdc. The position of the relay contact shall be supervised by the control panel software. Operation of the relay shall be controlled either by its respective detector processor or under program control from the control panel as required by the application. Detector relays not capable of programmed operation independent of the detector's state shall not be considered as equal. The detector shall be equipped with a local magnet-activated test switch.

Each duct detector shall be installed and testing in accordance with manufacturer's instructions, including pressure differential and, velocity testing. Test results shall be submitted to the owner.

Remote test switches/LED indicators shall be provided below the detector on the ceiling to indicate location of the detector in non-mechanical areas, at locations indicated on the drawings.

The Intelligent Photoelectric Duct Smoke Detector shall be an Edwards model SIGA-SD or Approved Equal..

The remote key operated test switch / LED shall be a Edwards model SD-TRK or Approved Equal.

D. Duct Mounting Plate

Where addressable smoke detectors are directly mounted on a low velocity ducts up to 3 ft (0.91m) high x 3 ft (0.91m) wide, provide factory mounting plate assemblies to facilitate mounting the detectors. The mounting plate shall be code gauge steel with corrosion resistant red enamel finish. The detector

mounting plate shall support an addressable detector along with a standard, relay or isolator detector mounting base.

The detector mounting plate shall be an Edwards SIGA-DMP or Approved Equal.

E. Fixed Heat

Provide intelligent fixed temperature heat detectors at the locations shown on the drawings.

The detector shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The detector shall utilize a low mass thermistor heat sensor and operate at a nominal fixed temperature alarm point rating of 135°F (57°C). The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of thermistor data. Systems using central intelligence for alarm decisions shall not be considered as equal.

The heat detector shall be rated for ceiling installation at a minimum of 70 ft (21.3m) centers and also be suitable for wall mount applications.

The Intelligent fixed temperature detector shall be an Edwards SIGA-HFS or Approved Equal.

F. Rate of Rise

Provide intelligent combination fixed temperature / rate-of-rise heat detectors at the locations shown on the drawings.

The detector shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The detector shall utilize a low mass thermistor heat sensor and operate at a nominal fixed temperature alarm point rating of 135°F and at a temperature rate-of-rise alarm point of 15°F per minute. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of thermistor data. Systems using central intelligence for alarm decisions shall not be considered as equal.

The heat detector shall be rated for ceiling installation at a minimum of 70 ft centers and also be suitable for wall mount applications.

The Intelligent combination fixed temperature / rate-of-rise heat detector shall be an Edwards SIGA-HRS or Approved Equal.

G. Standard Base

Provide standard detector bases suitable for mounting on either North American 1-gang, 3½ or 4 inch octagon box and 4 inch square box, European BESA or 1-gang box.

The bases shall utilize a twist-lock design and provide screw terminals for all field wiring connections.

The base shall contain no active electronics and support all Signature series detector types.

The base shall be capable of supporting a Remote Alarm LED Indicator. Provide remote LED alarm indicators where shown on the plans.

Removal of the respective detector shall not affect communications with other detectors.

The standard addressable detector base shall be an Edwards SIGA-SB or SB4.

The remote LED indicator shall be an Edwards SIGA-LED or Approved Equal.

H. Relay Base

Provide relay detector bases suitable for mounting on either North American 1-gang, 3½ or 4 inch octagon box and 4 inch square box, European BESA or 1-gang box; at the locations shown on the drawings.

The bases shall utilize a twist-lock design and provide screw terminals for all field wiring connections.

The base shall contain no electronics and support all Signature series detector types. Removal of the respective detector shall not affect communications with other detectors.

The relay base shall meet the following requirements:

The relay shall be a bi-stable type and selectable for normally open or normally closed operation.

The position of the relay contact shall be supervised.

The operation of the base relay shall be configurable for control by its respective detector or for independent programmable control from the fire alarm panel. Relay bases not configurable for detector or panel operation shall not be considered equal.

The base relay shall provide form "C" contacts with a minimum rating of 1 amp @ 30 Vdc and be listed for pilot duty.

The standard addressable relay detector base shall be an Edwards SIGA-RB or RB4 or Approved Equal.

I. Manual Stations

Provide addressable single action, two stage fire alarm stations at the locations shown on the drawings.

The manual station shall be suitable for mounting on North American 2 ½ (64mm) deep 1-gang boxes and 1 ½ (38mm) deep 4 square boxes with 1-gang covers. If indicated as surface mounted, provide manufacturer's surface back box.

The fire alarm station shall be of metal construction, shall be finished in red with silver "PULL IN CASE OF FIRE" lettering, shall show visible indication of operation and incorporate an internal toggle switch for first stage alarm and key switch for second stage alarm.

The manual pull station will have an addressable module integral to the unit.

Manual pull stations that initiated an alarm condition when opening the unit are not acceptable.

The addressable single action two stage manual fire alarm station shall be an Edwards SIGA-270P or Approved Equal.

J. Guards

Provide manual pull station guards on all pull stations.

The guard shall consist of a factory-fabricated clear polycarbonate enclosure, hinged at the top. Lifting the cover shall provide access to the manual pull station and activate an integral battery powered audible horn intended to discourage false alarms.

The manual pull station guards shall Edwards STI-1000 Series or Approved Equal.

K. Modules

General

Intelligent addressable multifunction modules shall be provided at the locations shown on the drawings to provide the specific system input and output functions described by the operation section and functional matrix found elsewhere in this specification.

The operation of multifunction modules shall be software configurable at the site to meet operational conditions, and may be changed at any time by download changes from the control panel. The intelligent multifunction modules shall utilize electronic addressing. Modules using rotary or DIP switches, memory chips and / or jumpers for addressing shall not be considered as equal.

Each intelligent multifunction module on the Signaling Line Circuit (SLC) shall transmit information regarding its location with respect to other intelligent devices on the signaling line circuit to the control panel, creating an "As-Built" circuit map. The circuit mapping function shall provide location supervision of all intelligent devices on the signaling line circuit. An intelligent device's programmed system response functions shall be associated with the device's actual *location* on the signaling line circuit and *not with the device's address*. After system commissioning, devices improperly installed in the wrong location shall function according to the mapped programmed response for its *location* on the circuit, not its device address.

All input /output status decisions shall be made by the microprocessor within the module. Communications with a control panel shall not be required in order for the module to identify off-normal input/output conditions. Modules with supervised input or output circuits shall be capable of identifying ground fault conditions down to the module address level.

Each module shall be equipped with two (2) diagnostic indicators; a green LED to confirm communications and a red LED to display active status. LEDs shall be visible through the finished cover plate. The module shall be capable of storing a unique serial number and up to 24 diagnostic codes, hours of operation, number of alarms and troubles, and time of last alarm in its memory which can be retrieved for troubleshooting.

Modules shall be rated for operation in the following environment:

- Temperature: 32°F to 120°F (0°C to 49°C)
- Humidity: 0-93% RH, non-condensing

Where multiple modules are mounted in close proximity to each other, plug-in modular versions of the modules and motherboards shall be available to minimize field wiring and facilitate troubleshooting.

The addressable multifunction modules shall Edwards Signature Series devices or Approved Equal.

1. Monitor

Provide addressable multifunction modules at the locations shown on the drawings.

The module shall be suitable for mounting on North American 2½" (64mm) deep 1-gang boxes and 1½" (38mm) deep 4" square boxes with 1-gang covers.

Each module shall provide one (1) supervised Class B input circuit configurable as one of the following "personalities."

1. Normally-Open Alarm Latching (for alarm initiation applications)
2. Normally-Open Alarm Delayed Latching (for waterflow switch applications)
3. Normally-Open Active Non-Latching (for limit switch and monitor applications)
4. Normally-Open Active Latching (for tamper switch and supervisory applications)

Each module shall identify and report by device address, ground faults and opens associated with its initiating device circuit, to the control panel. Single function modules or without individual ground fault detection identification capability shall not be considered as equal.

The Intelligent Single Input Module shall be an Edwards SIGA-CT1 or Approved Equal.

L. Notification Circuit

Provide addressable notification appliance circuit modules at the locations shown on the drawings.

The module shall be suitable for mounting in North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes.

The addressable NAC module shall provide one (1) supervised Class B notification appliance circuit.

The NAC control module shall be configurable for the following operations:

- 24 VDC synchronized NAC circuit, 2 amps @ 24 VDC.
- Audio notification circuit 25Vrms @ 50 watts or 70 Vrms @ 35 watts
- Firefighter's Telephone control with ring tone

The addressable notification appliance circuit module shall be an Edwards SIGA-CC1(S) or MCC1(S) or Approved Equal.

M. Relay

Provide addressable control relay modules at the locations shown on the drawings.

The module shall be suitable for mounting on a North American 2 ½" (64mm) deep 1-gang box or 1 ½" (38mm) deep 4" square box with 1-gang covers.

The module shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The relay coil shall be magnetically latched to reduce wiring and ensure 100% of the relays on the SLC can be energized at same time.

The addressable control relay module shall be an Edwards SIGA-CR or MCR or Approved Equal.

N. Waterflow-Tamper

Provide addressable dual input waterflow / tamper modules at the locations shown on the drawings.

The module shall be suitable for mounting on North American 2½" (64mm) deep 1-gang boxes and 1½" (38mm) deep 4" square boxes with 1-gang covers.

Each module shall provide two (2) supervised Class B input circuit configured as:

1. Normally-Open Alarm Delayed Latching for waterflow switch applications.
2. Normally-Open Active Latching for tamper switch and supervisory applications.

Each module shall identify and report by device address, ground faults and opens associated with its initiating device circuits, to the control panel. Modules or without individual ground fault detection identification capability shall not be considered as equal.

The Addressable Dual Input Module shall an Edwards SIGA-WTM or Approved Equal.

O. Universal Modules

Provide intelligent universal Class A/B multifunction modules at the locations shown on the drawings.

The module shall be suitable for mounting on North American 2½" (64mm) deep 2-gang boxes and 1½" (38mm) deep 4" square boxes with 2-gang covers.

Each universal module shall be configurable as one of the following "personalities."

1. Two (2) supervised Class B Normally-Open Alarm Latching. (for alarm initiation applications)
2. Two (2) supervised Class B Normally-Open Alarm Delayed Latching. (for waterflow switch applications)
3. Two (2) supervised Class B Normally-Open Active Non-Latching. (for limit switch and monitor applications)
4. Two (2) supervised Class B Normally-Open Active Latching. (for tamper switch and supervisory applications)
5. One (1) form "C" dry relay contact rated at 2 amps @ 24 Vdc. (for circuit control applications)
6. One (1) supervised Class A Normally-Open Alarm Latching. . (for alarm initiation applications)
7. One (1) supervised Class A Normally-Open Alarm Delayed Latching. . (for waterflow switch applications)
8. One (1) supervised Class A Normally-Open Active Non-Latching. (for limit switch and monitor applications)
9. One (1) supervised Class A Normally-Open Active Latching. . (for tamper switch and supervisory applications)
10. One (1) supervised Class A 2-wire Smoke Alarm Non-Verified. (for alarm initiation applications)
11. One (1) supervised Class B 2-wire Smoke Alarm Non-Verified. (for alarm initiation applications)
12. One (1) supervised Class A 2-wire Smoke Alarm Verified (for alarm initiation applications)
13. One (1) supervised Class B 2-wire Smoke Alarm Verified (for alarm initiation applications)
14. One (1) supervised Class A Signal Circuit, 24Vdc @ 2A. (for occupant notification applications)
15. One (1) supervised Class B Signal Circuit, 24Vdc @ 2A. . (for occupant notification applications)

Each module shall identify and report ground faults, opens and shorts associated with its supervised input / output circuits, by device address, to the control panel. Single function modules or without individual ground fault detection identification capability shall not be considered as equal.

The Universal Class A/B Module shall an Edwards SIGA-UM or Approved Equal or Approved Equal.

2.11 Conventional Devices

A. Heat-Rate Comp Xproof

Provide explosion proof rate compensated heat detectors at the locations shown on the drawings.

Detectors shall be rated for a maximum smooth 10 ft. ceiling rating of 2,500 sq. ft. and shall be activate at 135°F for standard detectors and 194°F for high temperature detectors.

Detectors shall be hermetically sealed and automatically resetting. Detectors shall operate when ambient air temperature reaches detector setting, regardless of rate of temperature rise. Fixed temperature detectors without rate compensation or rate-of-rise detectors shall not be considered as equals. Detectors shall be equipped with screw terminals for each conductor.

Detectors shall be suitable for use in Class I, Groups C & D; and Class II, Groups E, F, &G.

The explosion proof rate compensated heat detectors shall be Edwards 302-EPM series devices or Approved Equal.

B. Manual Stations Explosion proof

Provide explosion proof double action manual pull stations at the locations shown on the drawings.

Pull stations shall be red in color and made of die-cast material. The pull station key shall match the control panel key. The pull station shall be furnished with an explosion proof backbox,

Pull stations shall be rated for operation in Class I, Groups B, C and D; Class II, Groups E, F and G; and Class III environments.

The explosion proof double action manual pull stations shall be Edwards MPSR series or Approved Equal.

2.12 Notification Appliances

A. General

All appliances supplied for the requirements of this specification shall be UL Listed for Fire Protective Service, and shall be capable of providing the "equivalent facilitation" which is allowed under the Americans with Disabilities Act Accessibilities Guidelines (ADA(AG)), and shall be UL 1971 Listed.

All appliances shall be of the same manufacturer as the fire alarm control panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturer's instructions.

Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended.

All strobes shall be provided with lens markings oriented for wall mounting. Exterior mounted devices shall be provided with a weatherproof backbox.

All visual appliances shall be synchronized. Light and audible output levels shall be designed to meet ADA and NFPA requirements

All notification appliances shall be red unless noted otherwise on the drawings.

B. Low Profile Strobes

Provide low profile wall mounted strobes at the locations shown on the drawings.

Low profile strobes shall mount in a North American 1-gang box, and protrude less than 1" from the finished wall. The word FIRE shall be prominently displayed on the housing.

The strobe output shall be switch selectable as required by its application from the following available settings: 15cd, 30cd, 75cd & 110cd. Selected strobe rating shall be visible when the strobe is in its installed position. Light shall be evenly distributed throughout the required volume using cavity and mask "FullLight" technology to prevent hot spots. Strobes using specular reflectors shall not be considered as equal.

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules.

Horn and strobe power, horn silencing, and strobe synchronization shall be accomplished over a single pair of wires. In and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The strobes shall be Edwards Genesis G1 Series or Approved Equal.

C. Speaker-Ceiling

Provide low profile ceiling mounted speaker at the locations shown on the drawings.

Speakers shall mount in a North American 4" x 2 1/8" square electrical box, or a 960A-4RF round flush box, and protrude less than 1.6" from the finished ceiling. The word FIRE shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings: 2W (91dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (80dBA) at 10 ft. when measured in reverberation room per UL-1480. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The speaker shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The low profile ceiling mounted speaker shall be an Edwards Genesis GC series or Approved Equal.

D. Speaker-Strobe-Wall

Provide low profile wall mounted speaker-strobes at the locations shown on the drawings.

The low profile speaker-strobes shall mount in a North American 4" x 2 1/8" square electrical box, without trims or extension rings, and protrude less than 1" from the finished wall. The word FIRE shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings: 2W (90dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (81dBA) at 10 ft. when measured in reverberation room per UL-464. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The strobe output shall be switch selectable as required by its application from the following available settings: 15cd, 30cd, 75cd & 110cd. Selected strobe rating shall be visible when the speaker-strobe is in its installed position. Amber lens strobes shall be available with outputs of 12/24/60/88cd. Light shall be evenly distributed throughout the required volume using cavity and mask "FullLight" technology to prevent hot spots. Strobes using specular reflectors shall not be considered as equal.

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules

Horn and strobe power, horn silencing, and strobe synchronization shall be accomplished over a single pair of wires. Both the speaker and strobe elements shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The low profile wall mounted speaker-strobes shall be an Edwards G4 series or Approved Equal.

E. Speaker-Strobe-Weatherproof

Provide low profile weatherproof speaker-strobes with wire guards at the locations shown on the drawings.

The weatherproof speaker-strobes shall mount in a North American 4" square 1 1/2" deep electrical box for indoor applications without a trim skirt and a 4" square 2 1/8" deep electrical box when used with a trim skirt. A factory supplied back box shall be supplied for weatherproof applications.

The speaker-strobe shall be suitable for wall or ceiling mount and operate in temperatures from -40 to 151 degrees F. The word FIRE <ALERT> shall be prominently displayed on the housing.

The speaker output shall be switch selectable from the following available settings:

Wattage	Switch Position	25Vrms	70Vrms
2W	T	90.0 dBA	89.7 dBA
1W	X	87.1 dBA	86.9 dBA
1/2 W	Y	84.0 dBA	83.9 dBA
1/4 W	Z	80.8 dBA	80.8 dBA

Output is at 10 ft. when measured in reverberation room per UL-464. Frequency response shall be 400 to 4,000Hz. The selected speaker wattage shall be visible when the speaker-strobe is in its installed position.

The strobe output shall be switch selectable as required by its application from the following available settings:

Listing	Location	Standard Candela Output Speaker-Strobes				High Candela Output Speaker-Strobes			
		D	C	B	A	D	C	B	A
UL 1971	Indoor, Clear lens	15 cd	29 cd	70 cd	87 cd	102 cd	123 cd	147 cd	161 cd
UL 1971	Indoor, Amber lens	13 cd	25 cd	59 cd	62 cd	84 cd	101 cd	125 cd	130 cd
UL 1638	Outdoor, Clear lens	6 cd	12 cd	28 cd	35 cd	41 cd	50 cd	60 cd	65 cd
UL 1638	Outdoor, Amber lens	5 cd	10 cd	24 cd	25 cd	34 cd	41 cd	51 cd	52 cd

Selected strobe rating shall be visible when the speaker-strobe is in its installed position

When multiple strobes are installed within view of each other, their outputs shall be synchronized within ten (10) milliseconds of each other for an indefinite period without the need for separate synchronization modules.

Horn and strobe power, horn silencing, and strobe synchronization shall be accomplished over a single pair of wires. Both the speaker and strobe elements shall provide in and out screw terminals shall accommodate 18AWG to 12 AWG wiring and have captive hardware.

The weatherproof speaker-strobes shall be Edwards Genesis WG4 Series or Approved Equal.

2.13 Accessories

A. Surge Suppression Devices

The system shall utilize the following electrical surge protection devices to prevent damage and nuisance alarms caused by nearby lightning strikes, stray currents, or voltage transients.

On the AC Input of all fire alarm panels, remote power supplies and HPSA sites: Transtector ACO100BWN3, Leviton OEM-120EFI, EFI HWM-120, Ditek DTK-120HW or DTK-120/240 CM. *AC Surge protectors shall be installed at the electrical panel board feeding the fire alarm equipment.* Excess lead length shall be trimmed. The branch circuit conductor shall be formed into a 5-10 turn 1" diameter tie-wrapped coil just downstream of the suppressor connection.

On each DC fire alarm circuit entering or leaving the building: Transtector TSP8601, Citel American B280 -24V, Edco P264 and P642, Ditek DTKxLVL series, or equal.

DC Surge protectors shall be installed on each required circuit at the point of entry into the building.

B. Inspection Bar Codes

Inspection bar codes shall be installed on all initiating devices, addressable modules, annunciators, control panels and power supplies.

Inspection bar codes used by the system must utilize Code 3 of 9 or other approved format, and contain a minimum of eight (8) digits that comprise a unique serial identifier within the Web-based Reporting System. There shall be no duplication of device ID numbers. The ID number shall be printed below the bar code for identification purposes.

Inspection bar codes shall be limited in size to no more than 2" (5cm) in width, and 3/8" (2 cm), in height and shall include a Mylar[®] or other protective coating to protect the bar code from fading due to sunlight or exposure.

Inspection bar codes shall be installed on each device in such a manner as to require that scanning of the bar code take place no further than 12" from the device during inspection.

2.14 FIRE ALARM TERMINAL CABINET

- A. Fire alarm terminal cabinets shall house expansion modules for signal line circuits and power modules for notification circuits.
- B. The system cabinet shall be red and can be either surface or flush mounted. The cabinet door shall be easily removable to facilitate installation and service.
- C. An audible system trouble sounder shall be an integral part of the control unit. Provisions shall also be provided for an optional supervised remote trouble signal.
- D. The terminal cabinet shall operate on 24 VDC, filtered switch mode power supply with the rated current available of 5 Amps. The FACP must have a battery charging circuit capable of complying with the following requirements:
 - 1. Sixty (60) hours of battery standby with five (5) minutes of alarm signaling at the end of this sixty (60) hour period (as required per NFPA 72 remote station signaling requirements) using rechargeable batteries with automatic charger to maintain standby gel-cell batteries in a fully charged condition.

2.15 FIRE ALARM WIRE AND CABLE

- A. Fire Alarm Power Branch Circuits: Building wire as specified in Section 260519.
- B. The SLC and Data Communication Bus shall be wired with standard NEC 760 compliant wiring, no twisted, shielded or mid capacitance wiring is required for standard installations. All FATC screw terminals shall be capable of accepting 14-18 AWG wire.
- C. Signaling Line Circuits: Each SLC shall be capable of a wiring distance of 10,000 feet from the SLC driver module and be capable of supporting 127 devices. The communication protocol to SLC devices must be digital. Any SLC loop device, which goes into alarm, must interrupt the polling cycle for priority response from the FACP. The FACP must respond consistently to a device that goes into alarm on an SLC in under 3 seconds. The auxiliary 5815XL SLC loop module must be capable of being located up to 6000 feet from the FACP on an RS-485 bus, which is separate from the SLC bus. The SLC shall be capable of functioning in a class A or class B configuration.
- D. SLC loop devices: Devices supported must include analog photoelectric, ionization smoke detectors, analog heat detectors, contact monitoring modules and relay output modules. There is to be no limit to the number of any particular device type up to the maximum of 127 that can be connected to the SLC.

- E. Provide fiber optic patch cords to connect the fire alarm panels to the Fiber Optic Cable System. Patch cords shall be multimode, 62.5/125 micron, duplex fiber optic cable with two (2) SC style connectors at one end. Connectors at the opposite end shall be selected as required to connect to the fire alarm equipment. Provide Cord length as required to connect fire alarm equipment to the Fiber Optic Cable System using conduit routed above Systems room ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power-Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC - Article 760 A and B. Upon completion, the Contractor shall so certify in writing to the Owner and General Contractor. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
- B. Fire Alarm Control Panel and Fire Alarm Terminal Cabinet shall be mounted with the center of panel 60 inches above floor level.
- C. The Fire Alarm Control Panel and Fire Alarm Terminal Cabinet shall be connected to a separate, dedicated 277 volt branch circuit, maximum 20 amperes. This circuit shall be labeled at the Main Power Distribution Panel as FIRE ALARM. Fire Alarm Control Panel Primary Power wiring shall be 12 AWG. The Control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod. Conduit shall enter into the Fire Alarm Control Panel back box only at those areas of the back box which have factory conduit knockouts.
- D. Installation of equipment and devices that pertain to other work in the Contract shall be closely coordinated with the appropriate subcontractors.
- E. The Contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.
- F. The manufacturer's authorized representative shall provide on site supervision of installation.
- G. Install manual station with operating handle 48 inches above floor. Install audible and visual signal devices 80 inches above floor except where lockers, bookcases or other furniture will obscure device. Raise devices to 12" above obstruction where necessary.
- H. Install all fire alarm wiring in conduit.
- I. Install fiber optic patch cords in conduit.
- J. Cable shall be the type listed for Fire Alarm/Life Safety use and shall be installed per NEC Article 760. Cable must be separated from any conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.

- K. Make conduit and wiring connections to sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors, and AHU shutdown devices.
- L. Automatic Detector Installation: NFPA 72.
- M. All splices, taps and terminations of fire alarm conductors shall be made on binder head screw terminals only.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services. The Manufacturer shall provide the on-site services of an Authorized, Factory Trained technical representative to supervise all connections and fully test all devices and components of the system during installation phase. The system shall be demonstrated to perform all the functions as specified.
- B. The Supplier shall provide comprehensive Training on the operation, proper use, testing and routine maintenance of the installed Fire Alarm System to the Building Owner's Representative.
- C. The completed fire alarm system shall be fully tested in accordance with NFPA 72 by the Contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the Contractor shall so certify in writing to the Owner and General Contractor.

3.3 FINAL SYSTEM ACCEPTANCE

- A. The Fire Alarm System will be accepted only after a satisfactory test of the entire system has been accomplished by a Factory-Trained Supplier in the presence of a representative of the Owner.
- B. The Supplier shall provide a complete set of "as-built" Fire Alarm/Life Safety system drawings at Substantial Completion.
- C. Provide the following in addition to as-built drawings:
 - 1. A computer file of the compiled Data Transfer Files for the installed system. (This file is intended to be a backup database for the installed system, and is not intended to be modified by any party other than the installing Engineered Systems Distributor.)
 - 2. Reports of all testing performed during installation of the system.
 - 3. Procedures for testing the Fire Alarm / Life Safety System.
- D. The Supplier shall make available contracted periodic system testing, maintenance, and/or calibration services.

3.4 WARRANTY

- A. The Contractor shall warrant the completed fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of five years from the date of the completed and certified test or from the date of first beneficial use.
- B. The Fire Alarm Systems Components including all Control Equipment, Analog Sensors and Addressable

I/O Modules shall be warranted by the manufacturer for five years. Damage by lightning shall be included in the warranty.

- C. Upon completion of the installation of the fire alarm system equipment, the electrical contractor shall provide to the architect, a signed written statement, substantially as follows:

"The undersigned, having engaged as the contractor on the (NAME OF THE PROJECT) confirms that the fire alarm system equipment installed is in agreement with the wiring diagrams and written instructions and directions provided by the Engineered Systems Distributor."

END OF SECTION 283100

SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS: 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 DESCRIPTION:

A. Work Included:

1. Notification of Utility Companies.
2. Protection.
3. Stripping and Stockpiling Topsoil.
4. Overexcavation & Removal of Unsuitable Soils.
5. Slope Restrictions, Shoring & Bracing of Excavations.
6. Existing Soil Compaction & Preparation.
7. Fill Placement.
8. Layout & Establishment of Grades.
9. Grading and Reshaping Site.
10. Construction of Stormwater Ponds, Ditches & Swales.
11. Spreading of Topsoil.
12. Repair & Restoration.
13. Clean Up.

B. Related Work Specified Elsewhere:

1. Site Clearing, Stripping and Grubbing: Section 312000.

1.3 REFERENCES:

A. American Society for Testing and Materials (Latest Edition):

1. ASTM D698, 'Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort'
2. ASTM D1140, 'Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 Sieve'
3. ASTM D1557, 'Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort'
4. ASTM D2216, 'Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock'
5. ASTM D2487, 'Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)'
6. ASTM D2922, 'Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)'
7. ASTM D2974, 'Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils'
8. ASTM D3017, 'Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)'
9. ASTM D4318, 'Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils'

10. ASTM D5268, 'Standard Specification for Topsoil Used for Landscaping Purposes'
11. ASTM D6913, 'Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis'
12. ASTM D448, 'Standard Classification for Sizes of Aggregate for Road and Bridge Construction'

B. Florida Department of Transportation (FDOT):

1. Standard Specifications for Roadway & Bridge Construction.

C. Florida Statutes (F.S.):

1. Chapter 556: Underground Facility Damage Prevention and Safety.

1.4 JOB CONDITIONS:

- A. Inspection of the Site: It is the Contractor's responsibility to have carefully inspected the Site during the bidding period to determine the extent and nature of the site work and the conditions under which it must be performed.
- B. Subsurface investigations have been completed. A copy of the Geotechnical Investigation can be found in Section 020600, Soil Borings.
- C. Lines, Grades, Etc.: Verify all grades, lines and dimensions shown on Drawings and report any errors or inconsistencies to the Engineer before commencing work.
- D. Should any unusual conditions arise, contact the Engineer for instructions prior to continuation of clearing and grading operations.
- E. The site has received considerable quantities of fill placed under separate contract. The Contractor shall apprise themselves of the as-built conditions and govern their bids accordingly.

