



New Jetson Center for Youth

Baker, Louisiana

Construction Documents

Specifications – Volume 2

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State of Louisiana
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Division of Administration
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PART 1 GENERAL

1.01 GENERAL

- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements apply to the work specified in this section.
- B. The division of the specification into divisions 20, 22 and 23 is for contractor convenience only. This contractor is responsible for any and all references to their work that may be located within a different section of the specifications.

1.02 DESCRIPTION

- A. Perform all work under this heading, including the furnishing of labor, materials, equipment, and service necessary for and reasonably incidental to the proper completion of all mechanical work as shown on the drawings and herein specified.
- B. Visit and examine the job and confer with all authorities concerned in order to become familiar with all existing conditions pertinent to the work to be performed. No additional compensation will be allowed for failure to be so informed.
- C. Materials and equipment shall be new, except where otherwise indicated, of the best quality, with same brand or manufacturer for all similar material.
- D. Perform all work in a neat and workmanship manner.
- E. In general, provide the installation of plumbing systems, and heating, air conditioning and ventilating systems complete with piping, fittings, fixtures, equipment, etc.
- F. Regardless of titles and subdivisions herein employed, consider these specifications as a complete document with General Sections applying to all other sections. All bidders are cautioned to read entire specifications and to thoroughly familiarize themselves with all requirements thereto.
- G. Check all specifications and all drawings and bring to attention any conflicts or variations as soon as noted.
- H. Specifications and accompanying drawings apply to all contracts or sub-contracts entered into for supplying material or labor for construction of work specified herein and shown on the drawings.
- I. The drawings and specifications are complementary and what is shown and/or called for on one shall be furnished and installed the same as if shown and/or called for in the other.
- J. In case of discrepancies and/or ambiguities in the drawings and/or in the specifications, consult Architect prior to submission of a proposal. Failure to do so on the part of the successful bidder shall be construed as explicit agreement on his part to abide by the Architect's decision in such matters.
- K. The word "Provide" as used in these specifications and on the drawings shall be termed to mean "furnish and install".

1.03 QUALITY ASSURANCE

- A. The Contractor bidding on this portion of the work must be fully experienced in the installation of equal size, complexity, and quality, and must be licensed to perform such work as required by the Rules and Regulations Promulgated by the State Licensing Board for Contractors.
- B. In bidding he acknowledges that he fully understands the scope of the work and design, and has the ability for the contract price to assemble and install the equipment, piping, ductwork, etc., as shown and specified, so as to mold same into a satisfactory workable system and arrangement.
- C. Contractor shall recognize that a fault or error in his work remains his responsibility regardless of whether such difficulty was discovered after the work had progressed, and shall make corrections at no cost to Owner.

- D. Provide adequate and competent constant supervision to assure that work is done in accordance with good standard practice and workmanship and with intent of drawings and specifications.
- E. Install all work in strict accordance, with all local and state codes and ordinances, with National Board of Fire Underwriters, and in accordance with all O.S.H.A. Standards.
- F. Secure all permits and inspections and pay all legal fees and taxes and provide Owner with a certificate of approval from agencies having jurisdiction over various phases of the work.

1.04 SUBMITTALS

A. Shop Drawings and Submittal Data Required

1. Submit to the Architect for review, immediately after award of contract, six (6) copies of complete descriptive information and dimensional data on all items of equipment, materials and accessories. Submit all shop drawings at one time. Piece meal submission shall not be acceptable.
2. Shop drawings and submittal data shall be considered to be instruments to service only and submitted for the sole purpose of convenience to the Contractor to assist him in the performance of the contract. The Architect's review of the shop drawings and submittal data shall not supersede these specifications, the accompanying drawings or the contract terms, unless specifically covered by a properly executed change order, and then only to the extent specifically and explicitly stipulated therein.
3. Coordination with electrical: Contractor to submit copy of any & all shop drawings that indicate electrical requirements to the project electrical engineer for electrical service & electrical load verification. Applicable to all mechanical items.
4. Any and all changes within to the contract documents in submittals shall be highlighted in yellow on the submittals (dimension, size, electrical requirements, material, color, etc.).
5. The contractor shall provide a copy of the respective Mechanical Equipment Schedule of the equipment that is being submitted with the information/data of the submitted equipment within the schedule. This is required to be able to compare the specified equipment with the submitted equipment on an exact format basis. Failure to submit custom mechanical equipment schedule with submittal may result in a rejected submittal.
6. The contractor shall submit to the mechanical engineer, as soon as feasible after award of the contract, equipment room layouts at a scale not less than 1/4" = 1'-0" showing the layout of the actual equipment to be used and all necessary clearances. This drawing is to be comprehensive of all trades as to eliminate conflicts. The contractor will be responsible to verify all access for maintenance as required by the manufacturer.
7. Well in advance of preparing the project shop drawings and well in advance of ordering any project equipment, and as part of the requirements and work of this project division:
 1. Employ, coordinate directly with, and pay (if such payment is required) the respective suppliers/vendors of all project equipment and/or the respective project subcontractors who are providing all project equipment, as respectively applicable:
 - a. To review all respective equipment performance, electrical characteristics and requirements which are indicated and/or given on any of the project drawings and/or in any of the project specifications; and
 - b. To determine whether or not each bit of the information that is relevant to such indicated equipment performance, electrical characteristics and requirements is accurate for the exact respective equipment which is being furnished for the project;
 2. Have such suppliers/vendors and/or subcontractors, as respectively applicable:

- a. Verify, in no uncertain terms, with proper documentation, which bits of the information that is relevant to such indicated equipment performance, electrical characteristics and requirements are indeed so accurate; and
 - b. Furnish the respective, properly-corrected, equipment performance, electrical characteristics and requirements for all indicated equipment electrical characteristics and requirements which are not so accurate;
3. Submit all such verifying and/or correcting documentation to the architect, in a timely manner, in the same formats in which the respective equipment performance, electrical characteristics and requirements were originally indicated and/or given. For example:
 - a. For all equipment performance, electrical characteristics and requirements which were originally indicated and/or given in the form of equipment schedules, submit the respective, properly-corrected, equipment performance, electrical characteristics and requirements in the form of corrected, similar, equipment schedules;
 - b. For all equipment performance, electrical characteristics and requirements which were originally indicated and/or given in the form of equipment notes (plan keynotes), submit the respective, properly-corrected, equipment performance electrical characteristics and requirements in the form of corrected, similar, equipment notes;
 - c. For all equipment performance, electrical characteristics and requirements which were originally indicated and/or given in the form of specification verbiage, submit the respective, properly-corrected, equipment performance, electrical characteristics and requirements in the form of corrected, similar, specification verbiage; and so on."

B. Record Drawings

1. The contractor shall be furnished with one (1) set of blue line prints, on which Contractor shall show any changes in the work caused by unforeseen circumstances and these drawings shall be turned over to the Architect in good order prior to final acceptance of the building. Architect in turn shall prepare record drawings from information furnished by contractor.

C. Parts Catalogs and Operating Instructions

1. Furnish to the Architect for the Owner, three (3) complete sets of parts catalogs and operating instructions bound in large binders for his use. Each set shall contain:
 - a. Complete wiring and control diagrams
 - b. Routine maintenance operations
 - c. Detailed operating instructions and instructions for making minor adjustments
 - d. Manufacturer's catalog data, pump curves, service instructions, and part list of each piece of operating equipment
2. One additional copy of the first item above shall be framed under glass and installed in each equipment room where applicable.
3. Instruct Owner's operator in the proper care, operation, lubrication, and maintenance of mechanical equipment installed.

D. Substitution

1. All material, equipment, methods and accessories entering into the work under this section of contract are subject to approval or disapproval of the Architect. Approval of any

manufacture or vender, any material, or product, shall not constitute a waiver of Architect's right to demand full compliance with contract requirements, including shape, size, quality and performance.

2. Equality of materials is that established by opinion of Architect. Decision of Architect is final.
3. Whenever a material or article of equipment is specified by use of a proprietary name, or by naming the manufacturer or vendor, any material or article which will perform adequately the duties imposed by the design will be considered for substitution, providing it is of equal substance, and function, meets specifications, and is aesthetically acceptable to the Architect, and that requests for approval along with all literature and technical data on proposed substitution is submitted in writing so as to be received in Office of Architect not less than seven (7) calendar days prior to opening of bids.
4. Literature, technical data, etc., includes complete data (including catalog names and model numbers) and samples if necessary, with submissions for substitutions. Burden of proof that material offered for substitution is equal, or superior, in construction and efficiency to that named, rests on Contractor, and unless proof is satisfactory to Architect, substitutions will not be approved.

1.05 PRODUCT, DELIVERY, STORAGE AND HANDLING

- A. Take necessary precautions to protect all material, equipment, apparatus and work from damage. Failure to do so to the satisfaction of the Architect will be sufficient cause for the rejection of the material, equipment or work in question. Contractor is responsible for the safety and the good condition of the materials installed until final acceptance by the Owner.

1.06 JOB CONDITIONS

- A. Accompanying drawings, including plans, details, diagrams, notes, etc., are shown to limit and explain structural conditions, construction requirements, sizes, capacities, and method of installation and erection. Structural and other conditions may require certain modifications and adjustments from conditions shown. Such deviations are permissible; however specific sizes, capacities, and requirements affecting the satisfactory performance and operation of the installation shall remain unchanged. Make allowances for normal job conditions and interferences.
- B. Whenever it becomes necessary to shift ducts or pipes or to change shape of ducts, such changes shall be referred to the Architect for approval.
- C. Ask for details whenever uncertain about method of installation. Lack of details not requested shall not excuse improper installation and correction shall be responsibility of Contractor.
- D. Furnish detailed ductwork shop drawings and large scale equipment room layouts base on field measurements, actual job conditions, and actual equipment to be installed on project.
- E. Schedule and perform all mechanical work to avoid delays.
- F. All piping, cleanouts and covers, and other mechanical items in way of construction or remodeling, shall be rerouted, relocated or otherwise adjusted to work out with such construction or changes shown or specified in any or all of various sections of specifications.
- G. Refer unknown site or job conditions that are encountered immediately to Architect for method of disposition before continuation of work.

1.07 GUARANTEE AND SERVICE

- A. Guarantee all equipment, materials and workmanship for a period of one (1) year following date of acceptance.
- B. Guarantee all equipment compressors shall come with a full ten (10) years (material, labor, refrigerant).
- C. During the period of guarantee and defects in equipment, materials or workmanship shall be promptly corrected without cost to Owner.
- D. Guarantee includes equipment capacity and performance ratings specified with excessive noise levels. Any deficiencies in equipment capacity specified shall be promptly corrected.

- E. Guarantee does not include normal maintenance items.
- F. Guarantee water heaters and all pressure vessels for a full ten (10) years.
- G. Warranty period begins at date of substantial completion, not when contractor starts equipment. Figure in bid extending warranty to accomplish this.

1.08 COORDINATION DRAWINGS

- A. The contractor shall coordinate work of all various sections having interdependent responsibilities for installing, connection to, and placing such equipment. At the contractor's expense, all (including but not limited to, mechanical, plumbing, electrical system) necessary offsets, bends, duct size/configurations, crossing/cross-overs shall be provided and installed as necessary to integrate within the structural system and the architectural features (ceilings and walls, etc.).
- B. Coordination Drawings: the purpose of the coordination drawings is to assure proper forethought and coordination of integrating all systems of the building within the structural framework, architectural ceilings, floors, and walls of the building. The contractor shall provide coordination drawings prior to the submittal of all system shop drawings. The coordination drawings shall include ductwork and all mechanical HVAC piping and associated items, plumbing verticals and sprinkler piping, chases, electrical conduit, and shall indicate sizes of these items and the structural members.
- C. The contractor shall submit the coordination drawings (four (4) complete sets) to the architect for the architect's approval no later than one month after the work has commenced on the project site. The contractor shall revise and re-submit the drawings as the architect may require. Provide a DVD/CD with each hard copy with PDF's of coordination drawings.
- D. The coordination drawings shall include, but is not limited to, the following:
 - 1. Plan drawings for each floor indicating structural member sizes, HVAC components/sizes/routes/locations, major electrical conduit grouping/routes, vertical chases/openings, and all other items as necessary to comply with the requirements of 1.8.A and 1.8.B of this section.
 - 2. Section drawings through major pathways for systems (such as corridors, if appropriate), and exemplary rooms.
 - 3. Prior to the commencement of preparing the drawings, the contractor shall confirm the proposed listing of drawings to be submitted.
 - 4. Any and all other drawings, schedules, and information necessary to illustrate the contractor's understanding of the architectural design intent of the critical ceiling heights, wall locations, and all other design parameters and how they are accommodated upon the contractor's proposed integration of the systems noted in the contract documents.
- E. During the course of construction, the contractor shall update the coordination drawings in a clean, clear, and legible manner and have the drawings readily available on-site for the architect's access. Upon substantial completion, the contractor shall submit the updated coordination drawings to the architect for the owner's future use and shall be the property of the owner.
- F. The General Contractor is to coordinate with all sub-contractors as to provide the coordination drawings. All contractors are to be responsible for coordinating their applicable work. The General Contractor and all sub-contractors shall work cohesively in a timely manner as to provide the coordination drawings.

1.09 ELECTRICAL COORDINATION WITH BUILDING AND AUTOMATIC TEMPERATURE CONTROLS PRIOR TO BID COORDINATION DRAWINGS

- A. The contractor shall Given the nature of the evolving technology in the field of Building & Automatic Temperature Controls (and the differences between various manufacturers), various Temperature Control Devices have been specified at various voltages (120-1-60, 24V, etc., Refer to Specification 230900). It is the responsibility of the General Contractor, Electrical

Contractor, Mechanical Contractor, & Temperature Controls contractor to coordinate prior to bid as to ensure all electrical provisions for all Temperature Control Devices are accounted for (material, equipment, conduit, breakers, wiring, devices, installation, labor, etc.) as to provide a complete and working Temperature Controls System. Should the Contractor (and subcontractors) fail to coordinate all electrical provisions prior to bid, then the cost to provide such electrical provisions shall be solely borne by the Contractor (and subcontractors). No additional cost to be provided by the owner to the Contractor for failure to coordinate prior to bid. Refer to specification 230900 for Building and Automatic Temperature Controls sequences of operation, EMS point list, product data, etc.

1.10 FEES AND DEPOSITS

- A. Arrange for and pay regulatory inspection and service connection fees (sewer, drainage, water and gas) including the cost of any main extensions. Pay meter deposits for utility services. After substantial completion of the project, the meter registration shall be transferred to the User/Owner.

1.11 VISITING SITE

- A. The Bidder shall visit the site of proposed work so that he may understand the facilities, difficulties and restrictions attending the execution of the contract. No additional compensation will be allowed for failure to be so informed.

1.12 UTILITY CONNECTIONS

- A. Coordination of utilities which are work of this contract to utilities installed as work of other divisions prior to starting any work. Verify connection points, inverts, valving, etc., prior to commencing any work. No additional compensation will be allowed for conflicts that occur due to lack of coordination.

1.13 NEW EQUIPMENT INSTALLATION

- A. New equipment installed under this project specified by other sections of these specifications which requires discipline specific connections shall be coordinated & installed by the contractor. These connection points are based on the manufacturer specified and laid out by the contractor. Should the contractor utilize another manufacturer, it is the contractor's responsibility to verify all new connections (mechanical, plumbing, electrical, etc.) and modify required services as necessary to place new piece of equipment into operation.

1.14 SPECIAL CONDITIONS

- A. No piping, ducts or other mechanical equipment foreign to the electrical equipment shall pass through or above the spaces dedicated to electrical panel boards, electrical distribution panels, electrical switchboards and motor control centers. Work shall conform with NFPA 70. Working clearances and dedicated spaces at electrical equipment shall be maintained per NFPA 70. Coordinate with each trade.

1.15 WORK IN OTHER DIVISIONS

- A. Prior to bidding, the Contractor shall coordinate items of work referred to as "work of other Divisions" to insure items are not omitted or duplicated.
 - 1. Utility Connections - sewer, natural gas, storm drainage and water unless otherwise noted on the drawings.
 - 2. Electrical work (wiring, raceways and disconnect switches), fire alarm work (wiring, raceways, equipment and devices) associated with work of this division and not specified as work of Division 26 - Electrical, shall be work of this division.

3. Supports for work of this Division, except supports specifically indicated to be provided under other Divisions, shall be provided as work of this Division. Supports provided under other Divisions shall be checked and coordinated under this Division to ensure that they suit the work to be installed.

4. Painting, including painting of exposed insulation, exposed piping and exposed ductwork not specified as work of DIVISION 9 - FINISHES, shall be work of this Division. Damaged surfaces of factory finished items shall be repaired to the satisfaction of the Architect/Engineer as the work of this Division. Nameplates shall be protected until painting has been accomplished. Protection shall be removed and nameplates cleaned prior to acceptance of equipment.