1.5 QUALITY ASSURANCE:

- A. Work specified herein will be subject to inspection and testing by an independent testing laboratory selected and compensated by the Contractor. Selection of the testing laboratory is subject to the approval of the Engineer.
- B. Testing: Contractor shall employ (at the Contractor's expense) a geotechnical firm capable of performing the below compliance testing at the indicated intervals. Geotechnical firm subject to Engineer's approval.
 1. The minimum compaction testing (ASTM D1557) shall be as follows for each lift of fill:
 - a. One (1) test per 5,000 SF under pavement area.
 - b. One (1) test per 10,000 SF of all other areas.

In the event an above item is not constructed on fill, the areas shall be tested as if one (1) lift of fill had been put in place. Compliance testing shall be in accordance with ASTM D2922.

2. Additionally, the following elements shall be tested (ASTM D1557) for compliance with the compaction requirements to a depth of 24" below the bearing elevation of each element. Field compliance testing shall be in accordance with ASTM D2922.
 - a. One (1) test per 300 LF of utility trench.
 - b. One (1) test at each utility structure.
 - c. One (1) test for each 50 LF of continuous footing.
 - d. One (1) test for each 2,500 sf of building slab.
 - e. One (1) test for each isolated footing
3. Representative samples of each source of suitable fill shall be collected and tested for optimum moisture content (ASTM D2216), gradation (ASTM D6913) and plasticity (ASTM D4318) characteristics. Tests shall also be performed to establish moisture density relationships and fill suitability in accordance with the modified proctor method (ASTM D1557).
4. Imported Topsoil Material shall be tested as follows for each source material:
 - a. pH.
 - b. Determine organic material content by ASTM D2974.
 - c. Presence of Herbicides.

1.6 SUBMITTALS:

- A. Copies of all soils testing showing compliance with this section. Copies of all retests as required.
- B. Shoring and bracing plans for excavations if required. Signed and sealed by a Florida Registered Professional Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Suitable On-Site or Imported Fill/Backfill:
 1. Well graded material conforming to ASTM D2487 (SW, SP) free from debris, organic material, fat clays, brick, lime, concrete, and other material which would prevent adequate performance of the backfill.
 2. Fill shall consist of an inorganic, non-plastic, granular soil containing less than 10 percent material passing the No. 200 mesh sieve.
 3. All fill proposed for use at the site whether from on-site grading operations or an off-site source shall be tested as required by this section.
- B. Topsoil: Shall be created on site using soil amendments. Refer to Grassing Specification.
- C. Crushed Stone:

1. Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing No. 8 sieve.

D. Pipe Bedding and Haunching Material:

1. Natural subgrade or backfilled material shall meet the requirements of the Unified Soil Classification for SW or SP material or AASHTO Soil Classification for A-3 material.

PART 3 - EXECUTION

3.1 NOTIFICATION OF UTILITY COMPANIES:

- A. Notify all utility companies that may have lines or services on or around the site prior to starting any work. Have the utility identify and locate their underground lines.
- B. Active utilities shall be adequately protected from damage and removed or relocated only as indicated or specified. The work shall be adequately protected, supported or relocated as directed by the Engineer. Take responsibility for the repair or replacement of any lines or services damaged during the course of this work.
- C. Remove, plug or cap all abandoned lines, meters, boxes, obstructions or piping in accordance with the requirements and approval of the agencies affected or as directed by the Engineer. Use licensed electricians or plumbers for this work.

3.2 PROTECTION:

- A. The Contractor shall design, furnish, install and maintain all support, shoring and sheet piling which may be required for the protection of site personnel and adjacent existing improvements.
- B. Maintain all bench marks, monuments and other reference points furnished by others and replace any that are disturbed or destroyed during the course of the work.
- C. Protect any trees or shrubs remaining within the vicinity of the work, or as indicated to remain on drawings. Refer to Section 312000 for related requirements.

3.3 STOCKPILING OF TOPSOIL:

- A. Topsoil shall be imported by the Contractor.

3.4 OVEREXCAVATION, REMOVAL AND REPLACEMENT OF UNSUITABLE SOILS:

- A. General: Geotechnical Reports have been provided for review. The following soil types shall be defined as unsuitable material: clay rich soils (SC, CL, CH, ML, MH) and organic rich soils (Pt, OH, OL). If encountered, this material is not suitable for use as backfill. Excavations for project improvements that extend into or bear on or near an unsuitable soil layer should be visually inspected and probed by the Contractor's Geotechnical

Engineer. Overexcavation and removal of unsuitable soils shall be mandatory. Extent and conditions for soil removal shall be as follows:

1. New Buildings and Equipment Pads:
 - a. Vertical removal of all clay rich soils beneath the bearing elevation of the foundation shall be to a depth of 3'.
 - b. Horizontal limits removal of clay rich soils shall be extended 5 feet beyond the perimeter of the structure.
 - c. Overexcavation of organic rich soils shall be full depth or 10' whichever is greater for an area extending 5' beyond the structure footprint.
 - d. Control of groundwater elevation is mandatory. Comply with Section 312319.
 - e. Backfill excavations with compacted suitable material.
 2. All Utility Structures, Paving Areas and Underground Piping:
 - a. Where unsuitable material occurs at subgrade elevations within the limits of construction, the Contractor shall excavate such material (for the width of the excavation) down to suitable foundation material or to a depth of two feet, whichever is less, and backfill with suitable material obtained from grading operations, borrow or imported fill
 - b. Control of groundwater elevation is mandatory. Comply with Section 312319.
 - B. Under no circumstances shall unsuitable materials be mixed with clean fill on the jobsite. Contractor shall make every effort to separate materials including distinct separation of organics, unsuitable inorganics and suitable fill.
 - C. All utility structures (manholes, wetwells, precast units) shall be underlain by 8" of crushed stone (No. 57) or gravel extending 12" beyond the base. See Drawings for additional requirements.
- 3.5 SLOPE RESTRICTIONS, SHORING & BRACING OF EXCAVATIONS:
- A. Excavations exceeding 5 feet in depth shall comply with the Trench Safety Act (F.S. 553.60-64) and shall employ the requirements of 3.05 B. or 3.05 C. as applicable.
 - B. Excavation walls adjacent to existing structures and pavements, such that foundations or bearing elements could be undermined, shall be laterally supported by sheet piles.
 1. Contractor shall at his expense design, furnish, and install sheet piles.

2. System shall use walers, tie-backs or deadman as necessary to prevent movement of soils under or adjacent to existing structures.
 3. System shall be designed under the supervision of a Florida Registered Professional Engineer.
 4. The use of jetting to install sheet piles is not allowed.
 5. Refer to the Geotechnical Report for design soil pressures.
 6. Upon completion of excavation activities all shoring & bracing materials shall be removed.
- C. Excavations not adjacent to existing structures may be open cut.
1. Excavation walls greater than 5 feet in depth shall not exceed 2:1 (H:V).
 2. Limits of excavation shall not advance beyond the property or right-of-way line.
 3. Slopes shall be protected from erosion.
 - a. Construct a perimeter berm redirecting stormwater.
 - b. Apply an impervious sheeting covering slopes during rain events as necessary.
 4. Excavation slopes shall be terraced every 5 feet vertically with a 4 foot wide continuous terrace. A shallow drainage ditch, 8-inches deep, shall be cut at the toe of each slope to collect stormwater.
 5. In lieu of 2:1 (H:V) sideslopes the Contractor may utilize a steel trench box and ladder designed for the purpose of protecting workers in steep wall excavations.
- D. See Section 312319 for groundwater control requirements.
- E. All utilities exposed by the excavation shall be supported or redirected as required to remain in service.
- F. Differing materials removed from the excavation shall be segregated into separate piles. Suitable fill, unsuitable fill, organics and trash shall not be combined into a single pile.
- 3.6 EXISTING SOIL COMPACTION AND PREPARATION:
- A. Subsequent to clearing and stripping, compact the upper 12 inches of exposed surficial sandy soils to the requirements of Paragraph B of this section.
1. Use non-vibratory or vibratory equipment (5 to 7 ton static weight roller, 3 to 4 foot drum diameter) as allowed by groundwater levels and proximity to existing structures.
 2. Provide a minimum of 8 passes.
 - a. Provide an equal number of passes in directions perpendicular to each other.
- B. Minimum compaction requirements (per ASTM D1557) for excavations in or activities on existing soils shall be as follows:

- | | |
|--|-----|
| 1. Foundations, slabs and sidewalks | 95% |
| 2. Paving areas | 98% |
| 3. Utility trenches/pipelines and structures | 98% |
| 4. Landscaping and athletic fields | 90% |
| 5. All other areas | 85% |

C. If encountered, surficial exposed clayey soils should not be compacted.

1. Clayey soils beneath proposed improvements are unsuitable and shall be removed as described elsewhere in this Section.
2. Elsewhere, cover exposed clayey soils as soon as possible with suitable fill, limit access to area until soil has been covered and protected from further disturbances.

D. After completion of compaction activities, proofroll existing surface with a heavy, pneumatic tired vehicle such as a fully loaded dump truck.

1. Remove and replace soft soils with suitable fill.
2. Recompact and retest area.
3. Proofrolling shall consist of (2) two complete passes of the vehicle in opposite directions.

3.7 FILL PLACEMENT:

A. Source: Imported fill shall be acquired from an entity with material capable of meeting the definition of suitable fill by established testing.

B. All fill material, whether from on-site or imported material, must be approved by the Geotechnical Engineer, hired and compensated by the Contractor, prior to placing it on the site.

C. Backfill Placement:

1. Within 50 feet of existing structures:
 - a. Compact soils with light (2,000 pounds or less) walk behind vibratory rollers or sleds.
 - b. Heavy (2 tons or greater) vibratory equipment shall not be allowed.
 - c. Place loose lifts not exceeding 6 inches.
2. With 24" or less separation between compaction surface and groundwater table:
 - a. Place loose lifts not exceeding 6 inches in depth.
 - b. Compact each lift using non-vibratory equipment.
3. With greater than 24" separation between compaction surface and groundwater table:
 - a. Place loose lifts not exceeding 12 inches in depth.
 - b. Compact each lift using vibratory equipment.
4. Regardless of compaction achieved all lifts shall receive a minimum of 8 passes of the compaction equipment. Provide an equal number of passes in directions perpendicular to each other.

- D. Compact each lift with 5 to 7 ton static weight roller until the following % of the maximum dry density (per modified proctor max. dry density, ASTM D1557) is obtained.

1. Foundations, Slabs & Equipment Pads	95%
2. Paving Areas, Utility Trenches & Structures	98%
3. Landscaping	90%
4. All Other Areas	85%

Recompact areas which fail to meet the compaction requirements until passing results are achieved.

- E. Compaction of utility trenches may be accomplished with a small walk behind jumping jack, until sufficient fill is in place to allow larger equipment to safely operate.
- F. Fill shall be moisture conditioned within 2 percent of optimum moisture content. Based on ASTM D1557.
- G. After completion of compaction activities, proofroll each lift with a heavy, pneumatic tired vehicle such as a fully loaded dump truck.
1. Remove and replace soft soils.
 2. Recompact and retest area.
 3. Proofrolling shall consist of (2) two complete passes of the vehicle.
- H. Differing materials removed from any excavation shall be segregated into separate piles. Suitable fill, unsuitable fill, organics and trash shall not be combined into a single pile.

3.8 LAYOUT AND ESTABLISHMENT OF GRADES:

- A. The Owner has established the lot line bearings and project benchmark elevation.
- B. The Contractor shall employ and pay for the services of a Florida licensed surveyor who shall make all required surveys for establishing all points, lines, grades and levels, and otherwise fully and completely lay out all the work required by the Contract.

3.9 GRADING AND RESHAPING SITE:

- A. Cut, fill, backfill, and rough grade as necessary to bring entire site level with elevations of undersides of concrete slabs, walks, paving and finished landscaping as indicated on Drawings or in Specifications.
- B. Grade areas to receive future topsoil and sod to allow for such material. Leave finished surfaces and surfaces to receive paving smooth, compacted and free from irregular surface drainage.
1. For areas receiving top soil set rough grades 4" below finish grades.
 2. For areas receiving sod set finish grades 1" below final grade.
 3. For areas receiving seed set grades at finish grades
 4. It is the intent of these grade offsets for the finish surface to be a flush condition with the adjacent hardscape. Differences in sod thickness may require the Contractor to adjust these requirements to suit.
- C. Surfaces and grade lines shall not vary from the established grades and slopes by more than the following tolerances:

1. Landscaped Surfaces	0.15 feet
2. Drainage Features	0.10 feet
3. Areas Under Paving and Structures	0.05 feet
4. Athletic Fields and other Playing Surfaces	0.05 feet
5. All Other Areas	0.10 feet

- D. Where elevations are indicated on the Drawings obtain such finish elevations and establish uniform slopes of finish grades between indicated elevations. Grade lines between any given elevations shall conform to the above tolerances.
- E. Where elevations are not indicated, establish and obtain uniform slope from finished spot elevations at the exterior face of the building or other vertically described site element out to the nearest indicated elevations for finished grades as shown on the Drawings.
- F. The Contractor shall provide suitable fill as necessary to achieve all proposed grades.

3.10 CONSTRUCTION OF STORMWATER DITCHES, PONDS AND SWALES:

- A. Construct ponds, drainage ditches and swales as shown on the Drawings and finish to permit proper surface drainage.
- B. Unless otherwise noted swales shall be graded with a minimum slope of 0.0025 ft/ft in the direction of flow.
- C. All swales shall be stabilized with sod.
- D. Sideslopes exceeding 2:1 shall be stabilized with sod which is staked in place to prevent movement.
- E. Excavated soil shall be temporarily stockpiled in an area coordinated with the Owner.
- F. Offsite swales receiving discharge from project site shall be regraded to drain as necessary.

3.11 EXCESS FILL AND DISPOSAL OF UNSUITABLE SOIL:

- A. Excess suitable fill shall belong to the Owner and deposited in at his Goodbread Road, Yulee facility as directed by the Owner's Representative.

3.12 REPAIR/RESTORATION:

- A. Repair damage to other portions of the Work resulting from work of this Section at no additional cost to Owner. On new work, arrange for damage to be repaired by original installer.
- B. Disturbed areas shall be sodded or seeded and mulched as described on the Drawings or elsewhere in these specifications.

3.13 CLEAN UP:

- A. Minimize the transmission of dirt or debris by equipment or personnel to any property, public or private, outside the project Site. Immediately remove any such debris or dirt transmitted.

- C. All streets, sidewalks and paved driveways adjacent to or within the construction limits shall be swept clean of debris.

END OF SECTION 310000

SECTION 312000 - SITE CLEARING, STRIPPING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. The General Requirements are made a part of this section as fully as if repeated herein.
- B. Work includes but is not limited to:
 - 1. Site clearing.
 - 2. Protection of existing trees to remain.
 - 3. Protection of streets, roads, adjacent property, and other facilities to remain.
 - 4. Disposal of all cleared materials.
 - 5. Disposal of all grubbed materials.

1.2 SUBMITTALS:

- A. Permit for transportation and disposal of debris.
- B. Disposal tickets from landfill.

1.3 DISPOSITION OF MATERIAL:

- A. Remove all cleared and grubbed materials from project site.

1.4 REGULATORY REQUIREMENTS:

- A. See Section 312500 for FDEP NPDES Permit requirements.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL:

- A. Segregation of Materials: Contractor shall be responsible for segregating dissimilar materials. Suitable fill, unsuitable fill, organics and/or trash shall not be mixed. Contractor shall stockpile material types independent of each other.

- B. Safety Procedures: The performance of the work shall be in strict compliance with all Local, State and Federal Regulations. This shall include, but not be limited to, Florida Trench Safety Act (F.S. 553.6) and OSHA 29 CFR 1926.651 and 1926.652.
- C. Trench excavations over 5 feet deep must provide a protective system for all personnel in the hole. Trench excavations over 20 feet in depth must provide a protective system designed by a Florida Registered Professional Engineer hired by the Contractor at the Contractor's expense.

3.2 CLEARING:

- A. Limits of Clearing: Remove trees and other vegetative matter only as required for construction of the project.
- B. Remove all trees and shrubs to ground level and grub as described below.
- C. Remove all dead trees, dead shrubs, rubbish, debris, weeds, vines and undergrowth to ground level.
- D. Remove all other obstructions resting on or protruding through surface of existing ground.
- E. Do not pull up or rip out roots of trees and shrubs that are to remain. If excavation through roots is required, excavate by hand and cut roots with fine tooth saw.

3.3 PROTECTION OF TREES:

- A. A visible barrier shall be constructed of 2x4 lumber standing 48" high and placed continuously 6 feet from the trunk of the tree or plant to remain.
- B. Barrier shall be secured in place and covered in safety orange netting.
- C. Barriers shall be completely removed at the conclusion of construction activities.
- D. Protect root systems from damage due to materials in solution caused by runoff or spillage during mixing and placement of construction materials or drainage from stored materials. Protect root systems from flooding, erosion or excessive wetting resulting from dewatering operations.
- E. Repair and Replacement of Trees to Remain:
 - 1. Repair trees or plants damaged by construction operations in a manner acceptable to the Engineer. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
 - 2. If trees die during the course of the project or within the warranty period, the Contractor shall remove them, and grind the stumps if the Owner so wishes, at no charge to the Owner.
 - 3. Trees that die during construction shall be replaced with same species, Grade A and 3" DBH. Trees shall be furnished and planted by the Contractor at no cost to the Owner.

3.4 CLEAN-UP:

- A. Remove from site trees, shrubs, uprooted stumps, vegetative layer, and surface debris. All material shall be disposed of legally.
- B. Remove and dispose of all stockpiled topsoil not claimed by Owner.
- C. Do not bury cuttings, stumps, roots, and other vegetative matter or burn waste material on site without prior authorization from Owner.
- D. Clean pavement, sidewalks and drainage features of debris and dirt.

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: 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: The Work to be performed under this section shall include furnishing all equipment and labor necessary to remove storm or subsurface waters from excavation areas in accordance with the requirements set forth and as shown on the drawings.
- 1.3 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS: The dewatering of any excavation areas and the disposal of the water shall be in strict accordance with the latest revision of all local and state government rules and regulations. The Contractor shall obtain any required dewatering permit from the appropriate agencies prior to commencing dewatering operations.
- 1.4 SUBMITTALS: Prior to the start of construction the Contractor shall provide a dewatering plan describing the surfacewater and groundwater controls which will be employed to control water levels in excavations so that construction is not inhibited.
 - A. Plan shall include temporary culverts, barricades and other protective measures to prevent damage to property or injury to any person or persons.
 - B. Plan shall indicate disposal method and location of point discharge.
 - C. Proof of Compliance with Florida Department of Environmental Protection Rule 62-621.300(2). See Paragraph 3.2 B.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

- 3.1 PERFORMANCE:
 - A. General:
 1. The Contractor shall provide adequate equipment for the removal of storm or subsurface waters which may accumulate in any excavation.
 2. The Contractor shall maintain groundwater levels as follows:
 - a. 2 feet (24") below foundation bearing elevation.
 - b. 2 feet (24") below pavement base bearing elevation.

- c. 1 foot (12") below bottom of utility pipes and structures.
 - d. Bottom of trench or other excavation shall be dry so that work can proceed.
 - e. 1 foot (12") below any other working surface.
 3. System shall intercept water on all sides of area to be drawn down.
 4. Contractor shall adhere to submitted Dewatering Plan.
 5. Engines driving any proposed dewatering pumps shall be equipped with residential type mufflers.
 - B. Acceptable Methods:
 1. Wellpoint System
 2. Trench and Sock Drain
 - a. Dewatering by trench pumping will not be permitted if migration of fine grained natural material from bottom, side walls or bedding material will occur.
- 3.2 DISPOSAL:
- A. General:
 1. Water pumped from an excavation shall be disposed (in strict compliance with all Local, State and Federal Regulations) or in the following:
 - a. Site Stormwater Pond or other Stormwater Facility serving the project.
 - b. Temporary disposal pit or trench.
 2. Direct discharge to waters of the state or other surface waters is strictly prohibited without prior written approval from the governing agency.
 3. No flooding of streets, roadways, driveways or private property shall be permitted.
 - B. Regulatory Requirements:
 1. Contractor is responsible for acquiring and complying with all permits and approvals necessary to perform the dewatering activity.
 - a. The Florida Department of Environmental Protection requires testing of groundwater prior to dewatering (F.A.C. 62-621.300(2)) for each point source that discharges to waters of the State.
 2. All waterways shall be protected from turbidity during the dewatering operation.

3.3 RESTORATION:

- A. All temporary drains, pipe or other non-soil materials shall be removed at the conclusion of the dewatering activity.
- B. Soils disturbed by the removal process shall be recompact and restabilized.

END OF SECTION - 312319

SECTION 312500 - EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: 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. Includes But Not Limited To: Provide, install, maintain, and remove erosion and sedimentation controls as described in Contract Documents and as required by Contractors Pollution Prevention Plan.
 - B. Related Sections:
 - 1. Section 310000 - Earthwork
 - 2. Section 312000 - Site Clearing, Stripping and Grubbing
 - 3. Section 312319 - Dewatering
- 1.3 REFERENCES:
- A. Florida Department of Transportation (Latest Editions):
 - 1. Standard Specification for Road and Bridge Construction.
 - 2. Design Standards for Design, Construction, Maintenance and Utility Operations on the State Highway System.
 - B. Florida Department of Environmental Protection:
 - 1. Rule 62-621 Generic Permits
 - C. Environmental Protection Agency (EPA)
 - 1. National Manual of Stormwater Best Management Practices.
- 1.4 QUALITY ASSURANCE: Contractor shall be certified by the Florida Department of Environmental Protection as an Erosion and Sedimentation Control Professional.
- 1.5 SUBMITTALS:
- A. Provide copy of application and stormwater pollution prevention plan as submitted to Florida Department of Environmental Protection as required by Section 312500 3.2 A.

- B. Provide a copy of Notice of Termination (NOT) of coverage under FDEP Generic Permit for Large and Small Construction Activities.
- C. Name of Certified FDEP Professional and a copy of the page of the permit application identifying the FDEP individual and their contact information.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Filter Fabric: Florida Department of Transportation Class D-3 material.
- B. Sand Cement Bags:
 - 1. Portland Cement: ASTM C150 Type I/II material.
 - 2. Fine Aggregate: Clean silica sand or other inert natural material of similar characteristics.
 - a. 97% material passing No.4 sieve
 - b. 20% material passing No.100 sieve
 - c. 5% material passing No. 200 sieve
 - 3. Sacks: Provide sacks of uniform size made of jute, cotton or scrim reinforced paper capable of holding the sand cement mixture without leakage. Sacks shall provide a finished unit approximately 12x18x6 inches in measurement. Material shall be permeable and absorptive enough to permit passage of water to provide for hydration of cement. Materials shall be biodegradable and contain no asphalt, oil or plastic lamination.
- C. Rubble:
 - 1. Provide clean, hard, durable rubble free of pollutants consisting of broken stone, concrete or masonry. Material shall be free of reinforcing wire or steel rebar.
 - 2. Material shall have a minimum nominal dimension of 3 inches for any given piece of rubble.
- D. Fiber Rolls:
 - 1. Tube shaped rolls of straw, flax, rice, coconut fiber, or compost.
 - 2. Rolls shall be wrapped with UV degradable polypropylene netting or biodegradable netting.
- E. Silt Fence:
 - 1. Florida Department of Transportation Type III silt fence meeting all requirements of FDOT Index 103.

- F. Seed for Temporary Erosion Control:
 - 1. Winter Months (October to March): Annual Rye Grass.
 - 2. Summer Months (April to September): Millet Grass.
- G. Water: Clean and potable.

PART 3 - EXECUTION

3.1 PERFORMANCE:

- A. General:
 - 1. Provide and maintain temporary erosion and sedimentation control measures from time site is disturbed to time permanent controls, paving, landscaping, and site restoration measures are able to perform erosion and sedimentation control functions.
 - 2. Clean-out, repair, and maintain control structures as necessary to enable them to perform properly.
 - 3. Prevent pollution of streams, water impoundments, and channels leading to them with chemicals, fuels, lubricants, bitumens, raw sewage, and other harmful waste.
- B. Sediment Barriers/Silt Fence:
 - 1. Place fence as shown on Drawings and as necessary to maintain regulatory compliance with Contractor's Pollution Prevention Plan.
 - 2. As a minimum, Silt Fence shall be installed along all downstream project property lines and between any construction activity and all waterways, water bodies, sewer inlets and wetlands.
- C. Fiber Rolls:
 - 1. Place rolls as shown on Drawings and as necessary to maintain regulatory compliance with Contractor's Pollution Prevention Plan.
- D. Seed or Sod:
 - 1. All areas disturbed by construction, and to remain unpaved or outside the building envelope, shall be stabilized by permanent seed and mulch or sod, as described elsewhere in the contract documents. Refer to Landscape Drawings for permanent grassing requirements.
 - 2. Areas that will be regraded or otherwise disturbed later during construction may be seeded with a temporary seed mix to obtain temporary erosion control.
- E. Sand-Cement Bag Rip Rap:
 - 1. Proportion sand and cement in the ratio of 5 cubic feet of sand to 94 lbs of cement.

2. Fill sacks to uniform size. Keep at least 6 inches of the sacks unfilled to allow for tying and closure.
3. Place sacks as shown on the drawings. Place sacks in a running bond type pattern. Align sacks/bags so that continuous joints are perpendicular to the primary flow and staggered joints are parallel to the primary flow.
4. Stake alternating bags in place with an 18" length of #3 rebar centered in bag. Set top of bar 1" below surface of bag.
5. After placement saturate bags with water.

F. Rubble:

1. Place rubble as required by drawings or specifications.
2. Dump rubble in place so as to provide a minimum depth of 18 inches.
3. Ensure that rubble does not segregate so that smaller pieces evenly fill the voids between the larger pieces.

3.2 REGULATORY REQUIREMENTS:

A. Florida Department of Environmental Protection (FDEP) - NPDES Program.

1. Contractor shall notify Florida Department of Environmental Protection of proposed construction and file Notice of Intent (NOI) to use Generic Permit for Stormwater Discharge from Large and Small Construction Activities with Florida Department of Environmental Protection.
2. Contractor shall be responsible for application fee and preparation of all attachments. Attachments shall include a Pollution Prevention Plan.
 - a. The minimum requirements for pollution prevention are described on the contract drawings and in these specifications.
 - b. The Contractor may use the pollution controls presented in these documents as the basis for his Pollution Prevention Plan.
 - c. The Contractor shall supplement the contract drawings and specifications as necessary to satisfy the Contractor's permit application and the Contractor's means and methods of construction.
3. It shall be the Contractor's responsibility to familiarize himself with the permit conditions and maintain the site in a condition that will be compliant with the permit.
4. Any testing or other requirements required by the governing agency to remain compliant or in response to a non-compliance event shall be the financial and material burden of the Contractor.
5. Contractor shall notify FDEP of conclusion of project and submit a notice of termination (NOT) coverage.