1.16 MANUFACTURER'S RECOMMENDATIONS

A. Equipment and materials provided under this Division of the specifications shall be installed according to manufacturer's recommendations. Each manufacturer' application and installation instructions shall be reviewed prior to ordering equipment or commencing with the work. If the drawings or specifications show or describe any deviations from the manufacturer's recommendations the Contractor shall request clarification, from the Architect/Engineer and provide as directed at no additional cost to the User Agency. Where the respective manufacturer's recommended installation required equipment/material not shown within the contract documents, the contractor shall provide & figure the cost of these additional equipment/material in their bid. The contractor shall provide a complete and working system.

PART 2 PRODUCTS

2.01 TOOLS AND SCAFFOLDING

A. Furnish all tools, equipment, scaffolding and other facilities required to properly and expeditiously perform the work.

2.02 BUCKS, GROUNDS AND CHASES

A. All bucks, grounds, lintels, blockouts, chases and grouting for work under this Division shall be done by the General Contractor.

B. This Division shall be responsible for proper location and sizes or for any errors of omission in placing same.

2.03 FOUNDATIONS AND SUPPORTS

A. Provide foundation and supports of concrete or steel shapes for equipment requiring same.

B. Mount all floor mounted mechanical equipment on nominal four (4) inch high concrete housekeeping pads.

2.04 ACCESS PANELS

A. Factory made access doors and frames, prime coat finish, screwdriver latch(s) of suitable size as required.

B. Access panels in rated ceiling to have same rating as ceiling. Where access panels are required in fire rated ceiling then the access panel shall be fire rated.

C. Access panels in lined ductwork to be double wall type with insulation sandwiched in between, same insulation value as adjacent ductwork.

D. Where valves (domestic water valves, etc.), dampers, controls, fire dampers, smoke dampers and detectors, etc., are concealed in walls or non-accessible ceilings, install factory made access doors and frames. Contractor shall refer to drawings for locations of items in need of access panels. Panels to be sized as to properly access equipment. Minimum access panel size to be 24x24.

E. Paint all exposed access panels to match finish of respective wall and/or ceiling.

- F. Where an access door is required in a security wall/ceiling, the contractor shall provide security access panel (concealed continuous hinge, security TORX type fasteners, security cylinder, 16 ga. Minimum.).

2.05 FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Where any pipe or risers pass exposed through walls, partitions, floors or ceiling, use chrome-plated floor and ceiling plates.
- B. Plates shall be large enough to completely close the hole around the pipes and shall be round with the least dimension not less than 1-1/2" larger than the diameter of the pipe. Plates shall be secured in an approved manner.

2.06 SIPHON PREVENTORS

- A. Furnish and install approved type siphon preventers on all equipment and fixtures in such a manner as to prevent water being siphoned back into the water supply in the event the water supply is shut off.

2.07 FLAME SPREAD PROPERTIES OF MATERIALS

- A. All materials and adhesives used for acoustical linings, jackets and insulation shall comply with requirements of NFPA 90A and 90B and UL guide no. 40 V.8.15. Products exceeding a flame spread rating of 25, or a smoke developed rating of 50, as determined by ASTM Test Method E-84 are prohibited. Adhesives and sealers shall be fire retardant and fire resistant when dry. Flame proofing treatments which are subject to decomposition, deterioration, or the effects of moisture are prohibited.

2.08 SCAFFOLDING, RIGGING AND HOISTING

- A. Each contractor shall furnish all scaffolding as required for the installation of his work. He shall either arrange with the General Contractor for servicing in connection with any rigging and hoisting required or provide his own equipment to hoist apparatus to be installed by him into place. Each contractor shall see that any equipment too large to permit passage through normal doorways and access ways is brought to the job and set in place before the mechanical spaces are enclosed. All apparatus not delivered in this manner shall be disassembled and reassembled in the proper location. Equipment specified to be factory assembled and tested prior to shipment shall not be disassembled for shipment to an installation into the building.

2.09 VIBRATION ISOLATION

- A. Transmission of vibration or structural borne noise to occupied areas by equipment installed under this contractor will not be permitted. Contractor shall furnish for approval, data showing disturbing frequency, supported weight, static deflection, efficiency and calculations supporting same for each isolator he proposes to use.
- B. All isolators shall be selected and certified, using published data, to limit vibration transmission to 10% for equipment located on floors in direct contact with grade and 5% for equipment located other than the above. Should any noise or vibrations be objectionable to the Architect and/or Owner, field instrumentation tests and measurements shall be made by the isolator manufacturer or his representative to determine the source and cause of such disturbance. Any non-compliance with these specifications shall be corrected by the contractor in a manner satisfactory to the Architect at no additional cost to the Owner.

2.10 UNDERGROUND PIPING WARNING TAPE

- A. All underground piping shall have warning tape installed directly above underground piping (beyond building slab). Tape shall be installed 12 to 18 inches below finished grade. Warning tape shall be metallic detectable type consisting of 0.35 mils thick solid core encased in a protective plastic jacket that is resistant to alkalis, acids and other destructive elements found in the soil. The lamination bond shall be strong enough that the layers cannot be separated by hand. Total composite thickness to be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. Warning tape for metallic piping may be 0.4 mils polyethylene film without metallic laminate.
- B. Warning tape shall have a continuous warning message repeated every 18 to 36 inches shall be imprinted on the tape surface. The tape shall contain an opaque color concentrate

designating the color code appropriate to the line being buried. Tape shall be minimum 3" wide.