3.3 DUST CONTROL:

- A. Contractor shall make every effort to limit the transport of windborne dust and particulates from the disturbed site.
- B. Soil erosion due to wind shall be controlled with the application of water to dampen soil.

3.4 REPAIR AND RESTORATION:

- A. If any seed is washed out before germination, repair damage, refertilize and reseed.
- B. Maintain silt fence in a functional condition. Repair any damage immediately. Implement a routine maintenance schedule for all erosion schedule. All erosion control features shall be inspected immediately following all storm events.

3.5 CLEANING:

- A. Remove temporary controls and accumulated sediments when permanent facilities are able to perform function and when approved by Engineer.
- B. Remove accumulations of silt and other erosion products from all permanent facilities.

END OF SECTION 312500

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Soil treatment.
- B. Related Requirements:
 - 1. Section 061000 Rough Carpentry for wood preservative treatment by pressure process.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
 - 2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.
- D. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.6 FIELD CONDITIONS

- A. Soil Treatment:
 - 1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
 - 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (*Coptotermes formosanus*). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source and from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
 - 1. Basis of Design: "Dominion 2L Insecticide/Termiticide" by Control Solutions, Inc.
 - 2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 - 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
 - 1. Slabs-on-Grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and bases; and along the entire outside perimeter, from grade to bottom of footing.
 - 3. Masonry: Treat voids.
 - 4. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.

- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 313116

SECTION 321300 - CONCRETE PAVING, SIDEWALK AND CURB

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: 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 REFERENCES: All work shall be in accordance with Section 522 Concrete Sidewalk, Section 350 Cement Concrete Pavement, and Section 520 Concrete Gutter, Curb Elements & Traffic Separator of the latest edition of the "Florida Department of Transportation Standard Specifications for Road and Bridge Construction" unless specifically stated or directed otherwise.
- 1.3 SUBMITTALS:
- A. Material Certificates: Provide copies of material certificates including design mixes, signed by the Contractor, certifying that each specified material complies with, or exceeds requirements.
 - B. Provide manufacturer's literature and installation instructions for all concrete accessories such as joint filler and detectable warning textures.
 - C. Copies of all compliance testing and retests.

PART 2 - PRODUCTS

- 2.1 CONCRETE MIX, DESIGN AND TESTING:
- A. Comply with requirements of applicable FDOT Section 346 for Class I concrete mix design, sampling and testing, and quality control, and as herein specified.
 - B. Design the mix to produce standard weight concrete consisting of portland cement, aggregate, air-entraining admixture and water to produce the following properties:
 - 1. Compressive Strength:
 - a. Sidewalks: 3,000 psi @ 28 days
 - b. Pavement: 4,000 psi @ 28 days
 - c. Curb: 3,000 psi @ 28 days
 - 2. Air Content: 3% to 6%
 - 3. Water cement ratio shall not exceed 0.45
 - C. Concrete placement slump shall not exceed plus or minus 1 inch from approved design slump.

- D. Aggregates: Aggregate shall be 3/8" round with the following sieve graduation:

<u>Size</u>	<u>% Passing</u>
1"	100
3/4"	100
3/8"	90-100
#4	40-60
#8	0-10

- E. Water: Potable, clean, fresh, free from oil, acid, organic matter or other deleterious substances.
- 2.2 WELDED WIRE FABRIC: ASTM A185, welded steel wire fabric, 65 ksi, flat sheets only.
- 2.3 DEFORMED BARS: ASTM A615, carbon steel, Grade 60.
- 2.4 DETECTABLE WARNING TEXTURE: Prefabricated resin mat with embeds for attachment to wet concrete or predrilled for manufacturer recommended anchor system. Truncated dome surface shall conform to ADAAG 4.29.2. Color shall contrast with concrete surface. Provide federal yellow or brick red as appropriate.
- 2.5 JOINT MATERIAL: Closed cell expanded polyethylene foam of dimensions shown on Drawing.
- 2.6 FORM MATERIALS: Unless otherwise indicated, construct formwork with plywood, metal, metal framed plywood faced or other acceptable panel type materials to provide continuous, straight, smooth, exposed surfaces.
- 2.7 CHEMICAL HARDENER: Hardener shall be a colorless, aqueous solution of zinc or magnesium fluosilicate. Approved proprietary hardeners shall be delivered ready for use in the manufacturer's original containers.

PART 3 - EXECUTION

3.1 CONCRETE SIDEWALK & PAVEMENT INSTALLATION:

- A. General: Sidewalk, Curb and Pavement shall be installed where indicated on the drawings. Width of surface shall be as called out on the drawings.
1. All sidewalk shall be a minimum of 4-inches thick and unreinforced.
 2. All sidewalk at driveways or other areas subject to vehicular traffic shall be 6-inches thick with 6x6, W1.4xW1.4 welded wire fabric reinforcement. The length of 6-inch thick sidewalk shall extend 5' each side of gated entries.
 3. All pavement shall be thickness described on drawings.

B. Surface Preparation:

1. Construct stabilized sub-grade within limits of proposed sidewalk or pavement and level with the underside of concrete. Stabilization material and procedures shall be as described in the FDOT Standard Specifications for Road and Bridge Construction.
 - a. Sidewalks: Construct 6" thick stabilized subgrade.
 - b. Pavement and Curb: Construct 12" thick stabilized subgrade.
2. Proof-roll prepared sub-grade surface to check for unstable areas and the need for additional compaction.
3. Remove loose material from the compacted sub-grade surface immediately before placing the concrete.
4. Sub-grade for sidewalks shall be compacted to a minimum of 98 percent of AASHTO T 180 density and achieve an LBR value of 40.
5. Density tests shall be required for every 300 LF of sidewalk installed, at a minimum.
6. Where failing density tests occur, Contractor shall be required to recompact and retest area in both directions from point of failure to insure proper compaction has been achieved.
7. Subgrade preparation and construction for a concrete pavement section shall be subject to the subgrade requirements described in the Project Manual and the Drawings.

C. Concrete Placement:

1. Do not place concrete until sub-base and forms have been checked for line and grade. Moisten if required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around meter boxes or other structures until they are completed to required finish elevation and alignment.
2. 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, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels and joint devices. Do not use vibrators to push or move concrete in forms or chute.
3. 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.
4. Joints: Construct expansion, weakened-plane (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. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.
 - a. Weakened-Plane Joints: Construct weakened-plane joints for a depth equal to at least 1 1/4-inch thickness or 1/4 the pavement thickness whichever is greater, by sawing within six to eight hours of placement or formed during finishing operations. Place joints as described on drawings.

- b. Construction Joints: 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. Construction joints shall be standard metal keyway-section form of appropriate height.
- c. Expansion Joints:
 - (1) Provide premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.
 - (2) Locate expansion joints as described on the drawings.
 - (3) Extend joint fillers full-width and depth of joint, and not less than ½" below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.
 - (4) 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. Pieces shorter than 4' shall not be used unless specifically shown as such.
 - (5) 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.
 - (6) Fillers and Sealants: Comply with the requirements of these specifications for preparation of joints, materials installation, and performance and as herein specified.
- D. Concrete Finishing:
 - 1. 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.
 - 2. All sidewalk surfaces shall be cross sloped (1.0%) to provide positive drainage towards curbing or grassed area.
 - 3. All pavement surfaces shall be sloped to grades shown on the drawings.
 - 4. After floating, test surface for trueness with a 20' straightedge. Variations exceeding 1/4" for any two points within 10' shall not be acceptable. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.
 - 5. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round 10 ½" radius, unless otherwise indicated. Eliminate any tool marks on concrete surface.
 - 6. After completion of floating and when excess moisture or surface sheen has disappeared, broom finish surface by drawing a fine-hair broom across concrete surface, perpendicular to the line of traffic.

7. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean up ends of joints and point-up any minor honeycombed areas.
- E. Curing: Protect and cure finished concrete paving and walks, as required. Use moist-curing methods for initial curing whenever possible or approved concrete curing compounds.
- F. Repairs and Protections:
1. Repair or replace broken or defective concrete as directed by the Engineer.
 2. Drill test cores where directed by the Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy resin grout.
 3. Protect concrete from damage until acceptance of work. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
 4. Sweep concrete pavement and wash free of stains and discolorations, dirt and other foreign material just prior to final inspection.

END OF SECTION 321300

SECTION 323113 - CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

- 1.1 RELATED DOCUMENTS: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- 1.2 DESCRIPTION OF WORK: Extent of chain link fences and gates is indicated on drawings.
- 1.3 QUALITY ASSURANCE: Provide galvanized steel, vinyl coated chain link fences and gates as complete units controlled by a single source including necessary erection accessories, fittings and fastenings.
- 1.4 SUBMITTALS:
- A. Product Data: Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, gates and accessories.
 - B. Manufacturers Certification of Zinc-Coating Compliance.
- 1.5 APPLICABLE PUBLICATIONS:
- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
 - B. American Society for Testing and Materials (ASTM):
 - 1. A121 Zinc Coated Carbon Steel Barbed Wire
 - 2. A392 Zinc Coated Steel Chain-Link Fence Fabric
 - 3. A817 Metal Coated Steel Wire for Chain-Link Fence Fabric and Marcellled Tension Wire
 - 4. C94/C94M Ready-Mixed Concrete
 - 5. F567 Installation of Chain-Link Fence
 - 6. F626 Fence Fittings
 - 7. F668 PVC Coated Steel Chain-Link Fence Fabric
 - 8. F900 Industrial and Commercial Swing Gates
 - 9. F1043 Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
 - 10. F1083 Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

PART 2 - PRODUCTS

- 2.1 GENERAL: Dimensions indicated for pipe, roll-formed and H-sections are outside dimensions, exclusive of coatings.
- A. Galvanized Steel Fencing and Fabric:
 - 1. Allied Tube and Conduit Corp.
 - 2. American Fence Corp.
 - 3. Armstrong Fence Company

4. Approved equal.

2.2 STEEL FABRIC:

- A. Fabric: No. 9 ga/ size steel wires, 2" mesh with top and bottom selvages knuckled.
 - 1. Furnish one-piece fabric height for fencing up to 12' high.
- B. Fabric Finish: Galvanized, ASTM A392, Class II, with not less than 2.0 oz. zinc per sq. ft. of surface.
- C. Polymer (Vinyl) Coating: ASTM F668 fused and adhered to exterior zinc coating (Class 2b).

2.3 FRAMING AND ACCESSORIES:

- A. Steel Framework, General: Galvanized steel, ASTM F1083, with not less than 1.8 oz. zinc per sq. ft. of surface. With fused and adhered polymer coating to the exterior zinc coating in accordance with ASTM F 1043.
- B. Fittings and Accessories, General: Galvanized Steel, ASTM F626, with not less than 1.8 oz. zinc per sq. ft. of surface with fused and adhered polymer coating to the zinc coating in accordance with ASTM F 1043.
- C. End, Corner, and Pull Posts: Minimum sizes as required for the purpose intended but no less than 2-3/8" (2" ID) Schedule 40 pipe for fences up to 4' high; no less than 2-7/8" (2-1/2" ID) Schedule 40 for fences up to 8' high; and no less than 3-1/2" (3" ID) Schedule 40 for fences up to 10' high.
- D. Gate Posts: Furnish posts for supporting single gate leaf, or one leaf or a double gate installation, for nominal gate widths as follows:

Leaf Width	Gate Post	lbs./lin. ft.
Up to 6'	3.5" x 3.5" roll-formed or 2.875" OD pipe	4.85 section or 5.79
Over 6' to 13'	4.000" OD pipe	9.11
Over 13' to 18'	6.625" OD pipe	18.97
Over 18'	8.625" OD pipe	28.55

- E. Line Post: Minimum size as required for the purpose intended but no less than 1-7/8" (1-1/2" ID) Schedule 40 pipe for fences up to 4' high; no less than 2-3/8" (2" ID) Schedule 40 for fences up to 8' high; and no less than 2-7/8" (2-1/2" ID) Schedule 40 for fences up to 10' high. The maximum horizontal spacing of line post shall be 10'
- F. Top Rail: Minimum size as required for the purpose intended but no less than 1-5/8" (1-1/4" ID) Schedule 40 pipe.
- G. Intermediate Rail: Minimum size and frequency as required for the purpose intended but no less than 1-5/8" (1-1/4" ID) Schedule 40 pipe. Provide intermediate rail on fences over 5' high at sections adjacent to end, corner, pull and gate post.

- H. Bottom Tension Wire: Minimum size as required for the purpose intended but no less than 7 gauge galvanized steel wire, continuous along the bottom of all height fences.
- I. Wire Ties: 9 ga. galvanized steel to match fabric core material.
- J. Post Brace Assembly: Manufacturer's standard adjustable brace at end of gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 0.375" diameter rod and adjustable tightener.
- K. Post Tops: Provide weather-tight closure cap with loop to receive tension wire or top rail; one cap for each post.
- L. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16" x 3/4". Provide one stretcher bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.
- M. Stretcher Bar Bands: Space not over 15" o.c. to secure stretcher bars to end, corner, pull and gate posts.

2.4 GATES:

- A. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding or with special fittings and rivets for rigid connections, providing security against removal or breakage connections. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories. Space frame members maximum of 8' apart unless otherwise indicated.
 - 1. Provide same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical edges and at top and bottom edges. Attach stretcher bars to gate frame at not more than 15" o.c.
 - 2. Install diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on gates to ensure frame rigidity without sag or twist.
- B. Swing Gates: Polymer coated, galvanized steel pipe welded fabrication, ASTM F900, Fabricate perimeter frames on minimum 1.90" O.D. pipe.
- C. Rolling Gates: Polymer coated, galvanized steel welded joint fabrication, ASTM F900. Provide manufacturer's standard heavy-duty track, framing and supports, guides, stays, bracing, hardware and accessories as required. Provide double steel wheels with hard rubber rollers at leading end.
- D. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM F1083, and in accordance with the following:
 - 1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 deg. gate opening. Provide 1-1/2 pair of hinges for each leaf over 6' nominal height.
 - 2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.

3. Keeper: Provide keeper for vehicle gates, which automatically engages gate leaf and holds it in open position until manually released.
 4. Double Gates: Provide gate stops for double gates, consisting of mushroom-type, flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.
- 2.5 CONCRETE: Provide concrete consisting of portland cement, ASTM C150, aggregates ASTM C33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3,000 psi using at least 4 sacks of cement per cu. yd., 1" maximum size aggregate, maximum 3" (+/- 1") slump, and 2% to 4% entrained air.

PART 3 - EXECUTION

- 3.1 GENERAL: Fences along property lines shall be set 6-inches inside the property line. Layout of property line fences shall be verified by a Florida Licensed Land Surveyor.
- 3.2 INSTALLATION: Do not begin installation and erection before final grading is completed, unless otherwise permitted. Install fence in accordance with ASTM F567, manufacturers printed instructions and as specified herein.
 - A. Excavation: Hand excavate (using post hole digger) holes for post to diameters and spacing indicated, in firm, undisturbed or compacted soil. Existing concrete shall be drilled to the dimensions shown on the Drawings.
 1. If not indicated on drawings, excavate holes in earth for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.
 2. Unless otherwise indicated, excavate hole depths approximately 3" lower than post bottom, with bottom of posts set not less than 36" below finish grade surface.
 - B. Setting Posts: Center and align posts in holes 3" above bottom of excavation.
 1. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
 2. Unless otherwise indicated, extend concrete footings 2" above grade and trowel to a crown to shed water.
 - C. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.
 - D. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.
 - E. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 ga. galvanized wire. Fasten fabric to tension wire using 11 ga. galvanized steel hog rings spaced 24" o.c.
 - F. Fabric: Leave approximately 2" between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie posts, rails and tensions wires. Install fabric on security side of fence and anchor to framework so that fabric remains in tension after pulling force is released.

- G. Stretcher Bars: Thread through or clamp to fabric 4" o.c., and secure to posts with metal bands spaced 15" o.c.
- H. Gates: Install gates plumb, level and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- I. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.
 - 1. Tie fabric to line posts, with wire ties spaced 12" o.c. Tie fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24" o.c.
- J. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score thread to prevent removal of nuts.

3.3 QUALITY ASSURANCE:

- A. Gates shall swing or run smooth and latch without difficulty.
- B. All gate operations shall be capable of being performed by any able bodied Owner personnel with a minimum of effort.
- C. Gates shall be adjusted and aligned to the satisfaction of the Engineer prior to final acceptance.

3.4 CLEANING:

- A. Remove waste fencing materials from the project site and dispose of off-site.
- B. Remove accumulations of silt and other erosion products from all permanent facilities.

END OF SECTION - 323113

SECTION 330513 - PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

- 1.1 DESCRIPTION OF WORK: The work under this section shall include the furnishing of all labor, materials and equipment necessary for the construction and installation of all manholes and drainage structures as called for on the drawings.
- 1.2 QUALITY ASSURANCE:
- A. Manufacturer of precast concrete covered in this section shall have a minimum of 5 years experience in the design and construction of wire wound circular precast structures.
 - B. Manufacturer of top and frames specified herein shall have a minimum of five years experience in the manufacture of like product.
 - C. Submittals:
 - 1. Provide shop drawings showing dimensions, finishes, reinforcement and connections details.
 - 2. Provide erection layout and details.
 - 3. Provide cut sheets of catalog cuts and details of all accessories.
 - 4. Provide test results for concrete.
 - D. Standards: Latest edition of the Florida Department of Transportation Standard Specification for Bridge and Roadway Construction.
- 1.3 PRODUCT DELIVERY AND HANDLING: Handle and store materials to prevent damage and deterioration.

PART 2 - PRODUCTS

- 2.1 PRECAST CONCRETE MANHOLES: Manhole bases, sections and cones shall conform to the requirements of ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections with the exception of Section 10 (a), except as modified herein. Cement shall meet the requirements of ASTM C150, Specification for Portland Cement, Type II. Concrete shall have a minimum compressive strength of 4,000 psi. Minimum wall thickness shall be 1/12 the inside diameter in inches plus one inch. The required minimum strength of concrete shall be confirmed by making and testing four standard cylinders at seven days. Rings shall be custom-made with openings to meet indicated pipe alignment conditions and invert elevations.
- A. Bases: 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 poured 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 leveling course, said section shall be placed just prior to initial set of the Class C concrete leveling course.

- B. Joints: Joint contact surfaces shall be formed with machined castings; they shall be exactly parallel with 2 degree slope and nominal 1/16-inch clearance with the tongue-equipped with a proper recess for the installation of an O-ring rubber gasket, conforming to ASTM C443, Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber gasket, or RAMNEK premolded Plastic Joint Sealer with joints preprimed.
- C. Coating: With the exception of joint contact surfaces, and the interior surfaces of all openings to receive the pipe and a one inch annular ring around the interior and exterior of said openings, the interior and exterior surfaces of each manhole shall be given two coats of Farbertite as manufactured by Briggs Bituminous Composition Company, Philadelphia, Pa., a subsidiary of Penn Crete Products Co., Inc.; no substitutes. Total minimum dry film thickness shall be 12 mils. Each coat shall be applied at a rate not to exceed one gallon per 100 square feet. The waterproofing materials shall be applied by brush or spray and in accordance with the instruction 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. Special precaution shall be taken not to coat joint contact surfaces, as Farbertite is not a joint prepriming material.
- D. Manhole Adjustment Materials:
1. Bricks: The brick shall be sound, hard and uniformly burned brick, regular and uniform in shape and size, of compact texture and satisfactory to the Engineer. Brick shall comply with the ASTM Standard Specifications for Sewer Brick (Made from Clay or Shale), Designation C-32, latest, Grade MM. Each brick shall be laid in a full bed and joint of mortar without requiring subsequent grouting, flushing, or filling, and shall be thoroughly bonded as directed. Only clean brick shall be used in brickwork. The bricks shall be moistened by suitable means, as directed, until they are neither so dry as to absorb water from the mortar, not so wet as to be slippery when laid. Outside faces of brick masonry shall be plastered with mortar from 1/4-inch or 3/8-inch thick. If required, the masonry shall be properly moistened prior to application of the mortar. The plaster shall be carefully spread and troweled so that all cracks are thoroughly worked out. After hardening, the plaster shall be carefully checked, by being tapped, for bond and soundness. Unbound or unsound plaster shall be removed and replaced. Brick masonry and plaster shall be protected from too rapid drying by the use of burlaps kept moist, or by other approved means, and shall be protected from the weather and frost.
 2. Rejected brick shall be immediately removed from the work and brick satisfactory to the Owner substituted.
 3. Mortar for Brickwork: The mortar shall be composed of portland cement and sand. Mortar shall be one part cement and two parts sand; lime shall not be used.
 4. Cement: Portland, ASTM C150, Specification for Portland Cement, Type II.
 5. Sand: Washed silica sand, ASTM C144, Specification for Aggregate for Masonry Mortar.
 6. Non-shrink Mortar: Embecco No. 167 and No. 381 Mortar as manufactured by the Master Builders Co. rapid drying by the use of burlaps kept moist, or by other approved means, and shall be protected from the weather and frost.
- 2.2 CAST IRON FRAMES, GRATINGS AND COVERS: Castings shall be made of good quality, strong, tough, even grained cast iron and shall be smooth, free from scale, lumps, blisters, 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 A48-64,

Specifications for Gray Iron Castings, Class No. 30, or Grade 65-45-12, Ductile Iron meeting the requirements of ASTM A536-70, Standard Specification for Ductile Iron Castings. In either case, manhole frame and cover shall be designed to withstand an HS20-44 loading defined in the AASHTO Specifications. 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.

- 2.3 FLEXIBLE MANHOLE CONNECTOR: Where the sewer pipe enters the precast manhole, a flexible pipe to manhole connector shall be used. The connector shall be the "Kor-N-Seal" as manufactured by National Pollution Control Systems, Inc., Milford, New Hampshire or equal. The connector shall be the sole element to assure a flexible watertight seal of the pipe to the manhole.
- A. Material: The Neoprene-EPDM material the connector is manufactured from shall conform to ASTM C-443 and shall be a minimum of 3/8 inches (9.4MM) thick or greater. The material shall be resistant to ozone, weathering, aging, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products.
- 2.4 BANDS: The stainless steel band and worm screw assembly shall be totally non magnetic series 304 stainless steel. The worm screw for tightening the stainless steel band shall be torqued by a break-away torque wrench available from the precast manhole supplier and set for a torque pressure of 60-70 inch/pounds.
- 2.5 CONNECTOR: The connector shall be of a size specifically designed for the specified pipe material and size. Also, the connector shall be installed in the manhole wall by the precast manufacturer in strict accordance with the recommendations of the connector manufacturer. During the invert construction stage, the interior annular space between the exterior of the pipe and the interior of the connector shall be filled with a Type II Lean Cement Grout by the Contractor.
- 2.6 WATERTIGHT POLYETHYLENE MANHOLE INSERT: Each manhole which is not installed in a paved road, where the top of the manhole lid is to be buried below grade, shall be fitted with a watertight manhole insert to prevent the intrusion of groundwater or rainwater. The manhole insert shall be constructed of rust-free, high density polyethylene and shall be shaped to allow the manhole cover to swing freely. The insert shall be furnished with a gasket, heat-welded to the liner, to help seal the manhole cover. The liner shall be furnished with a spring-loaded gas relief valve designed to relieve sewer gas at 1/2 psi. The liner shall also be furnished with a spring-loaded vacuum relief valve designed to release vacuum in the collection system at 2.25 psi. Both valves shall be constructed of non-corrosive materials and shall be sturdy enough to act as handles to remove the liner. Acceptable: Sewer Guard Manhole Insert by Fasroc, Inc. or equal.

PART 3 - EXECUTION

- 3.1 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 of previously set section shall have an O-ring installed in the recess or shall be sealed with pre-molded plastic joint sealer "RAMNEK." If "RAMNEK" is used, joints shall be pre-primed.
- 3.2 METALLIC NON-SHRINK MORTAR: All holes in sections used for their handling, and the annular space between the wall and entering pipes shall be thoroughly plugged with Embeco No. 167, or No. 381 as manufactured by the Master Builders Company, or Thoroset (RM) as manufactured by the Standard Dry Wall products Inc., or any approved equal non-shrinking mortar or grout, 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.

- 3.3 **MEMBRANE CURING COMPOUND:** As soon as mortar is hydrated to the point where it will not be marred by such application, and within two (2) hours after installing mortar, the Contractor shall apply an approved membrane curing compound, conforming to ASTM C-309-74, Type 1, Class B, to the finished mortar surfaces both inside and outside the manhole. Embecco mortar shall be coated with Master Builder's Masterseal; Thoroset (RM) grout shall be coated with Standard Dry Wall Products' Thorocure. Submission of alternate mortars or grouts should include an alternate membrane curing compound or indicate which of the above approved products is proposed for use.
- 3.4 **GRADE ADJUSTMENT:** For grade adjustment in setting the manhole frame, brick masonry 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.
- 3.5 **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 Owner. 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 water tight. 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.
- 3.6 **FLOW CHANNELS:** 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.
- 3.7 **CLEANUP:** The Contractor shall maintain the site of the work in a neat condition. The Contractor shall remove all excess materials, excess excavated materials and all debris resulting from his operations.

END OF SECTION - 330513

SECTION 331100 - PIPE WORK - PRIVATE DISTRIBUTION SYSTEM

PART 1 - GENERAL

- 1.1 DESCRIPTION: Work under this Section consists of furnishing all materials, supplies, equipment and labor in accordance with the requirements set forth herein and as shown on the Drawings.
- 1.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS: The work under this Contract shall be in strict accordance with the following codes and standards.
- A. All Local, County, Municipal and Federal Codes.
 - B. American National Standards Institute (ANSI).
 - C. American Society for Testing and Materials (ASTM).
 - D. American Water Works Association (AWWA).
 - E. American Association of State Highway and Transportation Officials (AASHTO).
 - F. Florida Department of Transportation Specifications (DOT).
 - G. Recommended Standards for Water Works, 10-States Standards. (RSWW).
 - H. Florida Dept. of Environmental Protection (FDEP).
 - I. National Fire Protection Association (NFPA).
- 1.3 QUALITY ASSURANCE STANDARDS:
- A. American National Standards Institute, Inc. (ANSI)/American Water Works Association (AWWA):
 - 1. ANSI/AWWA C104, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. ANSI/AWWA C105, Polyethylene Encasement for Ductile - Iron Piping for Water and Other Liquids.
 - 3. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - 4. ANSI/AWWA C115, Flanged Ductile-Iron Pipe with Threaded Flanges.
 - 5. ANSI/AWWA C150, Thickness Design of Ductile-Iron Pipe.
 - 6. ANSI/AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 7. ANSI/AWWA C153, Ductile-Iron Compact Fittings, 3 In. Through 16 In., for Water and Other Liquids.

8. AWWA C502, Dry-Barrel Fire Hydrants.
 9. AWWA C504, Rubber-Seated Butterfly Valves.
 10. AWWA C515, Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service.
 11. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
 12. AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 13. AWWA C651, Disinfecting Water Mains.
 14. AWWA C701, Cold-Water Meters - Turbine Type, for Customer Service.
 15. AWWA C800, Underground Service Line Valves and Fittings.
 16. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.
 17. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. through 48 In. for Water Transmission and Distribution.
- B. American Society for Testing and Materials (ASTM):
1. D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 2. D2464, Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 3. D2467, Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 4. D2564, Solvent Chemicals for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 5. D2855, Making Solvent Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- C. Manufacturer's name and model numbers are listed to establish a standard of quality. Equivalent items of other manufacturers are acceptable.
- 1.4 SUBMITTALS:
- A. Submit manufacturer's certification of materials' conformance to specifications.
 - B. Submit manufacturer's literature, catalog data and installation instructions.
 - C. Submit certified field pressure test reports.
 - D. Backflow Certification and testing results.
 - E. Field flow tests for fire system components in accordance with NFPA 24.

1.5 PRODUCT DELIVERY AND HANDLING:

- A. Exercise care to prevent damage of product during loading, transporting, unloading and storage.
- B. Do not drop pipe or fittings.
- C. Do not store directly on ground and assure that materials are kept clean. Pipe shall be kept bundled and strapped until it is ready for installation in order to prevent warping or disfiguring.
- D. Store material in areas approved by the Owner.
- E. Store material in such a manner as to not create a nuisance or safety hazard.

PART 2 - PRODUCTS

2.1 PIPE:

- A. General: Pipe shall be furnished free from defects impairing strength and durability and should be of best commercial quality for purpose specified. Structural properties shall be sufficient to safely sustain or withstand strains to which it is normally subjected. All pipe shall bear the National Sanitation Foundation Seal for potable water pipe.
- B. Pipe Materials:
 - 1. Ductile Iron (D.I.) ANSI/AWWA C151:
 - a. Metal Thickness, ANSI/AWWA C150:
 - 1) 3 Inch through 12 Inch: Pressure Class 350.
 - 2) 14 Inch and Larger: Pressure Class 250.
 - 3) Jack and Bore Crossings: Pressure Class 350.
 - b. Interior Lining, ANSI/AWWA C104: mortar lined.
 - c. Exterior Coating, Bituminous Coating, 1 Mil thick.
 - 2. Polyvinyl Chloride (PVC) 14 In. and larger:
 - a. Specification: AWWA C905.
 - b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Class 165, DR 25.
 - 3. WATER SERVICE: Polyvinyl Chloride (PVC) 4 In. Through 12 In.:
 - a. Specification: AWWA C900.

- b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Class 150, DR 18.
 - 4. FIRE SERVICE: Polyvinyl Chloride (PVC) 4 In. Through 12 In.:
 - a. Specification: AWWA C900.
 - b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Class 200, DR 14.
 - 5. Polyvinyl Chloride (PVC), 3 In.:
 - a. Specification: ASTM D2241.
 - b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Class 200, DR 18.
 - 6. Polyvinyl Chloride (PVC), 2 In. and Smaller:
 - a. Specification: ASTM D1785.
 - b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Schedule 80.
 - 7. Galvanized Steel (GS), 3 In. and Smaller:
 - a. Specification: ASTM A53.
 - b. Thickness: Schedule 40.
- C. Pipe Joints:
 - 1. Ductile Iron:
 - a. Mechanical: ANSI/AWWA C111.
 - b. Push On: ANSI/AWWA C111, single gasket type.
 - c. Flanged: ANSI B16.1, 125 lb.
 - d. Restrained: Acceptable: Lock-Fast, American Ductile Iron Pipe; TR Flex, U.S. Pipe; Super-Lock, Clow Corporation; Megalug 1100 and 1700 Series.

2. Polyvinyl Chloride, 3 In. and Larger:
 - a. Push On: ASTM F477 Elastomeric Gaskets
 - b. Restrained: UNI-BELL B-13, Uni-Flange Restrainer; Megalug 2000 PV and 1600 Series.
 3. Polyvinyl Chloride, 2 In. and Smaller:
 - a. Screwed: ASTM D2464.
 - b. Solvent Weld: ASTM D2855.
 - c. Solvent: ASTM D2564.
- D. Pipe Fittings:
1. Ductile Iron and Polyvinyl Chloride (PVC) 3 In. and Larger:
 - a. ANSI/AWWA C153, ductile iron compact fittings.
 - b. ANSI/AWWA C104, mortar lined.
 - c. Mechanical: ANSI/AWWA C111.
 - d. Push On: AWSI/AWWA C111.
 - e. Flanged: ANSI B16.1, 125 lb.
 - f. Restrained-Ductile Iron: Same as Ductile Iron Pipe Joints.
 - g. Restrained-PVC: Same as PVC Pipe Joints.
 2. Polyvinyl Chloride (PVC) 2 In. and Smaller:
 - a. ASTM D2464, Schedule 80 PVC threaded fittings.
 - b. ASTM D2467, Schedule 80 PVC socket type fittings.
 - c. ASTM D2855, solvent weld joints.
- E. Pipe Marking and Identification:
1. Ductile Iron Pipe: Permanent marking tape, with the words "WATER MAIN" printed along the tape, shall be attached to the pipe for its entire length. In addition, similar marking tape shall be placed in the trench over the pipe, six to twelve inches below finished grade, of the entire length of pipe.

2. PVC Pipe:

- a. All non-metallic water main pipe installed underground shall have a #12 gauge, solid strand, copper type UF insulation trace wire (blue in color) attached for locating purposes. Half hitches shall be made behind each pipe bell and on each side of a valve or fitting. Branch splices shall be made at all tees, fire hydrants, and service lines. Trace wire shall be run into valve boxes. Watertight splicing connectors shall be utilized for all splices. Contractor shall be responsible for continuity of trace wire between valve boxes.
- b. All PVC water main pipe shall be manufacturer's standard blue color or shall have permanent marking tape attached with the words "WATER MAIN" printed along the tape. In addition, similar marking tape shall be placed in the trench over the pipe, six to twelve inches below finish grade, for the entire length of pipe.

2.2 GATE VALVES:

- A. Larger than Two Inch: Shall be AWWA C515, iron body, resilient wedge, resilient seat, non-rising bronze stem with 2" square operating nut on buried valves, turn to left (counter clockwise) to open.
 1. Working pressure of 200 psi.
 2. Internal Metal Surfaces shall have two-part thermosetting epoxy coating, 4 mils thick.
 3. Sealing Mechanism shall have zero leakage at 200 psi with flow in either direction.
 4. End Conditions: Fit joints specified and/or required for piping.
 5. Acceptable: Mueller Series A-2370, American Series 2500 or equal.
 6. Provide (2) two valve wrenches for each type of valve installed.
- B. Two Inch and Smaller:
 1. Type III (double wedge disc, rising stem, inside screw).
 2. Class B.
 3. Threaded ends.
 4. 150 psi working pressure.

2.3 HOSE BIBBS (3/4"):

- A. Body to be all brass construction.
- B. Male connection threads suitable for 3/4" hose connection.

- C. Loose key, anti-tamper operation.
- D. Anti-siphon check valve connection to hose.

2.4 YARD HYDRANT (3/4"):

- A. Encased, non-freeze ground hydrant for flush with grade or finished floor installation, complete with galvanized steel casing, all bronze interior parts, replaceable bronze seat and seat washer, non-turning operating rod with free-floating compression closure valve, and 3/4" female IP inlet connection.
- B. Lockable chrome-plated bronze box and hinged cover. Provide (2) keys with each unit installed.
- C. Hydrant shall be equipped with a tapped 1/4" drain port in the valve housing, and 3/4" hose connection
- D. Equipped with integral vacuum breaker.
- E. Zurn Z1361-CL-VB or equal.

2.5 VALVE BOXES:

- A. Provide at all manually operated valves installed on underground lines.
- B. ASTM A48, cast iron, Class 30-B, 3-piece extension type, with cover marked "WATER" and flared base to suit valve furnished.
- C. Acceptable: Figure No. F-2450, Clow Corporation; Catalog No. H10357, Mueller Co.; Figure No. E-3002, M & H Valve and Fittings Co. or equal.

2.6 FLUSHING VALVE:

- A. Blow offs shall be box hydrants with a 2" main valve and a 2" bronze, male, thread discharge nozzle.
- B. All hydrants shall have lockable iron lids, all bronze working parts and removable bronze seats with rubber seals.
- C. One 24"-long operating wrench shall be provided for every three hydrants furnished.
- D. Working Pressure: 150 psi.
- E. Acceptable: Kupferle Foundry, Model 85B; H20K, Inc., the Sample Station; or equal.

2.7 TAPPING SADDLES:

- A. For Ductile Iron Mains: Service Saddles shall be made of malleable or ductile iron with a 4-bolt, stainless steel, ductile iron, cast brass or bronze strap.
- B. For Polyvinyl Chloride (PVC) Mains: Service Saddles shall be made of cast brass or bronze with a 4-bolt stainless steel, cast brass or bronze strap.

- C. The backside face of the saddle shall be provided with an extra-wide neoprene-rubber gasket.
 - D. The inside diameter of the saddle shall match that of the pipe outside diameter for a size-size match.
- 2.8 JOINT HARNESS: Steel straps and rods across joints, securely anchored on pipe or other adequate anchorage, to resist hydraulic thrust at maximum pressure pipe will be subjected to, 200 psi minimum.
- A. Coal Tar Coating: Koppers Bitumastic No. 50.
 - B. Clamps, Straps, and Washers: Steel, ASTM A506.
 - C. Rods: Steel, ASTM A575.
 - D. Rod Couplings: Malleable Iron ASTM A197.
 - E. Bolts: Steel ASTM A307.
 - F. Cast Iron Washers: Gray-iron ASTM A126.
- 2.9 CHECK VALVES: (3" to 10")
- A. Check valve open with 1 psi pressure differential in direction of flow.
 - B. Four (4) test cocks for field testing.
 - C. Epoxy coated cast iron body.
 - D. Minimum rated working pressure 175 psi.
- 2.10 PLASTIC LOCATING AND MARKING TAPE: Tape shall be plastic coated foil with a minimum width of 2 inches. Tape shall be highly visible and shall have the words "WATER MAIN" in at least 1" letters printed at least every 36 inches along the tape. Tape shall be located one foot below ground surface directly above the centerline of the pipe. Tape shall be Allen Marking Tape or equal.
- 2.11 LOCATING WIRE: #14 GAUGE THHN Trace Wire with blue insulation.
- 2.12 THRUST BLOCKING: Not allowed.
- 2.13 POST INDICATOR VALVES: Buried quarter-turn valve with an above grade indicator-operator. Factory assembled unit with true orientation guarantee by the manufacturers. Equal to Henry Pratt Co., Type FM 1.
- 2.14 THERMAL PROTECTION:
- A. THERMAL WRAP: Minimum 3/4" thick elastomeric thermal insulation (ASTM D 1622 or D1667). The closed cell foam shall have a UV resistant PVC or aluminum exterior covering. Product shall provide a 10 year warranty on the membrane.
 - B. HOT BOX: Insulated fiberglass box sized to fit RPZ and double detector check backflow prevention assemblies.

- 2.15 BACKFILL MATERIAL: All backfill shall be excavated material, essentially free of organic material, asphaltic concrete, clay, concrete, boulders and other deleterious material.
- A. Bedding and Haunching to 12" Above Top of Pipe: The Contractor shall furnish, place, and compact AASHTO Class A-3 sandy material containing less than 1% of organics or other unsuitable material.
 - B. Above Pipe Embedment: The material shall be AASHTO Class A-3 material or AASHTO Class A-2-4 with prior approval from the Engineer.
 - C. Top of Backfill: The top 12 inches of the backfill shall be topsoil and/or AASHTO Class A-3 material with mixed organics.
 - D. Additional Fill: If sufficient suitable backfill material is not available from the excavation, additional fill meeting the above requirements shall be provided by the Contractor at no expense to the Owner.
 - E. All backfill shall be tested for compliance with above requirements prior to placement in accordance with Section 310000.
- 2.16 CONCRETE: 3,000 psi 28 day strength mix, typical for all pipe encasements and concrete collars around utility access ports.

PART 3 - EXECUTION

3.1 EXCAVATION:

A. General:

1. The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the Drawings or as necessary.
2. Include all necessary clearing and grubbing of any foreign substance encountered within the structure or trench area.
3. Excavated material suitable for backfill shall be piled in an orderly manner at a sufficient distance from the trench to prevent slides or cave-ins.

B. Protection of Existing Facilities and Utilities:

1. All existing improvements such as pavements, conduit, poles, pipes and other structures, shall be carefully supported and fully protected from injury and, in case of damage, they shall be restored, pressure tested and disinfected by the Contractor without compensation.
2. Existing utilities and other underground obstructions are shown on the plans, but the accuracy of the locations and depths is not guaranteed.
3. The Contractor shall contact all utilities prior to construction and arrange for the necessary assistance in locating and protecting the existing utilities.

4. The Contractor shall be responsible for damages to these existing utilities and shall, in the event they are damaged, restore them to their original condition.
- C. Trench Excavation:
1. The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8 in. each side of pipe for unsheeted or sheeted trench, with the maximum width of trench, measured at the top of the pipe, not to exceed the outside pipe diameter, plus 24 in., unless otherwise shown on the Drawings.
 2. Trench walls shall be maintained vertical from the bottom of the trench to a line measured at the top of the pipe. From the top of the pipe to the surface of the trench walls shall be as vertical as possible under soil conditions.
 3. No more than 300 linear feet of trench shall be open in advance of the completed pipe laying operation without prior approval of the Engineer.
 4. Pipe trenches across roadways and driveways shall be backfilled as soon as the pipe is installed.
 5. No trench shall be left open across any roadway or driveway for more than 24 hours.
 6. It shall be the Contractor's responsibility to provide traffic control and barricades as necessary.
- D. Shoring, Sheeting and Bracing:
1. The Contractor shall be responsible for the design, installation and maintenance of all shoring, sheeting and bracing required to perform and protect the excavation and ensure the safety of the public, employees, existing roads, structures and other utilities.
 2. The top of any sheeting left in place shall be cut off at a minimum elevation of 2.5 ft. below finished grade.
 3. The Contractor may substitute a properly designed trench box in lieu of permanent bracing, where applicable.
 4. All excavation shall be in accordance with the Florida Trench Safety Act and all applicable requirements of OSHA.
- E. Pavement Removal:
1. The Contractor shall remove pavements as part of the trench excavation.
 2. The asphalt and base material from permanent pavement removal shall be carefully separated from trench excavation material.
 3. Asphalt millings and base material shall be used in place of stabilized subgrade under the new pavement.

- F. Boulder Removal: All rocks, stones, boulders or concrete, having any dimension larger than permitted to be used for backfill in the paragraph entitled "Backfilling" of these Specifications, shall be removed from the site and disposed of by the Contractor.
- G. Unsuitable Soil Conditions and Overdepth Excavation: In the event the project encounters unsuitable materials, the Contractor shall construct an adequate foundation to support the pipe.
 - 1. For Very Soft Clays (SC, CH, CL) ($N < 2.5$ blows/ft) foundation shall consist of 4" of compacted AASHTO A-3 Sand.
 - 2. For all other unsuitable soil conditions the foundation shall consist of 8" of compacted AASHTO A-3 Sand.
 - 3. The foundation shall be overlain by 4" of bedding material. Bedding material shall be A-3 sand.
 - 4. Shape bedding material to receive pipe bells and support 1/4 of the pipe surface.
- H. Disposal of Excess Material:
 - 1. All surplus excavated material which is unsuitable for fill shall become the property of the Contractor and shall be disposed of by the Contractor at his expense.
 - 2. Surplus suitable backfill material shall become the property of the Owner. In the event the Owner declines to accept this material it shall become the property of the Contractor and be disposed of at no expense to the Owner.

3.2 INSTALLATION OF WATER MAINS AND SERVICES:

- A. General: Unless otherwise noted on the Drawings or in other sections of this Specification, the pipe shall be handled and installed in strict accordance with the manufacturer's instructions and with the applicable AWWA or ASTM Standards.
 - 1. Ductile Iron Pipe: AWWA C600.
 - 2. Polyvinyl Chloride Pipe: ASCE Manual No. 37, ASTM D2321.
 - 3. If a conflict exists between the manufacturer's instructions and the AWWA or ASTM Standards, the manufacturer's instructions shall govern.
 - 4. Examine area to receive pipe work for defects that adversely affect execution of work or cause deviation beyond allowable tolerances for piping clearances.
 - 5. Carefully examine each section of pipe or valve before installation. Do not use defective or damaged pipe or materials. Remove such pipe or material from project site immediately.
- B. Preparation:
 - 1. The Contractor shall use every precaution during construction to protect the pipe against the entry of nonpotable water, dirt, wood, small animals and other foreign material that would hinder the operation

of the pipeline.

2. Where the groundwater elevation is above the bottom of the trench, the Contractor shall provide suitable dewatering equipment. All piping shall be placed in a dry trench.
- C. Depth of Cover: Unless otherwise shown on the Drawings, or otherwise authorized by the Engineer, the pipe shall have a minimum cover of 30 inches in unpaved areas and 36 inches in paved areas.
- D. Connections to Existing Mains:
1. The Contractor shall make connections to existing mains as shown on the Drawings.
 2. Connections shall be made only after arrangements have been completed by the Contractor with the Owner of the system and shall be under the System Owner's immediate supervision. Contractor shall be required to restrain existing pipe as necessary in accordance with pipe restraint schedule.
- E. Pipe Thrust Restraints:
1. Mechanical restrainers shall be installed as required to properly restrain all piping systems.
 2. Required lengths of restrained pipe each side of all fittings and valves shall be as shown in pipe restraint schedule at end of this paragraph for the type of soil encountered.
 3. For above-grade piping, all valves and fittings shall be threaded, flanged or solvent welded with supports as required.

PIPE RESTRAINT SCHEDULE

MINIMUM LENGTH OF PIPE (IN FEET) REQUIRED TO BE
RESTRAINED ON EACH SIDE OF A VALVE OR FITTING
FOR SANDY SOILS (SW, SP, SM, SC)

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
P V C P I P E	≤4	18	18	18	18	18	22	36	18	52
	6	24	18	18	18	18	30	38	36	73
	8	31	18	18	18	18	40	69	36	96
	10	37	18	18	18	18	48	93	54	115
	12	43	18	18	18	18	56	99	54	136
	14	49	20	18	18	18	64	101	72	155
	16	55	23	18	18	18	72	103	72	174
	18	60	25	18	36	20	80	104	72	192
	20	65	27	18	36	21	87	105	72	211
	24	75	31	18	36	25	102	134	90	246
	30	88	37	18	36	29	122	185	90	295

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
D U C T I L E I R O N	≤4	18	18	18	18	18	18	18	18	33
	6	20	18	18	18	18	19	35	36	47
	8	26	18	18	18	18	25	44	36	61
	10	31	18	18	18	18	30	60	54	73
	12	37	18	18	18	18	36	63	54	86
	14	41	18	18	18	18	41	64	72	98
	16	46	19	18	36	18	46	66	72	111
	18	51	21	18	36	18	51	66	72	122

	20	56	23	18	36	18	56	67	72	134
	24	64	27	18	36	21	65	85	90	156
	30	75	31	18	36	25	78	118	90	188

PIPE RESTRAINT SCHEDULE

MINIMUM LENGTH OF PIPE (IN FEET) REQUIRED TO BE
RESTRAINED ON EACH SIDE OF A VALVE OR FITTING
FOR CLAYEY AND SILTY SOILS (CL, CH, ML, MH)

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL OFFSET ^a		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
P V C P I P E	≤4	19	18	18	18	18	23	36	18	55
	6	26	18	18	18	18	32	40	36	77
	8	35	18	18	18	18	42	73	36	101
	10	42	18	18	18	18	50	98	54	121
	12	50	21	18	18	18	59	104	54	143
	14	57	23	18	36	20	67	106	72	163
	16	64	27	18	36	23	76	109	72	183
	18	71	29	18	36	25	84	109	72	202
	20	78	32	18	36	28	92	110	72	221
	24	92	38	18	36	33	107	140	90	258
	30	110	46	22	54	40	127	193	90	308

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL OFFSET ^a		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
D U C T I L E I R O N	≤4	18	18	18	18	18	18	18	18	35
	6	22	18	18	18	18	20	25	36	49
	8	29	18	18	18	18	27	46	36	64
	10	35	18	18	18	18	32	62	54	77
	12	41	18	18	18	18	37	66	54	90
	14	47	20	18	18	18	43	67	72	103
	16	53	22	18	36	19	48	68	72	115
	18	59	24	18	36	21	53	69	72	127
	20	65	27	18	36	23	58	70	72	140
	24	76	31	18	36	27	67	89	90	162
	30	91	38	18	36	32	80	122	90	194

- Assumptions:
1. Pipe Test Pressure = 150 PSI
 2. Minimum Pipe Depth = 3.0 Feet
 3. Laying Condition = Type 5
 4. Safety Factor = 2.0

^a "Low" represents the minimum length of pipe (in feet) required to be restrained on the low side of the vertical offset, which is typically downstream of the offset fitting. "High" represents the minimum length of pipe (in feet) required to be restrained on the high side of the vertical offset, which is typically upstream of the offset fitting. Required restrained lengths assume an offset angle $\leq 45^\circ$.

^b Distance represents the linear feet of large diameter pipe upstream of the reducer required to be restrained. Restrain small diameter pipe at reducer at a minimum. If there is an unobstructed run downstream of the reducer (i.e. small diameter pipe) of at least 2.5 times the required length of large diameter pipe to be restrained, then restraint is required only at the reducer fitting. If small end of reducer is more than three pipe sizes smaller than large end, consult Engineer for required length to be restrained.

3.3 WATER AND SEWER LINE ORIENTATION:

A. Water Mains Crossing Above Sewer Lines:

1. Potable water mains crossing above sanitary sewer lines (gravity and force mains) and storm sewers shall be laid to provide a minimum vertical distance of 6 inches between the invert of the water main and the crown of the sanitary sewer and/or storm sewer line. The crossing shall be arranged so that the water pipe joints are equal distance from the point of crossing with no less than 3 feet (outside of pipe to outside of pipe) between each joint & the sewer main.
2. The method of obtaining separation shall be as indicated on the Drawings or, if not indicated on the Drawings, as directed by the Engineer.
3. The contractor shall notify the Engineer immediately upon encountering situations not indicated on the Drawings where inadequate separation between water and sewer lines may occur.

B. Water Mains Crossing Below Sewer Lines:

1. Maintain a minimum of 12 inches of separation.
2. All water main joints shall be a minimum of 3 feet clear from the sewer main and 6 feet from the nearest joint.
3. One full joint of water pipe shall be centered on the crossing.
4. Contractor shall notify the Engineer immediately upon encountering situations not indicated on Drawings where inadequate separation between water and sewer lines may occur.

- C. Horizontal Separation Between Water Mains and Sewer Lines: A minimum horizontal separation of 10 feet shall be maintained between all water main joints and all sewer line joints, regardless of whether the lines cross or run parallel to each other. Water mains and sewer lines may be laid with a minimum of 3 feet horizontal

separation (outside of pipe to outside of pipe; 5 feet for reuse water mains) provided that one or more of the following conditions is satisfied:

1. The crown of the sewer line is a minimum of 18 inches below the invert of the water main.
2. The sewer line is constructed of or replaced with 20 LF section(s) of ductile iron pipe with "polybond" lining.
3. Sewer line is placed in a sleeve.
4. Sewer line is encased in concrete.
5. The pipes are laid where the water main joints and the sewer main joints are staggered ten feet apart.
6. The water main or the sewer main is constructed of HDPE pipe without mechanical joints.

The method of obtaining separation shall be as indicated on the Drawings or, if not indicated in the Drawings, as directed by the Engineer. Contractor shall notify the Engineer immediately upon encountering situations not indicated on the Drawings where inadequate separation between water and sewer lines may occur.

- D. Concrete Encasement of Pipe: Where concrete encasement of pipe is required for obtaining separation from other pipes or for other reasons (e.g., inadequate cover), the pipe shall be encased with 3,000 psi concrete having a minimum thickness of 6 inches all around the outside of the pipe. Pipe must be supported in trench to allow 6 inches of concrete on all sides. Concrete must be mechanically vibrated into place. The Engineer or his representative must be present at the time of encasement.

3.4 BACKFILLING:

A. Placing and Compaction:

1. Bedding and Haunching: The backfill shall be placed by hand under and around the pipe to the springline and compacted. Particular care shall be taken to ensure that the backfill at the pipe haunch is free from voids and is properly compacted. The backfill shall be laid in lifts not to exceed 6" and compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.
2. Pipe Embedment: Placement of backfill shall be completed in a 12" loose lift. Compaction of the lift shall achieve 98% of the maximum density modified proctor. Hand tamp or use light walk behind equipment in areas where subgrade soils are extremely soft ($N \leq 4$).
3. Above Pipe Embedment in Areas of Permanent Pavement: The backfill shall be placed in layers having a depth that will permit proper compaction but not exceeding 12" of loose measure. The backfill shall be compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.

4. Above Pipe Embedment In Areas Not Under Permanent Pavement: Within right-of-ways or other areas where permanent pavement does not exist or is not proposed, (including roads, walks and driveways consisting of broken stone, gravel, clay, marl, shell, shellrock or conglomerate), the entire backfill above the pipe embedment shall be compacted to a density of not less than 95 percent of the maximum density, as determined by AASHTO T 180.
- B. In areas where unpaved, stabilized roads are required, the finished stabilized road shall have a minimum LBR value of 50 for the top 12" of the roadbed. Contractor shall refer to Drawings for roadway material.
- C. Compaction:
1. Shall be by hand or by mechanical tampers.
 2. Care shall be taken that the pipe is not struck by the tamper.
 3. Compaction by flooding shall not be allowed.
 4. The Contractor is to compact the backfill in such a manner to prevent settlement.
 5. Compaction Tests:
 - a. Density tests shall be taken along the pipe a minimum of every 300 feet, at each road lane crossing, and as directed by Engineer.
 - b. All density tests shall be paid for by the Contractor.
 - c. Density tests shall be taken in one foot lifts from bottom of trench to finished grade.
- 3.5 CULVERT REMOVAL AND REPLACEMENT:
- A. Culverts, catch basins and other drainage structures that are removed or damaged during construction shall be replaced with materials and structures equal and similar to those removed or damaged.
 - B. Manhole covers and gratings shall be set at the original elevations unless otherwise directed.
 - C. The Contractor shall take precautions against the entry of excavated and other loose material resulting from his operations from entering catch basins, culverts and other drainage structures in the vicinity of his operations.
 - D. The Contractor shall maintain the cleanliness of all existing drainage structures in a condition equal to that prior to the commencement of his operations during the construction.
 - E. The Contractor shall be responsible for all damage to persons, roads, buildings, vehicles and other property resulting from the failure of the Contractor to maintain these drainage structures.

3.6 TESTING AND DISINFECTION:

A. Flushing of Completed Pipelines:

1. Each section of completed pipeline shall be thoroughly flushed. At a flow velocity in the pipe of 2.5 ft. per second.
2. Water required for testing and flushing will be furnished by the Contractor.
3. Contractor shall slowly fill system to eliminate air pockets, then flush to remove particulates.
4. Flushing shall comply with Figures 1 and 2, and Table 3 of AWWA C651.
5. Provide corporation stops at any high points in line in order to bleed air from pipe.
6. Contractor shall make provisions to properly dispose of water from his flushing operations.
7. Flooding of streets and private property shall not be permitted.