- C. All PE piping shall be traced with copper wire when bored (single solid conductor insulated, not stranded, wire, 12-gauge for 2" and smaller, 8-gauge for lines larger than 2", any connection to T-splice shall be made using multi-cable connector block (Polaris block) with silicone for underground/wet locations). Provide underground warning tape installed above underground piping. Underground warning tape shall read "Caution Gas Line Buried Below".
- D. An additional #10 copper wire shall be adhered to all underground nonconductive piping and fastened with plastic zip ties every 4'-0" on center. Provide a long tail tracer wire at valve with ring and cover.

2.11 MATERIALS IN AIR DUCTS AND PLENUMS

- A. No plastic or other non-metallic materials as defined by NFPA 90A shall be used in air ducts or plenums unless specifically rated for such service.

2.12 FLASHING

- A. Metal flashing: 26 gauge galvanized steel.
- B. Lead flashing: 5 lb/sq ft sheet lead for waterproofing.
- C. Flexible flashing: 47 ml thick sheet butyl; compatible with roofing.
- D. Caps: Steel, 22 gauge minimum; 16 gauge at fire resistant elements.

2.13 EQUIPMENT IDENTIFICATION

- A. Provide labels for each starter, control switch, and all equipment. Labels to be engraved black laminated bakelite nameplates with 1/4" high which cut letters, secure to starters, switches or equipment.

2.14 FIRE RATED WOOD

- A. All wood as specified within these construction documents (mechanical, plumbing, sprinkler plans and specifications) shall be of the fire rated type. PYRO-GUARD treated wood as manufactured by HOOVER treated wood products.

2.15 CONCRETE FASTENERS

- A. Fastenings set into concrete to support pipe, air handlers and other mechanical equipment shall be steel or malleable iron expansion shields set in proper size drilled holes. Do not exceed the manufacturer's rated pull out load. The manufacturer's rated load must be based on a factor of safety of 5 or else the allowable load must be reduced to give a factor of safety of 5. Self drilling Rawl Saber Tooth or Phillip Red Heads may be used. Anchors using lead, plastic or shields of any material other than steel or malleable iron shall not be used.
- B. Powder actuated fasteners, Hilti or Ramset, may be used for loads applied with a factor of safety of 5 but not more than 300 pounds for the largest size. The powder charge shall be found by trial and shall be the smallest charge that gives full insertion into the concrete. These fasteners may be used for ductwork and small pipe.
- C. Not used.
- D. Follow manufacturer's instructions and use setting tools procured from the manufacturer of the drilled-in anchors to expand the shields.
- E. Fasteners of the type set into concrete by drilling shall be self drilling Rawl Saber Tooth or Phillips Red Heads.
- F. Powder actuated fasteners shall be Hilti or Ramset.

2.16 PROTECTIVE COATING FOR UNDERGROUND PIPING

- A. Underground pipe and fittings including the portion through the floor shall be protected against corrosion by application of protective coatings.
- B. Prior to coating, pipe and fittings shall be cleaned of all rust, scale, dirt, and oil.
- C. Pipes and fittings shall be given a wash coat of epoxy primer having a dry film thickness of 1.5 - 2.0 mils. Over the primer apply two coats of coal-tar base epoxy coating, each having a dry film thickness of 6 mils.
- D. Coatings shall have a holiday test using a ½" spark. Recoat any areas not passing test.
- E. Provide for all underground metal piping up from grade.
- F. 2-Part coal-tar epoxy to be Carboline 300M or prior approved equal.

2.17 EMS CONDUIT AND BOXES

- A. UNDERGROUND EMS CONDUIT: Rigid Nonmetallic Conduit (RNMC): Schedule 40, rigid polyvinylchloride, rated for 90 degrees C conductors, with pull string, solvent cement connectors and couplings. Nonmetallic strap hangers allowing thermal expansion movement. Conduit to meet NEMA TC-2; fittings to meet NEMA TC-3. Expansion Coupling: Nonmetallic to compensate for thermal expansion.
- B. EMS CONDUIT WITHIN BUILDING: Shall be hot dipped galvanized rigid steel conduit. All conduits shall be new and shall bear the inspection label of the Underwriter's Laboratories, Inc. Metallic conduit shall be hot-dipped galvanized. Fittings for conduit shall be an approved type specially designed and manufactured for their purpose. Rigid metal conduit fittings, bushings, and other components shall be galvanized. Setscrew connector fittings shall not be permitted. All fittings for rigid steel or aluminum conduit shall be threaded and coupled unless specifically approved otherwise by the Engineer.
- C. Pull Boxes: Communication/EMS ground mounted pull boxes shall be polymer concrete, ANSI/SCTE 77 2002 – Tier 22 rated, provide dimensions indicated on the drawing. Open bottom. Cover to be labeled "Communications". Secure cover with stainless steel standard hex head bolts. Covers shall be traffic rated. ALL PULL BOXES TO BE SIZED IN ACCORDANCE TO NEC (NATIONAL ELECTRIC CODE).
- D. Stainless Steel EMS Enclosure: NEMA 3R enclosure (UL 508A Listed). Manufactured from Type 304 16 gauge stainless steel; 16 gauge doors and 14 gauge bodies, Minimum-width body flange provides maximum body opening, Pre-cut gland plate openings in the bottom of the enclosure with a seal to ensure protection, External formed 90 degree body flange, Door opens 210 degrees, Mounting holes in back of body for direct mounting or for optional external mounting brackets, Type 316 stainless steel hinge pins, Corner-formed doors are easily removed by pulling clip-style hinge pins, Quarter-turn latches furnished with 3mm double-bit insert, Seamless foam-in-place gasket, Self-grounding latch system with double seal, Grounding stud on the body, Full-sized galvanized steel back panel included, Bonding provision on the door, Furnished hardware kit includes: gasketed gland plates and hardware, grounding hardware and sealing washers for wall-mounting holes, Three-point latching, Finish: Door and body have smooth #3 brushed finish. Hoffman medium GL66 series stainless steel wall mount enclosure.