B. Leakage Test:

1. Leakage and pressure tests shall be conducted in the presence of the Engineer or his representative.
2. The Contractor shall provide all necessary apparatus including a pump, flow measuring device, piping connections and fittings and the necessary labor to conduct the tests.
3. The pipe being tested shall be maintained at a pressure of not less than 150 psi for not less than two (2) hours in duration.
4. All leaks evident at the surface shall be repaired and leakage eliminated regardless of total leakage shown by test.
5. Lines which fail to pass tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves, and accessories shall be removed and replaced.
6. The pipe lines shall be tested in sections between every consecutive in-line valve unless otherwise directed by the Engineer.
7. Leakage is defined as the quantity of water added to the pipe being tested during the test period.
8. No pipe installation will be accepted if the leakage exceeds the quantities specified in AWWA C605, which is represented by the following equation.

$$Q = \frac{LD\sqrt{P}}{148,000}$$

Where:

Q = Quantity of makeup water (allowed) in gallons per hour

L = Length of pipe section being tested, in feet

D = Nominal diameter of the pipe, in inches

P = Average test pressure during the hydrostatic test, in pounds per square inch (gauge)

C. Disinfection:

1. The disinfection of water main piping shall be conducted in accordance with AWWA C651 using the continuous-feed method or table method and shall be performed by specially trained personnel.
2. New water piping shall be kept isolated from the existing distribution system using a physical separation until satisfactory bacteriological testing has been completed.
3. Provide all temporary filling, flushing and testing connections, potable water, chemicals, sampling and bacteriological test results.
4. Continuous-feed method:
 - a. Slowly and completely fill the main to remove air pockets.
 - b. Preliminary flush, and fill the main with chlorinated water having a free chlorine concentration of no less than 25 mg/l.
 - c. At the end of a 24-hour contact time, the heavily chlorinated water, having a free chlorine residual of not less than 10 mg/l, shall be flushed from the main until the chlorine concentration leaving the main is no higher than that prevailing in the existing distribution system.
 - d. Neutralize the heavily chlorinated water leaving the main with one of the chemicals named in Appendix C of AWWA C651.
 - e. Make final, permanent connections to existing mains in accordance with Section 4.6 of AWWA C651.
 - f. Conduct bacteriological sampling and testing in accordance with Section 5 of AWWA C651.
 - g. After sampling, maintain a minimum pressure of 20 psig in the mains until regulatory permission is granted to place the mains into service.
 - h. Provide satisfactory test results consisting of two consecutive sets of samples, taken at least 24 hours apart, showing the absence of total coliform organisms and the presence of a chlorine residual.
 - i. Redisinfect until satisfactory test results are obtained.

5. Tablet Method
 - a. Place calcium hypochlorite granules or tablets at the upstream end of the first joint, at 500' intervals and at the end of each branch main.
 - b. Pipes must be kept clean and dry prior to testing.
 - c. The quantity of granules or tablets shall conform to Table 1 or Table 2 of AWWA C651 respectively.
 - d. After installation is complete the main shall be filled with water at a velocity no greater than 1 ft/sec.
 - e. Remove air pockets with corporation stops at high points in the line.
 - f. Water shall remain in the pipe for 24 hours.
 - g. Test for free chlorine residual and absence of bacteriological organisms.
 - h. Perform (2) Bac-T tests, 24-hours apart for every 1,200 LF of pipe installed.
 - i. Redisinfect for unsatisfactory results.
 - j. Maintain 20 psig pressure in main.
- D. Flushing:
 1. After receiving clearance from AHJ to place line into service, the line shall be flushed of all heavily chlorinated water.
 2. Chlorinated water shall be neutralized prior to disposal with AWWA approved chemicals.
- 3.7 PROTECTION: At the end of each workday the mains under construction shall be plugged to prevent the entry of small animals or rodents. Temporary plugs shall be provided for this purpose.
- 3.8 CONCRETE COLLARS: All valve boxes and meter boxes shall have their lids at grade encased in a 24x24x8 concrete collar unless otherwise shown on the drawings.
- 3.9 THERMAL PROTECTION: All above-ground piping shall be freeze protected with custom fitting closed cell foam wrap and U.V. resistant covering.
- 3.10 RESTORATION OF DAMAGED SURFACES, STRUCTURES AND PROPERTY: Where pavement, trees, shrubbery, fences or other property and surface structures have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the Contract Documents, state laws, municipal ordinances or the specific direction of the Engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced and repaired at the expense of the Contractor to a condition equal to that before work began within a time frame approved by the Engineer.

3.11 RESTORATION AND CLEANUP:

A. Restoration:

1. General: Restoration of areas disturbed by the Contractor's operations shall begin as soon as practical. Contractor's restoration operations shall keep pace with utility installation. Engineer reserves the right to halt utility installation until restoration and cleanup requirements are satisfied.
2. Time Frame for Restoration: Restoration of areas disturbed by the Contractor's operations shall begin no later than 14 days and shall be completed (excluding punch list items) no later than 28 days from the time construction first began in the area. No more than 1,000 LF along the path of the work may be completely unrestored (excluding punch list items) at the end of each day.

- B. Cleanup: The Contractor shall maintain the site of the work in a neat condition. The Contractor shall remove all excess materials, excess excavated materials, and all debris resulting from his operations a minimum of once per week.

END OF SECTION - 331100

SECTION 333100 - PIPE WORK - GRAVITY SEWER

PART 1 - GENERAL

- 1.1 DESCRIPTION: Work under this Section consists of furnishing all materials, supplies, equipment and labor in accordance with the requirements set forth herein and as shown on the drawings.
- 1.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS: The work under this Contract shall be in strict accordance with the following codes and standards.
- A. All Local, County, Municipal and Federal Codes.
 - B. American National Standards Institute (ANSI).
 - C. American Society for Testing and Materials (ASTM).
 - D. American Water Works Association (AWWA).
 - E. American Association of State Highway and Transportation Officials (AASHTO).
 - F. Florida Department of Transportation Standard Specifications for Road and Bridge Construction (DOT).
 - G. Recommended Standards for Wastewater Facilities, (10-States Standards).
 - H. Florida Dept. of Environmental Protection
- 1.3 QUALITY ASSURANCE STANDARDS:
- A. American National Standards Institute, Inc. (ANSI)/American Water Works Association (AWWA):
 - 1. ANSI/AWWA C105, Polyethylene Encasement for Ductile - Iron Piping for Water and Other Liquids.
 - 2. ANSI/AWWA C110, Ductile-Iron and Gray-Iron Fittings, 3 In. through 48 In., for Water and Other Liquids.
 - 3. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - 4. ANSI/AWWA C115, Flanged Ductile-Iron Pipe with Threaded Flanges.
 - 5. ANSI/AWWA C150, Thickness Design of Ductile-Iron Pipe.
 - 6. ANSI/AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 7. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3-inch through 16 inch, for water and other liquids.
 - 8. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.

9. AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

B. American Society for Testing and Materials (ASTM):

1. ASTM C828, Standard Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
2. ASTM D2321, Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
3. ASTM D2412, Standard Practice for external loading properties of plastic pipe by parallel plate loading.
4. ASTM D2444, Standard Test Method for determination of the impact resistance of thermoplastic pipe and fittings by means of a TUP (falling weight).
5. ASTM D3034, Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
6. ASTM D3212, Joints for Drain and Sewer Pipes using Flexible Elastomeric Seals.
7. ASTM F477, Standard Specification for Elastomeric seals (gaskets) for joining plastic pipe.
8. ASTM F679, Standard Specification for Poly (Vinyl Chloride) (PVC) large diameter plastic gravity sewer pipe and fittings.

C. Manufacturer's name and model numbers are listed to establish a standard of quality. Equivalent items of other manufacturers are acceptable.

1.4 SUBMITTALS:

- A. Submit manufacturer's certification of materials' conformance to specifications.
- B. Submit manufacturer's literature, catalog data and installation instructions.
- C. Submit certified field pressure test reports.
- D. Submit pipeline video testing results.
- E. Submit as-built drawings of completed system.

1.5 PRODUCT DELIVERY AND HANDLING:

- A. Exercise care to prevent damage of product during loading, transporting, unloading and storage.
- B. Do NOT drop pipe or fittings.
- C. Do not store directly on ground and assure that materials are kept clean. Pipe shall be kept bundled and strapped until it is ready for installation in order to prevent warping or disfiguring.
- D. Store material in areas approved by the Owner.
- E. Store material in such a manner as to not create a nuisance or safety hazard.

PART 2 - PRODUCTS

2.1 PIPE:

- A. General: Pipe shall be furnished free from defects impairing strength and durability and should be of best commercial quality for purpose specified. Structural properties shall be sufficient to safely sustain or withstand strains to which it is normally subjected.
- B. Pipe Materials:
 - 1. Polyvinyl Chloride (PVC):
 - a. Specification: ASTM D3034 (4 Inch through 16 Inch)
ASTM F679 (18 Inch through 48 Inch)
 - b. Thickness: SDR 35 for sewers up to 12 feet deep, SDR 26 for sewers over 12 feet deep.
 - c. All PVC gravity sewer pipe is to be green in color and have "Sewer" permanently marked on each joint.
- C. Pipe Joints:
 - 1. Polyvinyl Chloride: Push On: ASTM D3212.

2.2 PIPE FITTINGS:

- A. Ductile Iron:
 - 1. ANSI/AWWA C110, Ductile Iron Fittings.
 - 2. ANSI/AWWA C153, Ductile Iron Compact Fittings.
 - 3. Lining: 40 mils Protecto 401 Epoxy or equal.
 - 4. Mechanical: ANSI/AWWA C111.
 - 5. Push On: AWSI/AWWA C111.
 - 6. Flanged: ANSI B16.1, 125 lb.
 - 7. Thickness: Match class of gravity main.
- B. Polyvinyl Chloride:
 - 1. ASTM D3034, PVC Bell and Spigot Fittings.
 - 2. ASTM D3212, Joints.
 - 3. Thickness: Match SDR of gravity main.

2.3 FLOWABLE FILL:

- A. General: Excavatable Flowable Fill shall be provided for filling abandoned gravity sewers.
- B. FDOT Standard Specifications for Road and Bridge Construction, Section 121.

2.4 CONCRETE:

- A. Benches and Flowchannels: 4,000 psi 28 day mix, Type II Cement.
- B. Encasement: 3,000 psi 28 day mix, Type I or II Cement.

PART 3 - EXECUTION

3.1 EXCAVATION:

- A. General: The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the drawings or as necessary. This shall include all necessary clearing and grubbing of any foreign substance encountered within the structure or trench area. Excavated material suitable for backfill shall be piled in an orderly manner at a sufficient distance from the trench to prevent slides or cave-ins.
- B. Protection of Existing Facilities and Utilities: All existing improvements such as pavements, conduit, poles, pipes and other structures, shall be carefully supported and fully protected from injury and, in case of damage, they shall be restored by the Contractor without compensation. Existing utilities and other underground obstructions are shown on the plans, but the accuracy of the locations and depths is not guaranteed. The Contractor shall contact all utilities prior to construction and arrange for the necessary assistance in locating and protecting the existing utilities. The Contractor shall be responsible for damages to these existing utilities and shall, in case they are damaged, restore them to their preconstruction or better condition.
- C. Trench Excavation: The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8 in. each side of pipe for unsheeted or sheeted trench, with the maximum width of trench, measured at the top of the pipe, not to exceed the outside pipe diameter, plus 24 in., unless otherwise shown on the drawings. Trench walls shall be maintained vertical from the bottom of the trench to a line measured one foot above the top of the pipe. From the top of the pipe to the surface of the trench walls shall be as vertical as possible under soil conditions.

No more than 300 linear feet of trench shall be open in advance of the completed pipe laying operation without prior approval of the Engineer. Pipe trenches across roadways and driveways shall be backfilled as soon as the pipe is installed. Where, in the opinion of the Engineer, adequate detour facilities are not available, no trench shall be left open across a roadway or commercial property driveway where adequate detour routes are not available for a period in excess of 30 minutes, or as directed by the governing authority. No trench shall be left open across any roadway or driveway for more than 24 hours. It shall be the Contractor's responsibility to provide traffic control and barricades as necessary.

- D. Shoring, Sheet piling and Bracing: The Contractor shall design, furnish, and install all shoring, sheet piling and bracing or provide other approved facilities required to perform and protect the excavation and as necessary for the safety of the public, the employees, and the preservation of existing roads, structures and other utilities.

The top of such sheeting left in place shall be cut off at a minimum elevation of 2.5 ft. below finished grade. All work shall be in accordance with the Florida Trench Safety Act.

- E. Pavement Removal: The Contractor shall remove pavements as part of the trench excavation. The material from permanent pavement removal shall be carefully separated from trench excavation material and disposed of by the Contractor.
 - F. Boulder Removal: All rocks, stones, boulders or concrete, having any dimension larger than permitted to be used for backfill in the paragraph entitled "Backfilling" of these Specifications, shall be removed from the site and disposed of by the Contractor.
 - G. Unsuitable Soil Conditions and Overdepth Excavation: In the event the project encounters unsuitable materials, the Contractor shall construct an adequate foundation to support the pipe.
 - 1. Foundation shall consist of 4" of granular fill (No. 57 stone) or 8" of A-3 sand (ASTM D2321, Class II) compacted to 95% of maximum density (ASSHTO T 180).
 - 2. Where granular fill foundations are used, bedding material shall be added to fill voids in foundation material prior to constructing required bedding depth.
 - 3. Granular fill foundation shall be overlain by 4" of bedding material. Bedding material shall be A-3 sand (ASTM D2321, Class II).
 - 4. Shape bedding material to receive pipe bells and support 1/4 of the pipe surface.
 - 5. Limits of overexcavation shall be determined by a qualified geotechnical observer or as described on the drawings.
 - 6. Compensation shall be in accordance with Measurement and Payment section of this document.
 - H. Disposal of Excess Material: The Contractor shall dispose of the excavated materials not required or suitable for backfill. All surplus excavated material which is unsuitable for fill shall become the property of the Contractor and shall be disposed of by the Contractor at his expense. Pieces of broken asphalt shall be carefully separated from suitable fill material and hauled to an asphalt plant for disposal or shall be disposed of by some other acceptable means by the Contractor at no expense to Owner. All excavated material not suitable for backfill (e.g., concrete, boulders, roots, etc.) shall be carefully separated from suitable fill material and disposed of by the Contractor at no expense to Owner. Owner has first right of refusal to accept suitable backfill material from the Contractor at no cost to the Owner.
- 3.2 INSTALLATION OF GRAVITY SEWERS AND SERVICES:
- A. Manufacturer's Instructions: Gravity sewer pipe shall be handled, stored and installed in strict accordance with the pipe manufacturer's instructions. A copy of the manufacturer's instructions shall be kept at the site of the work at all times by the Contractor.
 - B. Pipe Laying: The trench shall be excavated as specified and the bottom of the trench shall be shaped to give sufficient uniform circumferential support to the lower, one-fourth of each pipe. Pipe laying shall proceed upgrade. Each pipe shall be laid true to line and grade. As the work progresses, the interior of the pipe shall be cleaned of all dirt and superfluous materials.

Where cleaning of the pipe after laying is difficult because of the small diameter, the Contractor shall keep a suitable swab or drag in the pipe and shall pull the swab forward past each joint immediately after the jointing operation. At all times when the work is not in progress on the sewer lines, the Contractor shall securely seal the open ends of all pipes in order to prevent the entrance of foreign matter. Stoppers shall be installed in the ends of all services.

In the event that it is necessary to clean the pipe by flushing with water, no water or debris shall be permitted to enter an existing or previously approved sewer. Under no conditions shall the water and debris be removed with lift station pumps or discharged into or through force mains.

- C. Jointing: The bell and spigot surfaces shall be wiped free of dust, dirt, gravel or other foreign material before the application of the lubricant sealer. The resilient joint shall be connected by first brushing upon the mating surfaces the proper lubricant sealer as recommended by the pipe manufacturer. The spigot end shall then be centered on grade into the bell end of the last downstream pipe length and shoved home and properly seated with the application of moderate force by a pry or lever device. The pipes shall be jointed no later than five minutes after the application of the lubricant sealer. Jointing for connections with existing mains, or other special joints, shall be approved by the Engineer before use.
- D. Building Service Laterals:
 - 1. Contractor shall provide all pipe and fittings necessary to install sewer laterals from point of connection at 8-inch PVC gravity sewer to property line.
- E. Connections to Existing Manholes: Pipe connections to existing manholes shall be made so that finished work will conform as nearly as possible to essential requirements for new manhole construction. This shall include core drilling manhole, installing flexible boot connector and reconstructing the existing concrete benches and flow channel.
- F. Quality Assurance: It is the responsibility of the Contractor to install the gravity sewer pipe as shown on the plans. Prior to backfilling, the Contractor shall survey each gravity sewer section (i.e. manhole to manhole) to determine actual invert elevations and slope of the pipe. Invert elevations must be within ± 0.05 ft. of design invert elevations. Resulting calculated minimum pipe slope shall be as follows, depending on diameter of gravity sewer:

<u>Gravity Sewer Diameter (in)</u>	<u>Minimum Allowable Slope</u>
4	0.85%
6	0.50%
8	0.35%
10	0.25%
12	0.20%
15	0.15%
18	0.12%
21	0.10%
24	0.10%

Contractor shall provide invert elevations to Engineer or his representative each day to verify above requirements are met. If invert elevations and/or calculated pipe slopes do not meet requirements, Contractor shall remove and reinstall gravity sewer pipe and/or manholes such that the above requirements are met, at his own expense. See Paragraph 3.05 for gravity sewer testing requirements.

3.3 SEPARATION REQUIREMENTS BETWEEN GRAVITY SEWERS AND POTABLE WATER/RECLAIMED WATER MAINS:

A. Horizontal Separation: Gravity sewers shall be laid at least six (6) feet (outside to outside) horizontally from water mains and at least three feet (outside to outside) horizontally from any existing or proposed reclaimed water line. Smaller horizontal separation distances for gravity sewers are allowed if one or more of the following conditions is met:

1. The top of the gravity sewer is installed at least 12-inches below the bottom of the potable water line.
2. The gravity sewer is encased in watertight carrier pipe or concrete.
3. Both the gravity sewer and the water main are constructed of slip-on or mechanical joint pipe complying with public water supply design standards and pressure tested to 150 psi to assure watertightness.

B. Vertical Separation: Gravity Sewers shall cross under water mains, unless there is no alternative. Gravity sewers crossing water mains or reclaimed water lines shall be laid to provide a minimum vertical distance of 12-inches between the invert of the upper pipe and the crown of the lower pipe. The minimum vertical separation shall be maintained whether the water main is above or below the gravity sewer. For sewer crossings, the crossing shall be arranged so that the gravity sewer pipe joints are equidistant and as far as possible from the water main joints. Adequate structural support shall be provided for the gravity sewer to maintain line and grade. For gravity sewers, smaller vertical separation distances if one of the following conditions are met.

1. The gravity sewer is encased in a watertight carrier pipe or concrete.
2. The gravity sewer is designed and constructed equal to water pipe and pressure tested to 150 psi to assure watertightness.

No vertical or horizontal separation distances are required for above-ground crossings.

C. Concrete Encasement of Pipe: Where concrete encasement of pipe is required for obtaining separation from other pipes or for other reasons (e.g., inadequate cover), the pipe shall be encased with 3,000 psi concrete having a minimum thickness of 6 inches all around the outside of the pipe. Pipe must be supported in trench to allow 6 inches of concrete on all sides. Concrete must be mechanically vibrated into place. The Engineer or his representative must be present at the time of encasement.

D. Contractor shall notify Engineer immediately where separation criteria cannot be met.

3.4 BACKFILLING:

A. Material: All backfill shall be excavated material, essentially free of organic material, asphaltic concrete, clay, concrete, boulders and other deleterious material.

1. Bedding and Pipe Embedment to 12" Above Top of Pipe: The Contractor shall furnish, place, and compact AASHTO Class A-3 sandy material containing less than 1% of organics or other unsuitable material.
2. Above Pipe Embedment: The material shall be AASHTO Class A-3 material or AASHTO Class A-2-4 with prior approval from the Engineer. If the Contractor elects to use A-2-4 material, stringent moisture control will be required during the placement to achieve the required compaction, particularly during rainy periods which could cause delays in construction time.
3. Top of Backfill: The top 12 inches of the backfill shall be topsoil and/or AASHTO Class A-3 material with mixed organics.
4. Additional Fill: If sufficient suitable backfill material is not available from the excavation, additional fill meeting the above requirements shall be provided by the Contractor at no expense to the Owner.
5. If deemed necessary by Engineer or his representative, backfill shall be tested for compliance with above requirements prior to placement.

B. Placing and Compaction:

1. Bedding and Pipe Embedment: The backfill shall be placed by hand under and around the pipe to the springline and compacted. Particular care shall be taken to ensure that the backfill at the pipe haunch is free from voids and is properly compacted. The backfill shall be compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.
 - a. Above Pipe Embedment in Areas of Permanent Pavement: The backfill shall be placed in layers having a depth that will permit proper compaction but not exceeding 8" of loose measure. The backfill shall be compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.
 - b. Above Pipe Embedment In Areas Not Under Permanent Pavement: Within right-of-ways or other areas where permanent pavement does not exist or is not proposed, (including roads, walks and driveways consisting of broken stone, gravel, clay, marl, shell, shellrock or conglomerate), the entire backfill above the pipe embedment to the subgrade of the pavement or structures shall be made with predominantly sandy material free from rock, stones or organic matter, except that rocks having a maximum dimension of 3 ½ inch will be permitted in the backfill between the elevation 1 ft. above the top of the pipe and 1 ft. below the surface. The backfill material above 1 ft. over the pipe shall be compacted to a density of not less than 90 percent of the maximum density, as determined by AASHTO T 180.
2. In areas where unpaved, stabilized roads exist, the Contractor shall restore the road to its original grade and condition. The finished stabilized road shall have a minimum LBR value of 50 for the top 12" of the roadbed.
3. Miscellaneous: Backfilling around manholes, cleanouts and other structures shall be accomplished in the same manner as the connected pipe. Extreme care shall be used in backfilling wellpoint holes to prevent voids and settlement. If necessary, the holes should be plugged with a concrete slurry, such plugging to be at the expense of the Contractor.

4. Compaction: Shall be by hand or by mechanical tampers. Care shall be taken that the pipe is not struck by the tamper. Compaction by flooding may be allowed by written authorization of the Engineer although this will not release the Contractor of the responsibility to meet the required density.
5. The Contractor is to compact the backfill in such a manner to prevent settlement. Although the requirements of 3.04 may be met, nonsettlement is not assured and Contractor is not relieved of his responsibility by such compliance.
6. PVC Pipe shall be laid and backfilled so that pipe deflection does not exceed five (5) percent.
7. The Contractor shall perform density tests at 1 foot elevation increments, starting at the base of the pipe at the following locations:
 - a. Within 20 feet of each manhole.
 - b. At a point halfway between manholes.
 - c. At every road lane crossing.
8. The Contractor shall perform LBR Test at a minimum of 300' on center.

3.5 TESTING:

- A. Flushing of Completed Pipelines: Each section of completed pipeline shall be as thoroughly flushed as is possible. A minimum flow shall be used for flushing that will insure a velocity in the pipe of 2.5 ft. per second. Water required for testing and flushing shall be furnished by the Owner at existing pipes and outlets. Contractor shall be responsible for removal of all dirt and debris from all manholes/wetwells prior to Owner's acceptance.
- B. The Contractor shall furnish all necessary equipment and labor to perform testing of all gravity sewers as set forth in the following and shall conduct such tests in the presence of the Engineer and other authorized agencies, with five days advance written notice provided.
- C. All newly installed gravity sewers shall be televised. Televising shall occur immediately after sewers have been flushed so that areas of standing water can be observed.
 1. The television camera used for the survey shall be one specifically designed and constructed for such survey with tilt and pan capabilities. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing a clear color video picture. The video camera shall include a title feature capable of showing on the recording the following information:

■ Client	■ Line Number	■ Comment
■ Line Type	■ Line Size	
■ Date	■ Manhole Identification (both manholes)	
■ Street Name	■ Ongoing Footage Counter	
■ Contractor's Name	■ Tape ID Number	

- TV Direction
- Tape Index

Camera shall be equipped with a device capable of measuring dips in the pipe in 1/4-inch increments.

2. The video recording company shall prepare the final recording on DVDs for use by the Owner and the Engineer. A total of two sets shall be furnished on a 4.7 GB format DVD, suitable for playing on a standard DVD player or computer DVD drive.

The disk shall be bookmarked with a separate chapter title for each street that was recorded or with chapter bookmarkings at fixed three minute or five minute intervals. The DVDs shall not be copy righted or copy protected such that the Owner or Engineer will have the ability to make additional copies if necessary.

3. The camera shall be moved through the line, stopping when necessary to permit proper documentation of the sewer joint, lateral, defect or repair. In no case shall the television camera be pulled at a speed greater than 30 feet per minute. All sewer laterals shall be inspected using the camera tilt and pan features. At least 10 seconds of focused observation shall be included on each lateral. A measuring device visible to the camera shall be part of the equipment pulled through the pipe.
 4. Any dips in the gravity sewer holding more than $\frac{5}{8}$ " water shall be deemed defective and shall be corrected at Contractor's expense.
- D. The installed sewers shall be visually inspected by "lamping" between manholes, lampholes or other structures in order to ascertain that they are clear and to correct alignment. The concentricity of the lamp image received shall be such that the diameter of said image shall have no vertical or horizontal reduction from that of the pipe inside diameter.
- E. The watertightness of a sewer which has a crown lying below groundwater level shall be tested by measuring the infiltration. The watertightness of sewers having a crown 1 inch or more above groundwater level shall be tested by filling the pipe with water to produce a hydrostatic head of 2 feet or more above the crown of the sewer at the upper end of the test section or the water table outside of the sewer, whichever is higher, and then measuring the exfiltration. In no case shall the infiltration or exfiltration exceed 75 gallons per mile per inch of diameter of sewer per 24-hour day when field tested by actual infiltration conditions. If exfiltration testing is required an allowance of an additional 10 percent of gallonage shall be permitted for each additional 2-foot head over a basic 2-feet minimum internal head.
- F. Leakage testing shall proceed for a continuous period of eight hours with exfiltration or infiltration amounts measured by methods approved by the Engineer. Upon application of internal hydrostatic pressure for exfiltration testing, care shall be taken to preclude unseating the joint gaskets for a specific type of pipe by exceeding the pressure capability thereof.
- G. The Contractor may use, as an alternate leakage test, air testing by compressed air from manhole to manhole. Plugs, caps and branch connections must be secured against blow-off during the test. The pipe and manholes shall be free of water during the test.
1. The air testing shall be performed in accordance with ASTM C828 for Vitrified Clay Pipe of Sizes 4 Inch through 12 Inch.

2. Laterals shall be temporarily plugged and manhole to manhole pipe brought to a stable 3.5 psig air pressure.
 3. Air supply hose shall be shut off and time recorded.
 4. Pipe section shall be acceptable if time to drop from 3.5 psig to 2.5 psig is less than or equal to one half the pipe diameter, in minutes.
- H. Deflection Testing: The Contractor shall perform deflection tests of the pipe along the entire length of the sewer main. The internal diameter of the barrel shall not be reduced by more than five percent (5%) of its base inside diameter when measured not less than thirty (30) days following completion of installation. A deflection of more than the specified amount shall be cause for rejection of that particular segment of pipe located between successive manholes. All locations with excessive deflection shall be excavated and repaired by rebedding or replacement of the pipe. A properly sized nine (9) point go-no-go mandrel shall be used for testing the sewer. Adjustable mandrels shall not be acceptable. Deflection testing for pipe under roadways shall be performed after road base is complete.
- I. Should any of the test fail, necessary repairs shall be accomplished by the Contractor and the test repeated until within the established limits. The Contractor shall furnish the necessary labor, and all other items required to conduct the required testing, and shall perform the necessary system repairs required to comply with the specified test.
- J. No installation of roadway base or paving shall occur over a gravity sewer until said section of sewer has passed all required testing including televising, lamping, leakage, and deflection.
- 3.7 PROTECTION:
- A. At the end of each work day, the mains under construction shall be plugged to prevent the entry of small animals and rodents. Temporary plugs shall be provided for this purpose.
 - B. Open trenches shall be backfilled at the end of each work day.
- 3.8 RESTORATION OF DAMAGED SURFACES, STRUCTURES, AND PROPERTY: Where pavement, trees, shrubbery, fences, or other property and surface structures not designated as pay items have been damaged, removed, or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the contract documents, state laws, municipal ordinances, or the specific directions of the Engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired at the expense of the Contractor to a condition equal to that before work began within a time frame approved by the Engineer.
- 3.9 RESTORATION AND CLEANUP:
- A. Restoration:
 1. General: Restoration of areas disturbed by the Contractor's operations shall begin as soon as practical. Contractor's restoration operations shall keep pace with utility installation. Engineer reserves the right to halt utility installation until restoration and cleanup requirements are satisfied.