2.18 PREPARED OPENINGS

- A. Piping and tubing installed through masonry or concrete walls, floor/ceiling assemblies and floors above grade shall be installed through pipe sleeves.

- B. Duct installed through masonry or concrete walls and non-rated concrete floors above grade shall pass through 20-gauge galvanized sheet metal sleeves. Duct sleeve shall have a 1/2" maximum annular clearance around duct. Allowances shall be made for external duct wrap (if specified). Ducts, tubing and piping installed through floors of mechanical rooms shall have a 4" high concrete curb on each side to prevent water from leaking through openings. Exposed piping installed through walls shall be fitted with chromium plated escutcheons on each side of the wall. Exposed ductwork passing through non-rated masonry or concrete walls shall be fitted with a 2" wide sheet metal flange around each side of duct on each side of the wall.
- C. Ducts installed through partitions, walls or floors which are smoke rated or have a fire rating of one hour or greater shall be installed in accordance with SMACNA standards. Piping and tubing installed through partitions, walls or floors which are smoke rated or have a fire rating of one hour or greater shall be installed through pipe sleeves.

2.19 ROOF MOUNTED EQUIPMENT, DUCTS AND PIPING

- A. Roof mounted equipment shall be installed on equipment supports or curbs as detailed on the drawings or as specified. Tops of curbs shall be level. Ducts penetrating the roof shall be installed within a waterproof engineered roof penetration, The VAULT. Piping penetrating the roof shall be installed through a waterproof engineered roof penetration, The VAULT. Any penetrations of the roof shall be watertight.

2.20 SAFING MATERIAL

- A. Safing material shall be installed in annular spaces between sleeve and pipe or tubing where sleeve and pipe or tubing penetrate partitions that are designated as smoke separations. Material shall be mineral wool designed for hand packing. Material shall have an ASTM E 84 rating of flame spread -10, fuel contributed -0, smoke developed -0 and shall be rated non-combustible per ASTM E 136.

2.21 TAMPER PROOF FASTENERS

- A. Where equipment is specified to have tamper proof or vandal proof fasteners, the Contractor shall coordinate and use the same type of fastener on each item. Provide User Agency with two wrenches, screw drivers, etc., for each type of fastener used on the project.

2.22 ENCLOSURES

- A. Control equipment enclosures provided by the Contractor or provided as part of a packaged piece of equipment shall meet the following minimum standards unless specifically indicated otherwise. Where indicated on the drawings or specifications, flush mounted enclosures shall be provided.
- B. Control equipment enclosure provided within the building shall be equivalent to or greater than NEMA 12 type construction. Control equipment enclosures provided outside of the building, a non-enclosed area of the building or in an accessible crawl space under a building shall be equivalent to or greater than NEMA 3R type construction with drain and breather. Control equipment enclosures provided within hazardous areas, controlling explosion-proof equipment shall be NEMA 7 or 9 type construction. Control equipment enclosures provided for cooling towers and associated equipment within 20'-0" of towers shall be NEMA 4X noncorrosive type construction.

2.23 SAFETY PANS

- A. Safety pans shall be fabricated from 12-gauge (min.) 304 stainless steel. Sides of pans shall be a minimum of 4" high with top edges hemmed. Sides longer than 6'-0" shall have additional flat bar or angle top edge bracing to prevent sagging. Joints and seams shall be watertight. Pans shall be extended at least 6" beyond the sides of the equipment it is serving. Provide a 1" stainless steel female pipe coupling in side of pan near the bottom of overflow piping connection. All joints and seems to be of welded construction. This is applicable for all auxiliary drain pans under air handling units, hot water heaters, etc.
- 1. Provide float switch in auxiliary drain line, unit to de-energize when float switch is tripped.
- 2. Pipe safety pans to nearest floor drain. Provide ball valve in safety pan condensate drain line (normally closed).

PART 3 EXECUTION

3.01 CUTTING AND PATCHING

- A. Cut all openings as required for the work under this section. Patching shall be done by the craft whose work is involved. Furnish and install all necessary sleeves, thimbles, hangers, inserts, etc., at such time and in such a manner so as not to delay or interfere with the work of other trades. No beams or joists shall be cut. After resurfacing has been done, any further cutting, patching and painting shall be done at the expense of the Contractor.

3.02 COORDINATION

- A. Coordinate all mechanical work with other phases of the work, including ceilings systems and tiles, electrical work, other mechanical work, etc.

3.03 PAINTING

- A. Factory painted equipment that has been scratched or marred shall be repainted to match original color.
- B. Steel equipment hangers and supports, un-insulated black steel pipe, and black steel pipe supports exposed to sight outside the building which are not provided with factory prime coat shall be cleaned of rust, grease, and scale. After cleaning hangars, supports and pipe, a field-applied prime coat and two coats of a bituminous aluminum paint shall be provided. Insulated pipe outside the building shall be cleansed of rust, grease and scale. Paint all exposed piping, insulation, grilles, fans, etc., in building or on roof, if not factory finished. Paint piping equipment, hangers, and accessories in all mechanical equipment rooms, including covering and foundations with two (2) coats of approved paint after thoroughly cleaning. Size insulation covering before painting. Equipment having factory finish, if damaged or scratched, shall be touched up and given one additional coat of machinery enamel.
- C. All painting shall conform to the requirement of the PAINTING & COATINGS Section.