2. Time Frame for Restoration: Restoration of areas disturbed by the Contractor's operations shall begin no later than 14 days and shall be completed (excluding punch list items) no later than 28 days from the time construction first began in the area. No more than 1,000 LF along the path of the work may be completely unrestored (excluding punch list items) at the end of each day.

B. Cleanup:

1. The Contractor shall maintain the site of the work in a neat condition.
2. The Contractor shall remove all excess materials and all debris resulting from his operations a minimum of once per week.
3. Excess suitable fill not used in performance of the Work shall first be offered to the Owner. Upon refusal of the fill by the Owner, excess fill shall be removed from the site at the Contractor's expense.

END OF SECTION - 333100

SECTION 333216 - GRINDER PUMPS

PART 1 - GENERAL

- 1.1 DESCRIPTION: The Contractor shall furnish and install a Grinder Pump Station consisting of, but not limited to: (a) grinder pump suitably mounted in a polyethylene or fiberglass wetwell; (b) pump removal system; (c) shut-off valve; (d) check valve; (f) grinder pump station control panel; and (g) all necessary internal wiring and controls. The Contractor shall also provide all necessary coordination, material, and labor to provide a complete and operable system.
- 1.2 GENERAL REQUIREMENTS:
- A. Applicable Codes, Standards, and Specifications: The Work shall be in strict accordance with the following codes and standards:
1. FDEP Requirements.
 2. American Society for Testing and Materials (ASTM).
 3. National Electrical Code.
 4. Occupational Safety and Health Standards (OSHA).
 5. Florida Building Code.
- B. Assemblies or Units:
1. The Contractor shall furnish all component parts as required by the manufacturer of the assembly or unit. Where duplicate or similar units are required, unless approved otherwise by the Engineer, only units furnished by the same manufacturer shall be furnished and installed.
 2. Unless otherwise indicated in writing by the Engineer, the materials to be furnished shall be new, standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.
- 1.3 MANUFACTURER: The equipment specified shall be a product of a company experienced in the design and manufacture of grinder pumps for specific use in low pressure sewage systems. The company shall submit detailed installation and user instructions for its product; submit evidence of an established service program including complete parts and service manuals, and be responsible for maintaining a continuing inventory of grinder pump replacement parts. The equipment shall be a product of a manufacturer having a minimum of 5 years of experience of the specified grinder systems and shall have a minimum of 1,000 grinder pump stations currently in operation.

~~**Acceptable manufacturer for the Centrifugal Grinder Pump is E-One or approved equal. Basis of design is DH151.**~~

Acceptable manufacturer for the Semi-Positive Displacement Grinder Pump is E-One or approved equal. Basis of Design is DH151. Centrifugal pumps will be considered provided they can meet the design criteria. Acceptable Manufacturer shall be Hydromatic Pumps or equal.

Pre-bid review of acceptable products is not required. Evaluation shall occur in Shop Drawing review.

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Acceptable manufacturer for the Centrifugal Grinder Pump is E-One or approved equal. Basis of design is DH151.

1.4 OPERATING CONDITIONS:

- A. Semi-positive displacement pumps shall be capable of delivering a minimum of 14 gpm against a rated total dynamic head of 0 feet (0 psig) and a minimum of 8 gpm against a rated dynamic head of 80feet (33 psig).
- B. Centrifugal pumps shall be capable of delivering 20 gpm at 12' TDH. Acceptable pump shall have a 1 HP maximum size motor (240V, 1 phase).**
- C. Under no conditions shall in-line piping or valving be allowed to create a false apparent head.

1.5 WARRANTY: The grinder pump manufacturer shall provide a part(s) and labor warranty on the complete station and accessories for a period of twenty-four (24) months after notice of Owner's acceptance. Any defects found during the warranty period will be reported to the manufacturer by the Owner.

1.6 SHOP DRAWINGS: Submit copies of shop drawings and product data for equipment furnished under this section. Submittals shall include the following minimum items:

- A. Name of manufacturer, type, and model of grinder pump station.
- B. Shop Drawings showing all important details of equipment to be furnished, including dimensional data and materials of construction.
- C. Descriptive literature, bulletins, and/or catalogs of the equipment.
- D. Guaranteed pump performance curves which show that the pump meets the specified requirements for head, capacity, and horsepower. Curves shall be submitted on 8½ -inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from low flow at shut-off head to pump capacity at zero head.
- E. A complete total bill of materials of all equipment.
- F. Complete motor data.
- G. Complete Grinder Pump Station Control Panel power and control wiring diagrams with product data for each component.
- H. A copy of the 2-year warranty.
- I. Manufacturer's Installation Instruction Manual.

1.7 PERMITTING: The Contractor shall apply for and pay all application fees for any permits.

1.8 UNITARY RESPONSIBILITY: In order to unify responsibility for proper operation and services of the grinder pump stations, it is the intent of these Specifications that all system components (pumps, panels, controls, wetwell, unit piping, etc.) shall be furnished by a single supplier.

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PART 2 - PRODUCTS

2.1 PUMPS:

A. Pump shall include the following features:

1. Two Barrier Seal: One epoxy barrier and one compression fitting for maximum protection against wicking and water seepage into the motor housing.
2. Bearings: The heavy-duty ball bearings, upper (radial) and lower (thrust), are continuously lubricated by oil to ensure long service life.
3. Motor: Electrical design combines the advantages of high torque output with optimum running efficiency engineered specifically for grinder operation.
4. Stator Bolts: The stator is secured to the motor housing by means of stator bolts which ensure ease of maintenance if the need ever arises.
5. Shaft: Standard stainless steel shaft in grinder pump.
6. Dual Seals: Dual seals for maximum moisture protection.
7. Moisture Probe: Moisture detection probe.
8. Cutters: Exclusive "Dual Cutter" design cuts solids to smallest particle size thereby greatly reducing clogging, roping, or binding.
9. Impeller: Engineered nonmetallic semi-open impeller molded to a bronze insert for greatest torque driving capabilities. Impeller made of high strength Valox® which provides highest level of corrosion resistance and maximum toughness from impact for a wide variety of slurry pumpage. Pump-out vanes preclude material buildup around shaft and seal.

B. The pump shall be capable of reducing/macerating all components in normal domestic and commercial sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, rubber, sanitary napkins, disposable diapers, and the like, to finely-divided particles which will pass freely through the passages of the pump and the discharge piping.

2.3 ELECTRIC MOTOR: The motor shall be a UL listed 1 HP (max), 240 volt, 60 hertz, 1 phase, oil-cooled, induction start, Type B NEMA design, Class F insulation, ball bearing, squirrel cage induction type with a low starting current not to exceed 30 amperes. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor protector combination shall have been specifically investigated and listed by Underwriters Laboratories, Inc. for the application.

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- 2.4 GUIDE RAILS: Guide rails shall be utilized to direct the pump in proper alignment with the stationary discharge piping. Rails shall be a minimum of 2-inch diameter, 316 stainless steel. The pump shall be automatically connected to the discharge connection when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter wetwell. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump.
- 2.5 FLOAT MOUNTING BRACKET: A float mounting bracket shall be provided. Float mounting bracket shall provide cord grips to hold the level control cords and allow adjustment of level controls to desired pumping alarm levels. Continuous cords are to run from pump(s) and level controls to control panel. No splices shall be made in wiring. Float mounting bracket shall be fabricated from stainless steel. Float mounting bracket shall attach to access frame with 304 stainless steel fasteners. It shall be oriented so as to avoid flow from incoming pipes impinging on hanging floats to as great an extent possible.
- 2.6 LIFTING CHAIN/CABLE: Each pumping unit shall be provided with a 316 stainless steel lifting chain or cable. The lifting chain or cable shall be of sufficient length to extend from the pumping unit at one end to the top of the wetwell at the other end. The access frame shall provide a hook to attach the lifting chain or cable when not in use. The lifting chain or cable shall be sized according to the pump weight with a minimum safety factor of 7.0.
- 2.7 LIQUID LEVEL CONTROLS: Float switches shall be supplied to control wetwell level and alarm signal. A quantity of three floats shall be provided to control the liquid level in the duplex station. One additional switch shall be provided for a high water level alarm.
- A. The level control system shall be the mercury switch float type, incorporating weighted floats suspended from a stainless steel float holder in the wetwell. Rising and falling liquid level in the wetwell shall cause switches within the floats to open and close, providing start and stop signals for the level control components.
- B. The level control system shall start the lead pump when the liquid level in the wetwell rises to the "lead pump on" level. When the liquid is lowered to the "all pumps off" level, the system shall stop the pump. These actions shall constitute one pumping cycle. The alternator shall change lead pumps at the end of each cycle. A third float shall be provided to start the second pump in the event the level in the wetwell rises to the "lag pump on" level, both pumps shall then run until the level is dropped to the "all pumps off" level.
- C. Four float switch assemblies shall be supplied for installation by the Contractor. Each switch assembly shall contain a mercury-type switch and weight sealed in a polypropylene housing, and not less than 30 feet of cable or as required to reach the control panel without splices.
- D. The fourth float switch shall be provided to actuate a high level alarm relay. The signal relay shall complete a 115-volt AC circuit for external alarm devices. An electrical or mechanical indicator, visible on the front of the control panel, shall indicate that a high level exists. The signal relay shall maintain an alarm horn and light signal for an adjustable time period up to 24 hours or until the liquid level has been lowered or raised and the circuit has been manually reset, whichever comes first. After the timer has timed out, only the alarm light shall remain on until it has been manually reset.

- 2.4 GUIDE RAILS: Guide rails shall be utilized to direct the pump in proper alignment with the stationary discharge piping. Rails shall be a minimum of 2-inch diameter, 316 stainless steel. The pump shall be automatically connected to the discharge connection when lowered into place and shall be easily removed for inspection or service. There shall be no need for personnel to enter wetwell. Sealing of the pumping unit to the discharge connection shall be accomplished by a simple linear downward motion of the pump.
- 2.5 FLOAT MOUNTING BRACKET: A float mounting bracket shall be provided. Float mounting bracket shall provide cord grips to hold the level control cords and allow adjustment of level controls to desired pumping alarm levels. Continuous cords are to run from pump(s) and level controls to control panel. No splices shall be made in wiring. Float mounting bracket shall be fabricated from stainless steel. Float mounting bracket shall attach to access frame with 304 stainless steel fasteners. It shall be oriented so as to avoid flow from incoming pipes impinging on hanging floats to as great an extent possible.
- 2.6 LIFTING CHAIN/CABLE: Each pumping unit shall be provided with a 316 stainless steel lifting chain or cable. The lifting chain or cable shall be of sufficient length to extend from the pumping unit at one end to the top of the wetwell at the other end. The access frame shall provide a hook to attach the lifting chain or cable when not in use. The lifting chain or cable shall be sized according to the pump weight with a minimum safety factor of 7.0.
- 2.7 LIQUID LEVEL CONTROLS: Float switches shall be supplied to control wetwell level and alarm signal. A quantity of three floats shall be provided to control the liquid level in the duplex station. One additional switch shall be provided for a high water level alarm.
- A. The level control system shall be the mercury switch float type, incorporating weighted floats suspended from a stainless steel float holder in the wetwell. Rising and falling liquid level in the wetwell shall cause switches within the floats to open and close, providing start and stop signals for the level control components.
 - B. The level control system shall start the lead pump when the liquid level in the wetwell rises to the "lead pump on" level. When the liquid is lowered to the "all pumps off" level, the system shall stop the pump. These actions shall constitute one pumping cycle. The alternator shall change lead pumps at the end of each cycle. A third float shall be provided to start the second pump in the event the level in the wetwell rises to the "lag pump on" level, both pumps shall then run until the level is dropped to the "all pumps off" level.
 - C. Four float switch assemblies shall be supplied for installation by the Contractor. Each switch assembly shall contain a mercury-type switch and weight sealed in a polypropylene housing, and not less than 30 feet of cable or as required to reach the control panel without splices.
 - D. The fourth float switch shall be provided to actuate a high level alarm relay. The signal relay shall complete a 115-volt AC circuit for external alarm devices. An electrical or mechanical indicator, visible on the front of the control panel, shall indicate that a high level exists. The signal relay shall maintain an alarm horn and light signal for an adjustable time period up to 24 hours or until the liquid level has been lowered or raised and the circuit has been manually reset, whichever comes first. After the timer has timed out, only the alarm light shall remain on until it has been manually reset.

- E. An alarm silence switch and relay shall be provided to permit maintenance personnel to de-energize the external alarm device while corrective actions are underway. After silencing the alarm device, manual reset of the signal relay shall provide automatic reset of the alarm silence relay.
 - F. Float Switches shall be direct acting single pole mercury switch which actuates when the longitudinal axis of the float is horizontal and deactivates when the liquid level falls one inch (1") below the actuation elevation. Entire assembly (cable and float) shall be encapsulated to form a watertight and impact resistant unit. Float switches shall meet the following criteria:
 - 1. Mercury switch rating (non-inductive) shall be ten (10) amps (minimum) at 120 volts, 60 hertz.
 - 2. Float housing construction shall be polypropylene. Cable jacket shall be polyvinyl chloride (PVC).
 - 3. Provide normally open or normally closed contacts as required.
 - 4. Float switches shall be Anchor Scientific, Roto-Float, polypropylene jacketed, internally weighted NO/NC mercury actuated float switches, or approved equal.
 - G. Cable shall be polyvinyl chloride (PVC) type. Conductors shall be No. 18 gage (41 strand) rated 600 volts. Cable shall be continuous with no splices from the float switch to the control cabinet.
- 2.8 GRINDER PUMP STATION CONTROL PANEL: Unless noted otherwise, the requirements specified herein apply to all pump stations.
- A. Each grinder pump station shall include a NEMA 3R, UL listed Alarm/Disconnect Panel suitable for wall or pole mounting. The NEMA 3R enclosure shall be 304SS to assure corrosion resistance. The enclosure shall include a hinged, padlocked cover, secured dead front and component knockouts. The manufacturer shall minimize the enclosure's size. The panels shall be labeled with a serialized UL 508A label. The panel shall include the alarm light and alarm horn. The panel shall be designed and built to provide the necessary components to safely run and control pumps/motors as specified herein.
 - B. Properly sized Square "D", or equivalent, thermal-magnetic, molded case, heavy duty air circuit breakers shall be provided for each of the following: main breaker, pump breakers, and control breaker. Short circuit current rating (SCCR) of the panel shall be as indicated on the Drawings. Main breaker shall be 600 volt with lockable through-the-door operator. All single-phase motor breakers shall be Square "D", or equal, motor circuit protectors with adjustable trip settings. Control, GFI, and single-phase motor breakers shall be 120 volt, mounted on the back panel. The main circuit breaker and emergency circuit breaker shall be interlocked to inhibit the two (2) devices from being closed ("on") at the same time, but allow for both to be simultaneously open ("off").

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 - F. Float Switches shall be direct acting single pole mercury switch which actuates when the longitudinal axis of the float is horizontal and deactivates when the liquid level falls one inch (1") below the actuation elevation. Entire assembly (cable and float) shall be encapsulated to form a watertight and impact resistant unit. Float switches shall meet the following criteria:
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- C. 600 volt lightning and surge protection shall be provided for incoming power, and 120 volt surge protection shall be provided for control circuits. All surge protection devices shall be designed to react to transients in less than one nanosecond. 120 volt protectors shall include solid state bidirectional componentry. 120 volt surge protectors shall include EMI/RFI filtering to 56 dB, 100 kHz, and 100 MHZ.
- D. A fuse protected, 240 volt/120 volt transformer shall be provided for operation of control circuitry, above single-phase circuitry and all auxiliary equipment.
- E. Circuit breakers shall be provided for: (A) 15 amp, 120 volt, duplex GFCI receptacle mounted on the dead-front inner door; and (B) 10 amp, 12 volt LED site light.
- F. Pumps shall be provided with oil tight LED red "Alarm" lights, amber "Call" lights, green "Run" lights, H.O.A. switches, and elapsed time meters mounted through the panel inner door.
 - a. The panel shall be provided with amber pilot lights to indicate when pumps are called to operate. Lights shall be wired in parallel to the control circuits.
 - b. The panel shall be provided with one green pilot light for each pump motor. The light shall be wired in parallel with the related pump motor to indicate that the motor is, or should be, running.
 - c. Six digit elapsed time meters (non-reset type) shall be connected to each motor drive to indicate the total running time of each pump in "hours" and "tenths of hours".
 - d. Mode selector switches shall be provided to permit manual start and manual stop of each motor individually and to select automatic operation of each motor. Manual operation shall override all shutdown systems with the exception of motor overload relays.
 - e. The panel shall be provided with red pilot lights to indicate individual alarm and fault conditions.
- G. Each pump shall be provided with circuitry to lock out the pump in the event of high pump temperature or seal failure, take the pump out of "Lead Run" sequencing. LED indicator lights shall be provided for each condition, with manual reset required after condition has been corrected.
- H. A duplex, octal pin, plug-in style alternator shall be provided with LED indicator for lead pump selected. An inner-door-mounted selector switch shall be provided to choose lead pump or automatic alternation of lead pump. An adjustable 1 to 24 hour timer shall be provided to switch lead pumps if automatic alternation does not occur within the set time period.
- I. A waterproof, high intensity, Lexan magnifying lens, exterior Red alarm light shall be provided at the top of the panel with continuous flasher circuitry. Design and placement of the light fixture shall allow easy replacement of bulbs without removal of the fixture lens. A weatherproof 95 dBA alarm horn

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shall be provided with inner door mounted disable button. Disabled alarm horn shall automatically reset when an alarm clears or if another alarm is activated. Red LED pilot lights with manual push button resets shall be provided on the inner door for each alarm condition described above.

- J. All control panels shall be provided with "As-Built" line drawings laminated to the back of the inner panel door for ease of troubleshooting by service personnel.
- K. All conduits between the wetwell and control panel shall be provided with sealing fittings and filled with sealing cement to prevent the entrance of wetwell gases to the control panel. Each pump motor power cable shall be provided with a separate metal conduit to the control panel.
- L. A thermal heater and thermostat shall be installed to maintain the internal temperature of the enclosure above the dew point. The thermostat shall also activate a ventilation fan to keep the panel below the manufacturer's recommended temperature.
- M. The control panel shall include a 12 VDC, 7.0 AH sealed lead-acid battery with battery charger/power supply, a low battery power relay with reset button and pilot light, strobe light and alarm horn with silence relay and push button. The 12 VDC battery shall be capable of operating for approximately 22 hours when fully charged. This system shall provide audio-visual indication of a high level condition.
- N. The control system shall be designed to operate two pumps based on wetwell level monitored by float type level sensors. The sensors shall provide the following functions: stop all pumps and alternate lead pump, start lead pump, high level alarm, and start lag pump. The sensors shall operate on UL 913 approved intrinsically safe relays.
- O. An open frame, across the line, NEMA rated magnetic, motor starter shall be provided for each motor. Power contacts shall be double-break cadmium oxide silver. All motor starters shall be equipped to provide under voltage release and overload protection. An overload reset button shall be mounted through the dead front door for each motor starter.
- P. All electrical equipment shall be identified in accordance with these specifications. All identification labels, both within the enclosure and external, shall be engraved nameplates attached with stainless steel machine screws, photo etched, silk screened, or laser-screened laminated mylar. All control wiring shall be numbered on each termination. Engraved nameplates attached with stainless steel machine screws, photo etching, silk screened, or laser-screened laminated mylar shall be provided to identify all individually mounted push-buttons, switches, lights, meters, circuit breakers, motor starters, transformers, relays, fuses, phase monitors, and any other equipment for which identification is required for eventual service or replacement. This includes the appropriate equipment within the cabinet. Embossed tape is not acceptable.

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Q. The control panel shall be thoroughly tested at the factory prior to shipment. All components in the panel shall carry, at a minimum, a comprehensive, parts only, three (3) year (36 month) guarantee against defects in workmanship and material from the date of acceptance. The manufacturer of the panel shall warrant all components in the system for unit responsibility purposes.

2.9 CORROSION PROTECTION: All materials exposed to wastewater shall have inherent corrosion protection: i.e., epoxy powder-coated cast iron, fiberglass, stainless steel, PVC.

2.10 SAFETY: The grinder pump shall be free from electrical and fire hazards as required in a residential environment. As evidence of compliance with this requirement, the completely assembled and wired grinder pump station in its tank shall be listed by Underwriters Laboratories, Inc., to be safe and appropriate for the intended use.

The grinder pump shall meet accepted standards for plumbing equipment for use in or near residences, shall be free from noise, odor, or health hazards, and shall have been tested by an independent laboratory to certify its capability to perform as specified in either individual or low pressure sewer system applications. As evidence of compliance with this requirement, the grinder pump shall bear the National Sanitation Foundation seal.

PART 3 - EXECUTION

3.1 DELIVERY: All grinder pump units will be delivered to the job site, 100% completely assembled, including testing, ready for installation. Grinder pump units will be individually mounted on wooden pallets.

3.2 INSTALLATION: Shall be in accordance with manufacturer's written instructions. Contractor shall be responsible for all excavation, dewatering, plumbing, electrical, anti-flotation, restoration, etc. necessary for proper installation. Services shall include but are not limited to the following:

A. The Contractor shall connect the discharge piping to the grinder pump station as shown on the Drawings.

B. The Contractor shall mount a grinder control panel as shown on the Drawings.

C. Before testing, all equipment shall first be properly lubricated, serviced, and adjusted in accordance with the manufacturer's specifications to ensure that the equipment is properly installed without developing vibration, overheating, or excessive noise.

D. All testing shall be performed in the presence of the Engineer. The Contractor shall notify the Engineer in advance of all testing. All equipment, materials, and labor required for the testing shall be furnished by the Contractor.

E. The Contractor shall test the grinder pump station according to the manufacturer's specifications.

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E. The Contractor shall test the grinder pump station according to the manufacturer's specifications.

- F. Should any sewage grinder pump unit fail any part of the specified testing procedure, the Contractor shall ascertain the cause of the failure and make the necessary repairs or adjustments as required. The Contractor shall then retest as specified. The Contractor shall repair or replace any damaged component with factory-supplied new parts or components at no cost to the Owner.

- 3.3 START-UP AND FIELD TESTING: The manufacturer shall provide the services of qualified factory-trained technician(s), who shall inspect the placement and wiring of each station, perform field tests as specified herein, and instruct the Owner's personnel in the operation and maintenance of the equipment before the stations are accepted by the Owner. All equipment and materials necessary to perform testing shall be the responsibility of the Contractor. This will include, as a minimum, a portable generator (if temporary power is required) and water in each basin.

The services of a trained factory-authorized technician shall be provided for one 8-hour day. Upon completion of the installation, the authorized factory technicians will perform the following tests on each station:

1. Make certain the discharge shut-off valve is fully open. This valve must not be closed when the pump is operating. There is also a valve(s) at the right-of-way that must be open.
2. Turn on the alarm power circuit.
3. Fill the wetwell with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
4. Turn on pump power circuit. Initiate pump operation to verify automatic "on/off" controls are operative. Pump should immediately turn on. Within one (1) minute, alarm light will turn off. Within three (3) minutes, the pump will turn off.

Upon completion of the start-up and testing, the manufacturer shall submit to the Engineer the start-up authorization form describing the results of the tests performed. Final acceptance of the system will not occur until authorization forms have been received.

- 3.4 ACCEPTANCE:

- A. The Contractor shall perform all of the grinder pump manufacturer's mandatory and recommended startup tests on each grinder pumping station in the presence of the grinder pump manufacturer's representative. The purpose of the startup tests is to verify that each grinder pumping system (i.e., electrical system, alarms, pumps, piping, etc.) functions as intended by the grinder pump manufacturer. The Contractor shall supply all labor, materials, equipment, water, etc. necessary to perform the work.
- B. During the startup testing, the Contractor and Engineer shall observe the pipe joints within the valve box that contains the redundant check valve and at the buried piping connection to each wetwell for leaks. The Contractor shall excavate each wetwell piping connection to allow for the inspection and shall subsequently restore the site. The Contractor shall repair all leaking joints to the satisfaction of

- F. Should any sewage grinder pump unit fail any part of the specified testing procedure, the Contractor shall ascertain the cause of the failure and make the necessary repairs or adjustments as required. The Contractor shall then retest as specified. The Contractor shall repair or replace any damaged component with factory-supplied new parts or components at no cost to the Owner.

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2. Turn on the alarm power circuit.
3. Fill the wetwell with water to a depth sufficient to verify the high level alarm is operating. Shut off water.
4. Turn on pump power circuit. Initiate pump operation to verify automatic "on/off" controls are operative. Pump should immediately turn on. Within one (1) minute, alarm light will turn off. Within three (3) minutes, the pump will turn off.

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- B. During the startup testing, the Contractor and Engineer shall observe the pipe joints within the valve box that contains the redundant check valve and at the buried piping connection to each wetwell for leaks. The Contractor shall excavate each wetwell piping connection to allow for the inspection and

the Engineer. The Contractor shall fill/refill each wetwell with water as many times as necessary to complete the work and verify that the pipe/fitting joints do not leak.

- C. The pump manufacturer's representative shall submit written certification that he has inspected, adjusted, tested, etc. the installation and that all aspects of each installation meet the requirements of the pump manufacturer for satisfactory performance and working life of the equipment. Each station will only be accepted by the Owner after the Engineer approves the installation, the results of all required tests, and the manufacturer's written certification. The Contractor's bid shall include all work and re-work necessary to obtain acceptance of each station.
 - D. The written certification shall state that each station is installed and operating properly and is ready for acceptance by the Owner and shall include a list stating the serial number, the street address of the pump station installation, the name of the landowner of the property on which the pump station was installed, the date of installation of the pump station, the date the pump station was tested, and the date the pump station was placed into service.
 - E. Each certification shall have the signature of the pump manufacturer's representative who inspected and approved the pump station installation.
- 3.5 LOCKING: The manufacturer shall provide a padlock for each control panel and disconnect switch. The padlock shall be an all-weather padlock and have a hand-polished solid brass body with approximate body dimensions of 1-inch high by 1-inch wide by 1/2-inch thick with brass internals. The construction shall be pin tumbler with heel and toe locking for additional security. All padlocks shall be keyed alike and keyed to the City's master key system. Each lock shall be supplied with one key. The shackle shall be hardened steel with opening dimensions of approximately 1-inch high by 1-inch wide by 3/16-inch thick. The Contractor shall spray the internal parts of each lock (both ends) with WD-40 lubricant, or equal, before placing a lock into service.

END OF SECTION - 333216

shall subsequently restore the site. The Contractor shall repair all leaking joints to the satisfaction of the Engineer. The Contractor shall fill/refill each wetwell with water as many times as necessary to complete the work and verify that the pipe/fitting joints do not leak.