3.04 CLEANING AND ADJUSTING

- A. All equipment, pipe, valves, and fittings shall be cleaned of grease, oil, paint spots, metal cuttings, sludge, and construction debris.
- B. Ducts, plenums and casings shall be cleaned of all debris and blown free of all particles of rubbish and dust before installing outlet faces.
- C. Bearings shall be lubricated as recommended by the equipment manufacturer.
- D. Temporary filters shall be provided for fans that are used during construction. At the time of starting the balancing of the air distribution system, new filters shall be installed.

3.05 PENETRATION THROUGH FIRE SEPARATIONS

- A. Pack annular space between sleeve and pipe (insulation) and / or conduit in rated construction with fire resistant putty, sealant and / or caulk. Material shall be non asbestos based and installed in accordance with manufacturers instruction for fire rating required.

- B. Penetrations of multiple items and penetrations with annular space greater than ½" shall be provided with approved backing material in accordance with manufacturer's instructions.
- C. Fire retardant sealer and system shall meet ASTM E-84, ASTM E-814, and UL-1479.

3.06 EXCAVATION, TRENCHING AND BACKFILLING

- A. General: The Contractor shall perform all excavation to install piping herein specified. During excavation, material for backfilling shall be piled back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. All excavated materials not to be used for backfilling shall be removed and disposed of by the Contractor. Grading shall be done to prevent surface water from flowing into trenches and excavations, and any water accumulating therein shall be removed by pumping. All excavation shall be made by open cut. No tunneling shall be done. Trenches shall not be cut below a plane extending at a 45 degree angle down and away from any footing.
- B. Trench Excavation. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections excavated for sealing joints. Depressions for joints shall be dug after the trench bottom has been graded. Over depths shall be backfilled with loose, granular, moist earth, tamped. Remove unstable soil that is not capable of supporting the pipe and replace with specified material for a minimum depth of 12" below invert of pipe.
- C. Backfilling. The trenches shall not be backfilled until all specified pressure tests are performed. The trenches shall be backfilled with the excavated materials approved for backfilling consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the pipe has a cover of not less than the adjacent existing ground, but not greater than 2" above existing ground. The backfilling shall be carried on simultaneously on both sides of the trench so that injurious side pressures do not occur. All trenches under pavements and all trenches within the building walls and to 5 feet outside the building walls shall be compacted in accordance with requirements specified in the EARTHWORK Section. For all trenches, the compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material, except that trenches occurring in areas to be filled shall be backfilled in 6" maximum layers and each layer compacted to 95% maximum density. Settling the backfill with water will not be permitted. Re-open any trenches not meeting compaction requirements; or where settlement occurs, refill, compact, and / or restore the surface to the grade and compaction specified above, mounded over and smoothed off.

3.07 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or water proofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 sheet size. Fasten flashing to drain clamp device.
- D. Seal floor drains watertight to adjacent materials.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
- F. Provide curbs for mechanical installations 14 inches minimum high above roofing surface. Flexible sheet flash and counterflash with sheet metal; seal watertight.

3.08 TESTING PIPE AND DUCT SYSTEMS

- A. General: Concealed piping and duct work and insulated piping and ductwork shall be tested in place before concealing or covering. Piping and ductwork located underground shall be tested before backfilling. Equipment, materials, and instruments for testing shall be furnished by the contractor without additional cost to the owner. System components not rated for the respective test pressure shall be isolated from the system during the test.

- B. Observation: The Contractor shall notify the owner's representative 7 days prior to a scheduled test. The owner's representative, at his option, has the right to witness the test.
- C. Sanitary, Waste, and Vent System
1. The hydrostatic test shall be performed before installing fixtures. Water tests shall be applied to each system(s) either in its entirety or in sections. If the test is applied to the entire system, all openings in the piping shall be closed except the highest opening, and the system shall be filled with water and tested with at least a 10ft. head of water. In testing successive sections, at least the upper 10 ft. of the next preceding section shall be tested so that each joint or pipe in the building except the uppermost 10 ft. of the system has been submitted to a test of at least a 10 ft. head of water. The water shall be kept in the system or in the portion under test for at least 2 hours before the inspection starts. The system shall be tight at all joints.
 2. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.
 3. The final test of the completed drainage and vent system shall be visual and in sufficient detail to insure that the provisions of this section have been complied with, provided, however, that the plumbing undergo a smoke test. The smoke test shall be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof (at furthest vent), they shall be closed and a pressure equivalent to a one inch water column shall be built and maintained for fifteen minutes before inspection starts.
- D. Domestic Water Systems
1. The hydrostatic test shall be made upon completion of the roughing-in and before setting fixtures. The entire domestic cold water and hot water, and hot water circulation piping system shall be tested at a hydrostatic pressure of 1.5 times the working pressure of the system (but not less than 140 psig) and proved tight at this pressure for a period of not less than 2 hours in order to permit inspection of all joints. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.
 2. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.
- E. Fire Protection Systems
1. Automatic Sprinkler and Standpipe Piping. The automatic sprinkler and standpipe system(s) shall be hydrostatically tested in their entirety or in zones defined by shut-off valves. The piping shall be tested at a pressure of 200 psig or at component rated pressure measured at the low point in the system or zone, and shall be proved tight at this pressure for a period of not less than 4 hours. Leaks detected shall be repaired by tightening, rewelding joints, or replacing pipe fittings. Caulking of joints will not be permitted.
 2. Fire Service Piping. Underground fire service piping shall be hydrostatically tested in its entirety or in zones defined by shut-off valves. The piping shall be tested at a pressure of 200 psig or at component rated pressure for 4 hours. The amount of leakage shall not exceed 1 oz. liquid measure per hour per inch of pipe diameter per joint. The leakage amount shall be measure by pumping from a calibrated container.
 3. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.
- F. Heating and Air Conditioning Piping System
1. Not used.
 2. Field erected refrigerant piping shall be tested with a halide leak detector.