- C. The pump manufacturer's representative shall submit written certification that he has inspected, adjusted, tested, etc. the installation and that all aspects of each installation meet the requirements of the pump manufacturer for satisfactory performance and working life of the equipment. Each station will only be accepted by the Owner after the Engineer approves the installation, the results of all required tests, and the manufacturer's written certification. The Contractor's bid shall include all work and re-work necessary to obtain acceptance of each station.
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END OF SECTION - 333216

SECTION 333400 - PIPE WORK - FORCE MAINS

PART 1 - GENERAL

- 1.1 DESCRIPTION: Work under this Section consists of furnishing all materials, supplies, equipment and labor in accordance with the requirements set forth herein and as shown on the drawings.
- 1.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS: The work under this Contract shall be in strict accordance with the following codes and standards.
- A. All Local, County, Municipal and Federal Codes.
 - B. American National Standards Institute (ANSI).
 - C. American Society for Testing and Materials (ASTM).
 - D. American Water Works Association (AWWA).
 - E. American Association of State Highway and Transportation Officials (AASHTO).
 - F. Florida Department of Transportation Specifications (DOT).
 - G. Recommended Standards for Wastewater Facilities (10-States Standards).
 - H. Florida Dept. of Environmental Protection.
- 1.3 QUALITY ASSURANCE STANDARDS:
- A. American National Standards Institute, Inc. (ANSI)/American Water Works Association (AWWA):
 - 1. ANSI/AWWA C105, Polyethylene Encasement for Ductile - Iron Piping for Water and Other Liquids.
 - 2. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - 3. ANSI/AWWA C115, Flanged Ductile-Iron Pipe with Threaded Flanges.
 - 4. ANSI/AWWA C150, Thickness Design of Ductile-Iron Pipe.
 - 5. ANSI/AWWA C151, Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 6. ANSI/AWWA C153, Ductile-Iron Compact Fittings, 3 In. Through 16 In., for Water and Other Liquids.
 - 7. AWWA C508, Swing-Check Valves for Waterworks Service, 2 In. Through 24 In.
 - 8. AWWA C515, Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service

9. AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
 10. AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 11. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In., for Water Distribution.
 12. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe, 14-inch through 48-inch for Water Transmission and Distribution.
- B. American Society for Testing and Materials (ASTM):
1. D1785, Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 2. D-2464, Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fillings, Schedule 80.
 3. D2467, Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 4. D2564, Solvent Chemicals for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 5. D2855, Making Solvent Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- C. Manufacturer's name and model numbers are listed to establish a standard of quality. Equivalent items of other manufacturers are acceptable.
- 1.4 SUBMITTALS:
- A. Submit manufacturer's certification of materials' conformance to specifications.
 - B. Submit manufacturer's literature, catalog data and installation instructions.
 - C. Submit certified field pressure test reports.
- 1.5 PRODUCT DELIVERY AND HANDLING:
- A. Exercise care to prevent damage of product during loading, transporting, unloading and storage.
 - B. Do NOT drop pipe or fittings.
 - C. Do not store directly on ground and assure that materials are kept clean. Pipe shall be kept bundled and strapped until it is ready for installation in order to prevent warping or disfiguring.
 - D. Store material in areas approved by the Owner.
 - E. Store material in such a manner as to not create a nuisance or safety hazard.

PART 2 - PRODUCTS

2.1 PIPE:

- A. General: Pipe shall be furnished free from defects impairing strength and durability and should be of best commercial quality for purpose specified. Structural properties shall be sufficient to safely sustain or withstand strains to which it is normally subjected.
- B. Pipe Materials:
 - 1. Polyvinyl Chloride (PVC), 2 1/2 In. and Smaller:
 - a. Specification: ASTM D1785.
 - b. Compound: PVC 12454-B, ASTM D1784.
 - c. Thickness: Schedule 80.
- C. Pipe Joints:
 - 1. Polyvinyl Chloride, 2 1/2 In. and Smaller:
 - a. Screwed: ASTM D2464.
 - b. Solvent Weld: ASTM D2855.
 - c. Solvent: ASTM D2564.
- D. Pipe Fittings:
 - 1. Polyvinyl Chloride (PVC) 2 1/2 In. and Smaller:
 - a. ASTM D2464, Schedule 80 PVC threaded fittings.
 - b. ASTM D2467, Schedule 80 PVC socket type fittings.
 - c. ASTM D2855, solvent weld joints.
- E. Pipe Marking and Identification:
 - 1. Ductile Iron Pipe: Permanent marking tape, with the words "SANITARY FORCE MAIN" printed along the tape, shall be attached to the pipe for its entire length. In addition, similar marking tape shall be placed in the trench over the pipe, six to twelve inches below finished grade, for the entire length of pipe.
 - 2. PVC Pipe: All PVC force main pipe shall be manufacturer's standard green color for sanitary force mains. In addition, permanent marking tape with the words "SANITARY FORCE MAIN" shall be placed in the trench over the pipe, six to twelve inches below finish grade, for the entire length of pipe.

In addition, all PVC or HDPE force main pipe installed underground shall have a #12 gauge, solid strand, type UF insulation trace wire (green in color for sewer) attached for locating purposes. Half hitches shall be made behind each pipe bell and on each side of a valve or fitting. Branch splices shall be made at all tees and service lines. Trace wire shall be run into valve boxes as shown on valve detail. For grinder type pump stations, the tracer wire shall be run to the pump station control panel. Watertight splicing connectors shall be utilized for all splices. Contractor shall be responsible for continuity of trace wire.

2.2 PLUG VALVES:

- A. Non-lubricated, eccentric plug type with cast iron body, stainless steel bearings, balanced plug coated with E.P.T. (ethylene-propylene terpolymer or neoprene).

1. Minimum port area:

Valves less than 24 inch: 80% of pipe area

Valves 24 inch or larger: 70% of pipe area

2. Valve shall be designed for easy conversion from wrench-operated to gear-operated in field.

- B. Operators: All valves 8 inch or larger shall have totally enclosed worm and gear operators.

- C. Accessories:

1. Buried Valves 6 Inch and Smaller: Provide 2-inch square nut.

2. Buried Plug Valves 8 Inch or Larger: Provide buried worm gear activator.

3. Valves Not Buried: Provide handwheels for valves equipped with geared operators and valve wrenches of adequate size and length for all valves without geared operators.

4. Acceptable Manufacturers or Equal: DeZurik, Val-Matic, or equal.

2.3 GATE VALVES (2-inch and larger): Shall be AWWA C-515, iron body, resilient seat, non-rising bronze stem with 2" square operating nut on buried valves, turn to left (counter clockwise) to open.

- A. Working pressure of 200 psi.

- B. Internal Metal Surfaces shall have two-part thermosetting epoxy coating, 4 mils thick meeting AWWA C550.

- C. Sealing Mechanism shall have zero leakage at 200 psi with flow in either direction.

- D. End Conditions:

a. Above ground, \geq 2-inch: Flanged Joint

b. Below ground, \geq 3-inch: Mechanical Joint

c. Below ground, 2-inch and 2-1/2-inch: Threaded Joint

- E. Acceptable Manufacturers: Mueller, American or equal.

- 2.4 CHECK VALVES: Shall be AWWA C508, cast iron or steel body, resilient coated disc ring, bronze seating ring, stainless steel bolting and hinge pin, and outside pin and lever.
- A. Swing type with weighted cantilever operator and externally mounted piston operated cushion chamber to prevent slamming or hammering.
 - B. Swing shaft shall be non-corrosive material (303 stainless steel).
 - C. Rated to 175 psig operating pressure.
 - D. Interior surface shall be epoxy coated in accordance with AWWA C550.
 - E. Acceptable: Golden Anderson, Mueller, American, or equal.
- 2.5 VALVE BOXES:
- A. Provide at all manually operated valves installed on underground lines.
 - B. ASTM A-48, cast iron, Class 30-B, 3-piece screw extension type, with cover marked "SEWER" and flared base to suit valve furnished.
 - C. Acceptable: Figure No. F-2450, Clow Corporation; Catalog No. H10357, Mueller Co.; Figure No. E-3002, M & H Valve and Fittings Co. or equal.
- 2.6 PLASTIC LOCATING AND MARKING TAPE: Tape shall be plastic coated foil with a minimum width of 2 inches. Tape shall be highly visible and shall have the words "SANITARY FORCE MAIN" in at least 1" letters printed at least every 36 inches along the tape. Tape shall be Allen Marking Tape or equal.

PART 3 - EXECUTION

3.1 EXCAVATION:

- A. General: The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the drawings or as necessary. This shall include all necessary clearing and grubbing of any foreign substance encountered within the structure or trench area. Excavated material suitable for backfill shall be piled in an orderly manner at a sufficient distance from the trench to prevent slides or cave-ins.
- B. Protection of Existing Facilities and Utilities: All existing improvements such as pavements, conduit, poles, pipes and other structures, shall be carefully supported and fully protected from injury and, in case of damage, they shall be restored by the Contractor without compensation. Existing utilities and other underground obstructions are shown on the plans, but the accuracy of the locations and depths is not guaranteed. The Contractor shall contact all utilities prior to construction and arrange for the necessary assistance in locating and protecting the existing utilities. The Contractor shall be responsible for damages to these existing utilities and shall, in case they are damaged, restore them to their original condition.
- C. Trench Excavation: All excavation shall be in accordance with the Florida Trench Safety Act. The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8 in. each side of pipe for

unsheeted or sheeted trench, with the maximum width of trench, measured at the top of the pipe, not to exceed the outside pipe diameter, plus 24 in., unless otherwise shown on the drawings. Trench walls shall be maintained vertical from the bottom of the trench to a line measured at the top of the pipe. From the top of the pipe to the surface of the trench walls shall be as vertical as possible under soil conditions.

No more than 300 linear feet of trench shall be open in advance of the completed pipe laying operation without prior approval of the Engineer. Pipe trenches across roadways and driveways shall be backfilled as soon as pipe is installed. Where, in the opinion of the Engineer, adequate detour facilities are not available, no trench shall be left open across a roadway or commercial property driveway where adequate detour routes are not available for a period in excess of 30 minutes, or as directed by the governing authority. No trench shall be left open across any roadway or driveway for more than 24 hours. It shall be the Contractor's responsibility to provide suitable traffic control and barricades as necessary meeting governing jurisdiction (i.e. City, County, FDOT, etc).

- D. Shoring, Sheet piling and Bracing: The Contractor shall design, furnish and install all shoring, sheet piling and bracing or provide other approved facilities required to perform and protect the excavation and as necessary for the safety of the public, the employees, and the preservation of existing roads, structures and other utilities. The top of such sheet piling left in place shall be cut off at a minimum elevation of 2.5 ft. below finished grade.
- E. Pavement Removal: The Contractor shall remove pavements as part of the trench excavation. The material from permanent pavement removal shall be carefully separated from trench excavation material and disposed of by the Contractor.
- F. Boulder Removal: All rocks, stones, boulders or concrete, having any dimension larger than permitted to be used for backfill in the paragraph entitled "Backfilling" of these Specifications, shall be removed from the site and disposed of by the Contractor.
- G. Unsuitable Soil Conditions and Overdepth Excavation: Where determined by Engineer or his representative that the soils encountered in the utility trench excavation are unsuitable for pipe bedding and/or backfill, the depth of excavation shall be increased as directed by Engineer or his representative. The bottom of the excavation shall be brought up to the proper excavation elevation utilizing suitable and properly-compacted backfill material or bedding material as directed by the Engineer or his representative. Bedding material if required, shall consist of 1/2" to 1" diameter stone placed in bottom of trench at a thickness of 4 to 6 inches. Suitable backfill material shall then be installed and compacted over pipe as described in Paragraph 3.04. Contractor shall be compensated for removal and replacement of unsuitable soils in accordance with applicable bid items.
- H. Disposal of Excess Material: The Contractor shall dispose of the excavated materials not required or suitable for backfill. All surplus excavated material which is unsuitable for fill shall become the property of the Contractor and shall be disposed of by the Contractor at his expense. Pieces of broken asphalt shall be carefully separated from suitable fill material and hauled to an asphalt plant for disposal or shall be disposed of by some other acceptable means by the Contractor at no expense to Owner. All excavated material not suitable for backfill (e.g., concrete, boulders, roots, etc.) shall be carefully separated from suitable fill material and disposed of by the Contractor at no expense to Owner. Owner has the option to accept suitable backfill material from the Contractor.

3.2 INSTALLATION OF FORCE MAINS:

- A. General: Unless otherwise noted on the drawings or in other sections of this Specification, the pipe shall be handled and installed in strict accordance with the manufacturer's instructions and with the applicable AWWA or ASTM Standards.
1. Ductile Iron Pipe: AWWA C-600.
 2. Polyvinyl Chloride Pipe: ASCE Manual No. 37, ASTM D2321.
 3. If a conflict exists between the manufacturer's instructions and the AWWA or ASTM Standards, the manufacturer's instructions shall govern.
 4. Examine area to receive pipe work for defects that adversely affect execution of work or cause deviation beyond allowable tolerances for piping clearances.
 5. Carefully examine each section of pipe or valve before installation. Do not use defective or damaged pipe or materials. Remove such pipe or material from project site immediately.
- B. Preparation: The Contractor shall use every precaution during construction to protect the pipe against the entry of nonpotable water, dirt, wood, small animals and other foreign material that would hinder the operation of the pipeline. All valves installed in main shall be kept tightly closed during installation. Where the groundwater elevation is above the bottom of the trench, the Contractor shall provide suitable dewatering equipment. All piping shall be placed in a dry trench, unless wet trench installation is approved by the Engineer.
- C. Depth of Cover: Unless otherwise shown on the drawings, or otherwise authorized by the Engineer, the pipe shall have a minimum cover of 36 inches.
- D. Connections to Existing Mains: The Contractor shall make connections to existing mains as shown on the drawings. Connections shall be made only after arrangements have been completed by the Contractor with the Owner of the system and shall be under the System Owner's immediate supervision. Contractor shall be required to restrain existing pipe as necessary in accordance with pipe restraint schedule.
- E. Pipe Thrust Restraints: Mechanical restrainers shall be installed as required to properly restrain all piping systems. At a minimum, restrainers shall be provided on all below-grade valves and fittings and at the required number of pipe joints in each direction. Required lengths of restrained pipe shall be as shown in pipe restraint schedule at end of this paragraph for the type of soil encountered. For above-grade piping, all valves and fittings shall be threaded, flanged or solvent welded with supports as required.

PIPE RESTRAINT SCHEDULE

MINIMUM LENGTH OF PIPE (IN FEET) REQUIRED TO BE
RESTRAINED ON EACH SIDE OF A VALVE OR FITTING
FOR SANDY SOILS (SW, SP, SM, SC)

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
P V C P I P E	≤4	18	18	18	18	18	22	36	18	52
	6	24	18	18	18	18	30	38	36	73
	8	31	18	18	18	18	40	69	36	96
	10	37	18	18	18	18	48	93	54	115
	12	43	18	18	18	18	56	99	54	136
	14	49	20	18	18	18	64	101	72	155
	16	55	23	18	18	18	72	103	72	174
	18	60	25	18	36	20	80	104	72	192
	20	65	27	18	36	21	87	105	72	211
	24	75	31	18	36	25	102	134	90	246
	30	88	37	18	36	29	122	185	90	295

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
D U C T I L E I R O N	≤4	18	18	18	18	18	18	18	18	33
	6	20	18	18	18	18	19	35	36	47
	8	26	18	18	18	18	25	44	36	61
	10	31	18	18	18	18	30	60	54	73
	12	37	18	18	18	18	36	63	54	86
	14	41	18	18	18	18	41	64	72	98
	16	46	19	18	36	18	46	66	72	111
	18	51	21	18	36	18	51	66	72	122
	20	56	23	18	36	18	56	67	72	134
	24	64	27	18	36	21	65	85	90	156
	30	75	31	18	36	25	78	118	90	188

PIPE RESTRAINT SCHEDULE
MINIMUM LENGTH OF PIPE (IN FEET) REQUIRED TO BE
RESTRAINED ON EACH SIDE OF A VALVE OR FITTING
FOR CLAYEY AND SILTY SOILS (CL, CH, ML, MH)

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL OFFSET ^a		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
P V C P I P E	≤4	19	18	18	18	18	23	36	18	55
	6	26	18	18	18	18	32	40	36	77
	8	35	18	18	18	18	42	73	36	101
	10	42	18	18	18	18	50	98	54	121
	12	50	21	18	18	18	59	104	54	143
	14	57	23	18	36	20	67	106	72	163
	16	64	27	18	36	23	76	109	72	183
	18	71	29	18	36	25	84	109	72	202
	20	78	32	18	36	28	92	110	72	221
	24	92	38	18	36	33	107	140	90	258
	30	110	46	22	54	40	127	193	90	308

PIPE TYPE	PIPE SIZE	90° BEND	45° BEND	≤22.5° BEND	TEE OR CROSS	VERTICAL OFFSET ^a		REDUCER ^b	VALVE	DEAD END
						LOW	HIGH			
D U C T I L E I R O N	≤4	18	18	18	18	18	18	18	18	35
	6	22	18	18	18	18	20	25	36	49
	8	29	18	18	18	18	27	46	36	64
	10	35	18	18	18	18	32	62	54	77
	12	41	18	18	18	18	37	66	54	90
	14	47	20	18	18	18	43	67	72	103
	16	53	22	18	36	19	48	68	72	115
	18	59	24	18	36	21	53	69	72	127
	20	65	27	18	36	23	58	70	72	140
	24	76	31	18	36	27	67	89	90	162
	30	91	38	18	36	32	80	122	90	194

Assumptions: 1. Pipe Test Pressure = 150 PSI

2. Minimum Pipe Depth = 3.0 Feet
3. Laying Condition = Type 5
4. Safety Factor = 2.0

^a "Low" represents the minimum length of pipe (in feet) required to be restrained on the low side of the vertical offset, which is typically downstream of the offset fitting. "High" represents the minimum length of pipe (in feet) required to be restrained on the high side of the vertical offset, which is typically upstream of the offset fitting. Required restrained lengths assume an offset angle $\leq 45^\circ$.

^b Distance represents the linear feet of large diameter pipe upstream of the reducer required to be restrained. Restrain small diameter pipe at reducer at a minimum. If there is an unobstructed run downstream of the reducer (i.e. small diameter pipe) of at least 2.5 times the required length of large diameter pipe to be restrained, then restraint is required only at the reducer fitting. If small end of reducer is more than three pipe sizes smaller than large end, consult Engineer for required length to be restrained.

3.3 SEPARATION REQUIREMENTS BETWEEN FORCE MAINS AND POTABLE WATER/RECLAIMED WATER MAINS:

- A. Horizontal Separation: Force mains shall be laid at least ten feet (outside to outside) horizontally from water mains at least three feet (outside to outside) horizontally from any existing or proposed reclaimed water line. Smaller horizontal separation distances for force mains are allowed if one of the following conditions is met:
 1. The top of the force main is installed at least 18-inches below the bottom of the potable water line.
 2. The force main is encased in watertight carrier pipe or concrete.
 3. Both the force main and the water main are constructed of slip-on or mechanical joint pipe complying with public water supply design standards and pressure tested to 150 psi to assure watertightness.
- B. Vertical Separation: Force mains shall cross under water mains, unless there is no alternative. Force mains crossing water mains or reclaimed water lines shall be laid to provide a minimum vertical distance of 18-inches between the invert of the upper pipe and the crown of the lower pipe. The minimum vertical separation shall be maintained whether the water main is above or below the force main. For sewer crossings, the crossing shall be arranged so that the force main pipe joints are equidistant and as far as possible from the water main joints. For force mains, smaller vertical separation distances if one of the following conditions are met.
 1. The force main is encased in a watertight carrier pipe or concrete.
 2. The force main is designed and constructed equal to water pipe and pressure tested to 150 psi to assure watertightness.

No vertical or horizontal separation distances are required for above-ground crossings.

- C. Concrete Encasement of Pipe: Where concrete encasement of pipe is required for obtaining separation from other pipes or for other reasons (e.g., inadequate cover), the pipe shall be encased with 3,000 psi concrete having a minimum thickness of 6 inches all around the outside of the pipe. Pipe must be supported in trench to allow 6 inches of concrete on all sides. Concrete must be mechanically vibrated into place. The Engineer or his representative must be present at the time of encasement.

- D. Contractor shall notify Engineer immediately where separation criteria cannot be met.

3.4 BACKFILLING:

- A. Material: All backfill shall be excavated material, essentially free of organic material, asphaltic concrete, clay, concrete, boulders and other deleterious material.

1. Bedding and Pipe Embedment: The material in the bedding, around the pipe and to a depth of 1 ft. over the pipe, shall be sand or a mixture of sand, shell or crushed stone properly graded and mixed so that fine grain material from the side walls of the trench or backfill above the embedment will not migrate into the backfill material. The backfill shall meet the following limitations.
 - a. Ductile Iron Pipe: All material shall pass through a 3/4 in. square opening laboratory sieve.
 - b. Plastic Pipe: All materials shall pass through a 1/2 in. square opening laboratory sieve.
2. Above Pipe Embedment: The material shall be sand or a mixture of sandy material with rock, stone and shell. Rock, stone and shell shall pass through a 3-1/2 inch ring.
3. Top of Backfill: The top 12 inches of the backfill shall be topsoil and/or sandy material.
4. Additional Fill: If sufficient suitable backfill material is not available from the excavation, additional fill meeting the above requirements shall be provided by the Contractor.

B. Placing and Compaction:

1. Under Pavement: Where the excavation is made through existing or proposed pavements, including shoulders, curbs, driveways, sidewalks, or structures, the entire backfill to the subgrade of the pavement or structures shall be made with predominantly sandy material free from rock, stones or organic matter, except that rocks passing a 3-1/2 inch ring will be permitted in the backfill between the elevation one foot above the top of the pipe and the bottom of the pavement subgrade.

The entire backfill material, including the material placed around and one foot above the pipe, shall be compacted to a density of not less than 98% of the maximum density, as determined by AASHTO T-180, in 12" lifts. Particular care shall be taken to insure that the backfill at the haunch is free from voids and is properly compacted. Compaction by flooding or puddling will be permitted only by written authorization from the Engineer.

Roads, walks and driveways consisting of broken stone, gravel, clay, marl, shell, shellrock, or a conglomerate of such materials, are not considered as being permanent pavement.

2. In Areas Not Under Permanent Pavement: Within right-of-ways or other areas where permanent pavement does not exist or is not proposed, including roads, walks and driveways consisting of broken stone, gravel, clay, marl, shell, shellrock or conglomerate, the entire backfill to the subgrade of the pavement or structures shall be made with predominantly sandy material free from rock, stones or organic matter, except that rocks having a maximum dimension of 3 1/2 inch will be permitted in the backfill between the elevation 1 ft. above the top of the pipe and 1 ft. below the surface. Particular care shall be taken to insure that the backfill at the haunch is free from voids and is properly compacted. The bedding and embedment shall be compacted to a density of not less than 98 percent of maximum as determined by AASHTO T-180,

in 12" lifts. The backfill material above 1 ft over the pipe shall be compacted to a density of not less than 90 percent of the maximum density, as determined by AASHTO T-180, in 12" lifts. Compaction by flooding or puddling will be permitted only by written authorization from the Engineer.

In areas where unpaved, stabilized roads exist, the Contractor shall restore the road to its original grade and condition. The finished stabilized road shall have a minimum LBR value of 50 for the top 12" of the roadbed.

3. Miscellaneous: Backfilling around meter boxes, valve boxes and other structures shall be accomplished in the same manner as the connected pipe. Extreme care shall be used in backfilling wellpoint holes to prevent voids and settlement. If necessary, the holes should be plugged with a concrete slurry, such plugging to be at the expense of the Contractor.
4. Compaction Tests: The Engineer or his representative may at any time instruct the Contractor to partially excavate a previously backfilled trench or temporarily backfilling of a short section of the trench for the purpose of obtaining measurements of the density of the backfill. All density testing shall be paid for by the Contractor. Density tests shall be taken along the pipe a minimum of every 300 feet, at each road lane crossing, and as directed by Engineer. Density tests shall be taken in one foot lifts from bottom of trench to finished grade.

3.5 TESTING:

- A. Flushing of Completed Pipelines: Each section of completed pipeline shall be thoroughly flushed. A minimum flow shall be used for flushing that will insure a velocity in the pipe of 2.5 ft. per second. Water required for testing and flushing will be furnished by the Owner at existing pipes and outlets. Contractor shall slowly fill system to eliminate air pockets, then flush to remove particulates. Flushing shall comply with Figures 1 and 2, and Table 3 of AWWA C651. Provide corporation stops at any high points in line in order to bleed air from piper. Contractor shall make provisions to properly dispose of water from his flushing operations. Flooding of streets and private property shall not be permitted. Contractor shall arrange with Owner 72 hours in advance of the time of flushing for the availability of water. Water required for testing and flushing will be furnished by the Owner from a potable water source satisfactory to the Owner.
- B. Leakage Test: Leakage and pressure tests shall be conducted in the presence of the Engineer. The Contractor shall provide all necessary apparatus including a pump, flow measuring device, piping connections and fittings and the necessary labor to conduct the tests. The test shall be of not less than two (2) hours in duration. During the test, the pipe being tested shall be maintained at a pressure of not less than 150 psi. All leaks evident at the surface shall be repaired and leakage eliminated regardless of total leakage shown by test. Lines which fail to pass tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves, and accessories shall be removed and replaced. The pipe lines shall be tested in sections between every consecutive in-line valve unless otherwise directed by the Engineer. The line shall be filled with water and all air removed, and the test pressure shall be maintained in the pipe for the entire test period by means of a force pump to be furnished by the Contractor. Accurate means shall be provided by the Contractor for measuring the makeup water required to maintain this pressure. Leakage is defined as the quantity of makeup water added to the pipe being tested during the test period. No pipe installation will be accepted if the leakage exceeds the quantities specified in AWWA C605-05, which is represented by the following equation.

$$Q = \frac{LD\sqrt{P}}{148,000}$$

Where:

Q = Quantity of makeup water (allowed) in gallons per hour

L = Length of pipe section being tested, in feet

D = Nominal diameter of the pipe, in inches

P = Average test pressure during the hydrostatic test, in pounds per square inch (gauge)

- C. Testing Plan: The Contractor must review his plan for testing with the Engineer at least two (2) working days before starting the test. The Contractor shall remove and adequately dispose of all blocking material and equipment after completion and acceptance of the field hydrostatic test, unless otherwise directed by the Engineer. Any damage to the pipe coating shall be repaired by the Contractor. Lines shall be totally free of debris prior to final acceptance.
- 3.6 PROTECTION: At the end of each workday, the mains under construction shall be plugged to prevent the entry of small animals and rodents. Temporary plugs shall be provided for this purpose. Keep all valves closed during construction.
- 3.7 RESTORATION OF DAMAGED SURFACES, STRUCTURES, AND PROPERTY: Where pavement, trees, shrubbery, fences, or other property and surface structures not designated as pay items have been damaged, removed, or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the contract documents, state laws, county or municipal ordinances, or the specific directions of the Engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced or repaired at the expense of the Contractor to a condition equal to that before work began within a time frame approved by the Engineer.
- 3.8 RESTORATION AND CLEANUP:
- A. Restoration:
1. General: Restoration of areas disturbed by the Contractor's operations shall begin as soon as practical. Contractor's restoration operations shall keep pace with utility installation. Engineer reserves the right to halt utility installation until restoration and cleanup requirements are satisfied.
 2. Time Frame for Restoration: Restoration of areas disturbed by the Contractor's operations shall begin no later than 14 days and shall be completed (excluding punch list items) no later than 28 days from the time construction first began in the area. No more than 1,000 LF along the path of the work may be completely unrestored (excluding punch list items) at the end of each day.
- B. Cleanup: The Contractor shall maintain the site of the work in a neat condition. The Contractor shall remove all excess materials, excess excavated materials, and all debris resulting from his operations a minimum of once per week.

END OF SECTION - 333400

SECTION 334100 - PIPE WORK - STORM SEWER

PART 1 - GENERAL

- 1.1 DESCRIPTION: Work under this Section consists of furnishing all materials, supplies, equipment and labor in accordance with the requirements set forth herein and as shown on the drawings.
- 1.2 RELATED DOCUMENTS: 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.
- 1.3 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS: The work under this Contract shall be in strict accordance with the following codes and standards.
 - A. All Local, County, Municipal and Federal Codes.
 - B. American National Standards Institute (ANSI).
 - C. American Society for Testing and Materials (ASTM).
 - D. American Water Works Association (AWWA).
 - E. American Association of State Highway and Transportation Officials (AASHTO).
 - F. Florida Department of Transportation Specifications (DOT).
 - G. St. Johns River Water Management District. (SJRWMD).
 - H. Florida Dept. of Environmental Protection. (FDEP).
- 1.4 REFERENCED CODES AND STANDARDS:
 - A. American Association of State Highway & Transportation Officials (AASHTO)/ American Society for Testing and Materials (ASTM):
 1. ASTM C76/ AASHTO M 170, Round Reinforced Concrete Pipe.
 2. ASTM C443 / AASHTO M 198, Joints for Circular Concrete Sewer and Culvert Pipe with Rubber Gaskets.
 3. ASTM C497, Determining Physical Properties of Concrete Pipe or Tile.
 4. ASTM C507/AASHTO M 207, Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe.
 5. ASTM C655/AASHTO M 242, Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe.
 6. ASTM D1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

7. ASTM D2321, Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
 8. ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
 9. AASHTO M 252, Specification for Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter.
 10. AASHTO M 294 Type S, Specification for Corrugated Polyethylene Pipe, 12 to 36 Inch Diameter.
 11. ASTM F405, Standard Specification for Corrugated Polyethylene Tubing and Fittings, 4" to 8" diameter.
 12. ASTM F667, Standard Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings, 10" to 24" diameter.
 13. ASTM F477, Standard Specification for Elastomeric Seals.
 14. AASHTO M 294, Standard Specification for Corrugated Polyethylene Pipe, 12" to 24" diameter.
 15. AASHTO M 190, Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 16. ASTM A798, Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
 17. ASTM A760/AASHTO M 36, Metallic (zinc or aluminum) Coated Corrugated Steel Culverts.
 18. AASHTO M 196, Corrugated Aluminum Alloy Culverts and Underdrains.
 19. ASTM A762, AASHTO M 245, Precoated, Galvanized Steel Culverts and Underdrains.
 20. ASTM C139, Concrete Masonry Units for Construction of Catch Basins and Manholes.
 21. ASTM C150, Portland Cement.
 22. ASTM C443, Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
 23. ASTM C478, Precast Reinforced Concrete Manhole Sections.
 24. ASTM C1433, Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers.
 25. ASTM C923, Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Materials.
 26. ASTM F2306/F2306M Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
- B. Manufacturer's name and model numbers are listed to establish a standard of quality. Equivalent items of other manufacturers are acceptable.
- 1.5 SUBMITTALS:
- A. Submit manufacturer's certification of materials' conformance to specifications.

- B. Submit manufacturer's literature, catalog data and installation instructions.
 - C. Precasters shop drawings indicating all dimensions, finishes, reinforcement and accessories for each unit.
 - D. As-built drawings in compliance with Section 01 71 00. As-built drawings of the drainage system shall be provided prior to making permanent above pipe improvements.
- 1.6 PRODUCT DELIVERY AND HANDLING:
- A. Exercise care to prevent damage of product during loading, transporting, unloading and storage.
 - B. Do NOT drop pipe or fittings.
 - C. Do not store directly on ground and assure that materials are kept clean.
 - D. Store material in areas approved by the Owner.
 - E. Store material in such a manner as to not create a nuisance or safety hazard.
- 1.7 QUALITY CONTROL:
- A. Contractor shall make a timely submittal of as-built drawings of the stormwater system and prior to making permanent above pipe improvements.
 - B. Installed pipe slopes shall not deviate by more than 5% of the specified slope for each run.
 - C. Structure inverts and control elevations shall not deviate by more than 0.10 feet from the specified elevation.
 - D. Pipe slopes and inverts not meeting the standards of this section shall be relaid to the required slope or invert at the contractor's expense. Failure to correct a deficient item shall be cause for the contractor to forfeit payment for the materials and installation costs incurred for the item.

PART 2 - PRODUCTS

2.1 PIPE:

- A. General: Pipe shall be furnished free from defects impairing strength and durability and should be of best commercial quality for purpose specified. Structural properties shall be sufficient to safely sustain or withstand strains to which it is normally subjected.
- B. Pipe Materials:
 - 1. Reinforced Concrete Circular Pipe (RCP) and Elliptical Pipe (ERCP):
 - a. Specification: ASTM C76 (RCP), C507 (ERCP).
 - b. Thickness: Class III, minimum.

- c. Reinforcing: 65 ksi: Steel mesh.
 - 2. Corrugated Polyethylene Pipe (CPP):
 - a. Specification: AASHTO M 294, ASTM F405, ASTM F667, AASHTO M 252, ASTM F2306.
 - b. Advanced Drainage Systems Air Chamber N-12 WT "watertight pipe" or approved equal.
 - c. Dual wall HDPE pipe with smooth interior lining and exterior corrugations.
 - d. Provide manufacturer installed "anti-float" perforations.
 - C. Pipe Joints:
 - 1. Reinforced Concrete Pipe (RCP & ERCP):
 - a. Bell & Spigot with Rubber Gaskets: ASTM C443.
 - 2. Corrugated Polyethylene Pipe (CPP):
 - a. Couplings: ASTM F405, ASTM D3212, ASTM F1417.
 - b. All joints shall be rated as Water Tight.
 - D. Filter Fabric:
 - 1. Specification: FDOT Specification Section 985 (Geotextile Fabrics).
 - 2. Class D-3 Material.
- 2.2 PRECAST UNITS:
- A. Manholes, Inlets and Catch Basins:
 - 1. Manholes, inlets and catch basins shall be constructed of precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. Manholes, inlets and catch basins shall be in accordance with State of Florida Department of Transportation standard details.
 - a. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 48 inches in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type.
 - b. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric.
 - c. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.

- d. Precast Catch Basins: Concrete for precast sections shall have a minimum compressive strength of 4,000 psi at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C857.
 - e. Brick Mortar: Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 5-1/2 gallons per sack of cement.
 - f. Frames and covers shall be cast iron conforming to ASTM A48.
 1. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover with the Owner's name and the words "storm sewer" stamped into the surface. The studs and the lettering shall be raised 5/16 inch.
 2. The cover shall be a minimum of 24 inches in diameter and shall have four 3/4 inch vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
 - g. Grates shall be cast grey iron conforming to ASTM A48 in accordance with Florida Department of Transportation standard details. The grate shall fit firmly on the frame without movement when subject to traffic.
 1. All grates shall be traffic rated for HS20-44 loading.
 2. All grates shall be fitted with an eyebolt and chain secured to the concrete to prevent unauthorized removal.
 3. The shape and size of waterway openings shall be as shown on the drawings
 - h. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M 198B.
2. Adjusting Brick and Rings:
 - a. Brick: Sound, hard and uniform shape. Comply with ASTM C32, Grade MM.
 - b. Rings: Pre-case unit complying with ASTM C478.
 3. Mortar: Metallic non-shrink mortar applied and cured in conformance with the manufacturers recommendations. EMBECO 167 or equal.
- B. Headwalls & Mitered End Sections:
1. Headwalls and mitered end sections shall be cast-in-place or precast concrete and in accordance with Florida Department of Transportation standard details.

2. Concrete shall be in accordance with State Department of Transportation standard specifications. Concrete shall have a minimum compressive strength of 4,000 psi at 28 days. The cement shall be Type II conforming to ASTM C150.

- C. Reinforcing Steel: Reinforcing steel shall be deformed bars, ASTM A615, Grade 60 unless otherwise noted.

2.3 PREFABRICATED PLASTIC MANHOLES AND DRAIN BASINS:

- A. Plastic manholes and drainage basins shall be as indicated on the drawings.
- B. Basis of design shall be Nyloplast Storm Drainage Structures
- C. Grates shall be traffic rated and ductile iron (ASTM A536) or cast iron (ASTM A48).
- D. Grates shall be Pedestrian Safe and fitted with a locking mechanism to prevent unauthorized removal.
- E. All joints shall be water tight.
- F. All grates shall receive a concrete collar as shown on the drawings.

2.4 RESILIENT CONNECTORS AND DOWNSPOUT BOOTS:

- A. Resilient Connectors:
 1. Connectors shall be boots or external gaskets.
 2. Flexible, watertight connectors used for connecting flexible pipe to manholes and inlets shall conform to ASTM C923.
- B. Downspout Boots: Boots used to connect exterior downspouts to the storm drainage system shall be a round adaptor as manufactured by Fernco, Advanced Drainage System or equal. Size to match downspout and collection pipe.

PART 3 - EXECUTION

3.1 EXCAVATION:

- A. General: The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the Drawings or as necessary. This shall include all necessary clearing and grubbing of any foreign substance encountered within the structure or trench area. Excavated material suitable for backfill shall be piled in an orderly manner at a sufficient distance from the trench to prevent slides or cave-ins.
- B. Protection of Existing Facilities and Utilities: All existing improvements such as pavements, conduit, poles, pipes and other structures, shall be carefully supported and fully protected from injury and, in case of damage, they shall be restored by the Contractor without compensation. Existing utilities and other underground obstructions are shown on the plans, but the accuracy of the locations and depths is not guaranteed. The Contractor shall contact all utilities prior to construction and arrange for the necessary assistance in locating

and protecting the existing utilities. The Contractor shall be responsible for damages to these existing utilities and shall, in case they are damaged, restore them to their original condition at no cost to the Owner.

- C. Trench Excavation: The minimum width of the trench shall be equal to the outside diameter of the pipe at the joint plus 8 in. each side of pipe for unsheeted or sheeted trench, with the maximum width of trench, measured at the top of the pipe, not to exceed the outside pipe diameter, plus 24 in., unless otherwise shown on the drawings. Trench walls shall be maintained vertical from the bottom of the trench to a line measured at the top of the pipe. From the top of the pipe to the surface of the trench walls shall be as vertical as possible under soil conditions.

No more than 150 linear feet of trench shall be open in advance of the completed pipe laying operation without prior approval of the Engineer. Pipe trenches across roadways and driveways shall be backfilled as soon as the pipe is installed. Where, in the opinion of the Engineer, adequate detour facilities are not available, no trench shall be left open across a roadway or commercial property driveway where adequate detour routes are not available for a period in excess of 30 minutes, or as directed by the governing authority. No trench shall be left open across any roadway or driveway for more than one daylight period. It shall be the Contractor's responsibility to provide traffic control and barricades as necessary.

- D. Shoring, Sheet piling and Bracing: The Contractor shall design, furnish, install, and maintain all shoring, sheet piling and bracing or provide other approved facilities required to perform and protect the excavation and as necessary for the safety of the public, the employees, and the preservation of existing roads, structures and other utilities. The top of such sheet piling left in place shall be cut off at a minimum elevation of 2.5 ft. below finished grade. All work shall be in accordance with the Florida Trench Safety Act. See Section 02300 for additional requirements.
- E. Boulder Removal: All rocks, stones, boulders or concrete, having any dimension larger than permitted to be used for backfill in the paragraph entitled "Backfilling" of these Specifications, shall be removed from the site and disposed of by the Contractor.
- F. Trash Removal: Non-hazardous waste material encountered within the trench section including, but not limited to, household solid waste, wood, tires, and plastic shall be removed from the site. Under no circumstances, shall this material be reburied.
- G. Disposal of Excess Materials: The Contractor shall dispose of the excavated materials not required or suitable for backfill. All surplus excavated material which is suitable for fill shall become property of the Contractor and shall be disposed of by the Contractor at his expense.
- H. Unsuitable Soil Conditions and Over Depth Excavation: Overexcavate and backfill as required by Section 310000.

3.2 INSTALLATION OF STORM SEWER PIPE:

- A. Manufacturer's Instructions: Storm sewer pipe shall be handled, stored and installed in strict accordance with the pipe manufacturer's instructions. A copy of the manufacturer's instructions shall be kept at the site of the work at all times by the Contractor.

- B. The trench shall be excavated as specified and the bottom of the trench shall be shaped to give sufficient uniform circumferential support to the lower, one-fourth of each pipe.
- C. Pipe laying shall proceed upgrade.
- D. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade.
- E. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- F. Support pipe on compacted bedding material. Excavated bell holes only large enough to properly make the joint.
- G. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- H. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- I. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- J. Where cleaning of the pipe after laying is difficult because of the small diameter, the Contractor shall keep a suitable swab or drag in the pipe and shall pull the swab forward past each joint immediately after the jointing operation.
- K. Jointing: The bell and spigot surfaces shall be wiped free of dust, dirt, gravel or other foreign material before the application of the lubricant sealer. The resilient joint shall be connected by first brushing upon the mating surfaces, the proper lubricant sealer as recommended by the pipe manufacturers. The spigot end shall then be centered on grade into the bell end of the last downstream pipe length and shoved home and properly seated with the application of moderate force by a pry or lever device. The pipes shall be jointed no later than five minutes after the application of the lubricant sealer. Jointing for connections with existing mains, or other special joints, shall be approved by the Engineer before use.
 - 1. All joints shall be wrapped in a 30" wide layer of filter fabric. Fabric shall be centered on the joint and completely surround the pipe with a 18" lap.
- L. Do not lay sewer pipe in same trench with another pipe or other utility unless authorized by the engineer.
- M. Do not walk on pipe in trenches until covered by layers of fill to a depth of 12 inches over the crown of the pipe.
- N. Connections to Manholes or Inlets:
 - 1. Pipe connections to concrete manholes or inlets shall be made with resilient connectors.
 - 2. Watertight gaskets shall be fitted to the pipe and embedded in the grouted annular space in accordance with the manufacturer's requirements.

- O. It is the responsibility of the Contractor to install the stormsewer pipe as shown on the Drawings. The Contractor shall survey the newly installed line before backfilling to determine the actual invert elevations of the pipe. If the calculated slope is below the minimum acceptable requirements, the Contractor shall remove and relay the stormsewer pipe at his own expense before further installation continues. The Contractor shall submit the as-built information to the Engineer at the end of each work day. This information will be included in the daily inspection report. Constructed slopes shall not vary more than 5% from the design value.

3.3 PRECAST UNIT 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 of previously set section shall have an O-ring installed in the recess or shall be sealed with pre-molded plastic joint sealer "RAMNEK." If "RAMNEK" is used, joints shall be pre-primed.
- B. Non-Metallic Non-Shrink Grout: All holes in sections used for their handling, and the annular space between the wall and entering pipes shall be thoroughly plugged with Masterflow 713 Plus as manufactured by the BASF, or any approved equal non-shrinking mortar or grout, applied and cured in strict conformance with the manufacturer's recommendations, so that there will be zero leakage through openings and around pipes.
 - 1. The mortar shall be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces.
 - 2. Non-concrete pipe connections shall be fitted with a resilient connector to provide a watertight connection between the pipe and the manhole.
- C. Membrane Curing Compound: As soon as grout is hydrated to the point where it will not be marred by such application, and within two (2) hours after installing grout, the Contractor shall apply an approved membrane curing compound, conforming to ASTM C309, Type 1, Class B, to the finished mortar surfaces both inside and outside the manhole. Submission of alternate mortars or grouts should include an alternate membrane curing compound or indicate which of the above approved products is proposed for use.
- D. Grade Adjustment: For grade adjustment in setting the man-hole frame, brick masonry 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.
- E. 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 Owner. 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 water tight. 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.
- F. Flow Channels: 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.

3.4 BACKFILLING:

A. Material: All backfill shall be suitable fill as described in Section 31 00 00 and as further described below:

1. Bedding and Pipe Embedment: The material in the bedding, around the pipe and to a depth of 1 ft. over the pipe, shall be sand or a mixture of sand, shell or crushed stone properly graded and mixed so that fine grain material from the side walls of the trench or backfill above the embedment will not migrate into the backfill material. The backfill shall meet the following limitations.
 - a. Concrete Pipe: All material shall pass through a 3/4 in. square opening laboratory sieve.
 - b. Corrugated Metal and Plastic Pipe: All materials shall pass through a 1/2 in. square opening laboratory sieve.
2. Above Pipe Embedment: The material shall be suitable fill as described in Section 310000.
3. Top of Backfill: The top 6 inches of the backfill shall be topsoil (as defined in 310000 in areas to be landscaped or grassed).
4. Additional Fill: If sufficient suitable backfill material is not available from the excavation, additional fill meeting the above requirements shall be provided by the Contractor at no expense to the Owner.

B. Placing and Compaction:

1. Bedding and Pipe Embedment: The backfill shall be placed by hand under and around the pipe to the springline and compacted. Particular care shall be taken to ensure that the backfill at the pipe haunch is free from voids and is properly compacted. The backfill shall be compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.
 - a. Above Pipe Embedment in Areas of Permanent Pavement: The backfill shall be placed in layers having a depth that will permit proper compaction as described in Section 310000. The backfill shall be compacted to a density of not less than 98% of maximum as determined by AASHTO T 180.
 - b. Above Pipe Embedment In Areas Not Under Permanent Pavement: Within right-of-ways or other areas where permanent pavement does not exist or is not proposed the backfill material above 1 ft. over the pipe shall be compacted to a density of not less than 90% of the maximum density, as determined by AASHTO T 180.
2. In areas where unpaved, stabilized roads exist, the Contractor shall restore the road to its original grade and condition. The finished stabilized road shall have a minimum LBR value of 50 for the top 12" of the roadbed.
3. Miscellaneous: Backfilling around manholes, cleanouts and other structures shall be accomplished in the same manner as the connected pipe. Extreme care shall be used in backfilling wellpoint holes to prevent voids and settlement. If necessary, the holes should be plugged with a concrete slurry, such plugging to be at the expense of the Contractor.

4. Compaction: Shall be by hand or by mechanical tampers. Care shall be taken that the pipe is not struck by the tamper. Compaction by flooding may be allowed by written authorization of the Engineer although this will not release the Contractor of the responsibility to meet the required density.
5. The Contractor is to compact the backfill in such a manner to prevent settlement. Although the requirements of 3.03 may be met, nonsettlement is not assured and Contractor is not relieved of his responsibility by such compliance.
6. Pipe shall be laid and backfilled so that pipe deflection does not exceed five (5) percent.
7. All pipe shall laid to within 5% of the specified slope. Structure inverts shall be within 0.10 foot of the vertical elevation shown on the drawings.
8. Corrugated plastic pipe shall receive a minimum of 24" of cover. In the event that 24" of cover cannot be provided, the Contractor shall notify the Engineer immediately.
9. The Contractor shall perform soil density tests as described in Section 310000.
10. All testing shall be paid for by the Contractor by a qualified testing laboratory of his choosing.
11. Open trenches shall be backfilled to surrounding grade at the close of each work day.

3.5 CULVERT REMOVAL AND REPLACEMENT:

- A. Culverts, catch basins and other drainage structures that are removed or damaged during construction shall be replaced with materials and structures equal and similar to those removed or damaged. Manhole covers and gratings shall be set at the original elevations unless otherwise directed.
- B. The Contractor shall take precautions against the entry of excavated and other loose material resulting from his operations from entering catch basins, culverts and other drainage structures in the vicinity of his operations. He shall maintain the cleanliness of these drainage structures in a condition equal to that prior to the commencement of his operations during the construction. The Contractor shall be responsible for all damage to persons, roads, buildings, vehicles and other property resulting from the failure of the Contractor to maintain these drainage structures.

3.6 SYSTEM TESTING:

- A. The Contractor shall furnish all necessary equipment and labor to perform testing of all gravity sewers as set forth in the following and shall conduct such tests in the presence of the Engineer and other authorized agencies, with five days advance written notice provided.
- B. The installed sewers shall be visually inspected by "lamping" between manholes, inlets, lampholes or other structures in order to ascertain that they are clear and to correct alignment. The concentricity of the lamp image received shall be such that the diameter of said image shall have no vertical or horizontal reduction from that of the pipe inside diameter.

- C. Should any of the tests fail, necessary repairs shall be accomplished by the Contractor and the test repeated until within the established limits. The Contractor shall furnish the necessary labor, and all other items required to conduct the required testing, and shall perform the necessary system repairs required to comply with the specified test.
- 3.7 RESTORATION OF DAMAGED SURFACES, STRUCTURES AND PROPERTY: Where pavement, trees, shrubbery, fences or other property and surface structures not designated as pay items, have been damaged, removed or disturbed by the Contractor, whether deliberately or through failure to carry out the requirements of the contract documents, state laws, municipal ordinances or the specific direction of the Engineer, or through failure to employ usual and reasonable safeguards, such property and surface structures shall be replaced and repaired at the expense of the Contractor to a condition equal to that before work began within a time frame approved by the Engineer at no cost to the Owner.
- 3.8 CLEANUP: The Contractor shall maintain the site of the work in a neat condition. The Contractor shall remove all excess materials, excess excavated materials and all debris resulting from his operations within a time frame approved by the Engineer.

END OF SECTION - 334100

SECTION 337117 - MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Prefabricated concrete manholes.
- B. Manhole accessories.

1.2 RELATED SECTIONS

- A. Section 337118 - Ductbank.
- B. Section 260526 - Secondary Grounding.

1.3 REFERENCES

- A. AASHO H-20 - Standard Specification for Highway Bridges.
- B. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
- D. ASTM A48 - Gray Iron Castings.
- E. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in precast concrete structures with three years documented experience.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 260305, 1.6.
- B. Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.
- C. Provide product data for manhole accessories.
- D. Submit manufacturer's installation instructions under provisions of Section 260305, 1.12.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

- A. Precast Concrete: Air-entrained, 2000 psi compressive strength at 28 days.
- B. Reinforcing: AASHTO H-20; bridge loading.
- C. Construction: Monolithic.
- D. Manhole Shape: Square.
- E. Inside Dimensions: 6 ft length and width; 4 ft deep.
- F. Wall Thickness: 6 inches, minimum.
- G. Include 36 inch diameter grooved opening in top section.
- H. Necking and Shaft Sections: 30 inch diameter clear opening.
- I. Include 12 inch drain sump with 4" PVD drain opening and two (2) one inch ground rod openings in base section.
- J. Window for Duct Entry: 18 x 18 inches minimum on each wall, with top of opening 18 inches below top of manhole.
- K. Include cable pulling irons opposite each duct entry window.
- L. Include inserts for cable racks.

2.2 MANHOLE ACCESSORIES

- A. Manhole Frames and Covers: ASTM A48; Class 30B gray cast iron, machine finished with flat bearing surfaces.
- B. Sump Covers: ASTM A48; Class 30B gray cast iron.
- C. Pulling Irons: 7/8 inch diameter steel bar forming a triangle of 9 inches per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles.
- D. Cable Rack Inserts: Steel channel insert with minimum load rating of 800 pounds, length to match cable rack channel.
- E. Cable Rack Channel: 1-1/2 x 3/4 x 3/16 inch steel channel wall bracket, 48 inch length, with cable rack arm mounting slots on 1-1/2 inch centers. Provide two per wall on either side of conduit windows.
- F. Cable Racks: ANSI/ASTM A569; steel channel, 1-1/2 x 3/4 x 14 inches, with fastener to match mounting channel. Provide racks on all channels as required to support all cables without exceeding one layer of cables per rack.

PART 3 EXECUTION

3.1 PREPARATION

- A. Excavate, install base material, and compact base material in accordance with manufacturer's instructions.
- B. Coat manhole exterior with bituminous sealer prior to manhole installation.

3.2 INSTALLATION - PRECAST CONCRETE MANHOLES

- A. Install and seal precast sections in accordance with manufacturer's instructions.
- B. Use precast neck and shaft sections to bring manhole entrance to proper elevation.
- C. Install manholes plumb.
- D. Set the top of each manhole to finished elevation of sidewalk or grade.
- E. Seal all manhole penetrations water-tight.

3.3 INSTALLATION - MANHOLE ACCESSORIES

- A. Clean manhole of all construction debris, soil and water. Install sump grate.
- B. Install ground rod with top protruding 4 inches above manhole floor.
- C. Attach cable racks to inserts after manhole installation is complete.

3.4 MANHOLE DRAIN CONNECTION

- A. Install drains in manholes and connect to site storm drainage system at location shown on site plans. At location shown on site plans. Connection shall be made at storm drain invert location below bottom of manhole.
- B. Drain pipe shall be schedule 40 PVC, 4 inch minimum size.

END OF SECTION 337117

SECTION 337118 - DUCTBANK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Underground conduit in ductbank configuration.

1.2 RELATED SECTIONS

- A. Section 337117 - Manholes

1.3 REFERENCES

- A. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
- B. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- C. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- D. NEMA TC 6 and 8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
- E. NEMA TC 9 - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
- F. NEMA TC 14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- G. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit
- H. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- I. ANSI/IEEE C2 - National Electrical Safety Code.
- J. ANSI/NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

- A. Submit under provisions of Section 260305, 1.6.
- B. Product Data: Provide for non-metallic conduit. Provide data for conduit spacers.
- C. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 260305, 1.6.
- B. Accurately record actual locations of exact routing of ductbank, including elevations taken at all changes in direction of ductbank and at all midpoints of ductbanks.

1.6 QUALIFICATIONS

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

1.7 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept conduit on site. Inspect for damage.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.9 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Duct bank routing is shown on Drawings in approximate locations unless dimensions are indicated. Route as required to complete duct system.

PART 2 PRODUCTS

2.1 RIGID PLASTIC CONDUIT AND FITTINGS

- A. Comply with NEMA TC 2.
- B. Material: Schedule 40 PVC.
- C. Fittings and Conduit Bodies: Comply with NEMA TC 3.

2.2 PLASTIC COMMUNICATIONS DUCT AND FITTINGS

- A. Comply with NEMA TC 6 and 8 and with NEMA TC 9.
- B. Type: EB.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavation, base material installation, and compaction is completed.

3.2 PREPARATION

- A. Prepare excavation in accordance with manhole manufacturer's instructions.

3.3 DUCT BANK INSTALLATION

- A. Install duct in accordance with manufacturer's instructions.
- B. Install power and communications duct to locate top of ductbank minimum 30 inches below finished grade.
- C. Install duct with minimum slope of 4 inches per 100 feet. Slope duct away from building entrances.
- D. Cut duct square using saw or pipe cutter; de-burr cut ends.
- E. Install no more than equivalent of three 90-degree bends between pull points.
- F. Provide suitable fittings to accommodate expansion and deflection where required.
- G. Terminate duct at manhole entries using end bell.
- H. Stagger duct joints vertically in concrete encasement 6 inches minimum.
- I. Use suitable separators and chairs installed not greater than 4 feet on centers.
- J. Band ducts together before placing concrete.
- K. Securely anchor duct to prevent movement during concrete placement.
- L. Place concrete under provisions of Section 033000.
- M. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.
- N. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.
- O. Provide suitable pull string in each empty duct except sleeves and nipples.
- P. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- Q. Backfill trenches under provisions of Section 310000 Earthwork.
- R. Interface installation of underground warning tape with backfilling specified in Section 310000. Install tape 6 inches below finished surface.

END OF SECTION 377118