3. No loss in pressure will be permitted. Leaks detected shall be repaired by tightening, re-welding joints, or replacing pipe and fittings. Caulking of joints will not be permitted.
4. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.

G. Air Distribution Systems

1. Ductwork classified and constructed as pressure class 3" W.G. and above shall be tested for leakage. Leakage test shall be as outlined in AABC for Total System Balance. Test pressure and allowable leakage rate shall be as indicated in the table below. Pressure class and test pressure shall be positive (+) on fan system discharge side and negative (-) on fan system suction side.

TABLE 1 - DUCT LEAKAGE

<u>Pressure Class</u>	<u>Test Pressure</u>	<u>Maximum Leakage</u>
(3)"	3"	1.0%
(4)"	4"	1.0%
(6)"	6"	1.0%
(10)"	10"	1.0%

2. Ductwork in pressure classes less than +3" W.G. shall be tested for leakage. Leakage test shall be as outlined in AABC for Total System Balance. Test pressure and allowable leakage rate shall be not greater than 2.0%. Pressure class and test pressure shall be positive (+) on fan system discharge side and negative (-) on fan system suction side.
3. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.

H. Sanitary Sewer Systems Outside the Building

1. The sanitary sewer system shall be tested for leakage by either infiltration tests or exfiltration tests, as appropriate. Prior to testing for leakage, the trench shall be backfilled up to at least the lower half of the pipe. Backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 0.15 gallons per inch diameter per 100 feet of pipe line per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.
2. When the water table is 2 ft. or more above the top of the pipe at the upper end of the pipe line section to be tested, an exfiltration test shall be made by filling the line to be tested with water so that the head of at least 2 ft. is provided above the water table and the top of the pipe at the upper end of the pipe line to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re-established. The amount of water required to maintain this water level during a two-hour test period shall be measured and shall not exceed exfiltration rate specified hereinbefore.
3. Provide notice of test to engineer/architect for witness of test. Provide engineer/architect results of test in writing on contractor letterhead.

I. Natural Gas Systems

1. All piping shall be tested pneumatically and proved tight at a pressure of 100 psi for a period of not less than 4 hours. No loss in pressure will be permitted. Leaks detected shall be repaired by tightening, rewelding joints, or replacing pipe and fittings. Caulking of joints will not be permitted.
2. Gas piping, installed within conduit under concrete slabs, and the conduit shall be tested prior to pouring of the concrete slab.
3. All gas pressure test are to be witnessed by owner's representative, no exception.

J. Compressed Air

1. Not used.

K. Roof Drainage System

1. The hydrostatic test shall be applied to the drainage system, either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed except the highest openings, and the system filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10 ft. head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been submitted to a test of Less than a 10-ft. head of water. The water shall be kept in the system or in the portion under test for at least 15 minutes before inspection starts. The system shall then be tight at all points.

3.09 FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Where any pipe or risers pass exposed through walls, partitions, floors or ceiling, use chrome-plated floor and ceiling plates.
- B. Plates shall be large enough to completely close the hole around the pipes and shall be round with the least dimension not less than 1-1/2" larger than the diameter of the pipe. Plates shall be secured in an approved manner.

3.10 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or Split-casting, cast-brass type with polished chrome-plated finish.

- f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- g. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
- h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
- i. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- 2. Existing Piping
 - a. Not used.

3.11 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.12 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
- B. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
- C. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
- D. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
- E. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- F. Install anchor bolts to elevations required for proper attachment to supported equipment.
- G. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
- H. Use 5000-psi, 28-day compressive-strength concrete and reinforcement
- I. Provide #5 rebar 12" on center each way.
- J. Refer to detail sheets for typical concrete equipment pad detail.
- K. Contractor to install 4" wide reflective acrylic self-adhesive vinyl black/yellow striped caution/warning tape on vertical rise of all concrete housekeeping pads, tape to be in compliance with manufacturing model #146, tape to meet ASTM D-4956-99, submit submittal of tape to engineer for review.

3.13 GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout.
- B. Provide forms as required for placement of grout.
- C. Avoid air entrapment during placement of grout.
- D. Place grout, completely filling equipment bases.
- E. Place grout on concrete bases and provide smooth bearing surface for equipment.
- F. Place grout around anchors.
- G. Cure placed grout.

3.14 ADDITIONAL CLOSE-OUT DOCUMENT REQUIREMENTS

- A. LEAD CONTENT CERTIFICATE: As part of the close-out documents, the contractor is to include a certificate stating that the lead content in the domestic water system complies with governing code and Health Department criteria. A test shall be made at each faucet, spigot, drinking fountain, and any other fixture drinking water may be obtained.
- B. Contractor to provide a set of plans shows valve schedule & valve location on plans (full size set, 24"x36 plans). Plans to have valve type, manufacturer and model #. Also provide replacement part contact information for each valve.
- C. Contractor shall provide a minimum of three (3) sets of record documents of fire protection system. Contractor shall instruct designated owner personnel on system.

3.15 TROUBLESHOOTING

- A. By Contractor: If, during the start-up or warranty period, mechanical systems operational problems occur for which the root cause is not readily apparent, Contractor shall promptly, through a Subcontractor or other resource designated by Subcontractor, provide diagnostic and investigative services to determine the cause or causes.
- B. By Engineer:
 - 1. At Contractor's request, Engineer will provide the services necessary to determine the cause or causes of the operational problems.
 - 2. Under the provisions of the General Conditions, Engineer will also provide these services if Contractor fails to respond satisfactorily to operational problems within a reasonable time after written notice from Engineer.
 - 3. If while working at Contractor's request or under the provisions of the General Conditions, Engineer determines that the problems are due to failure of the Work to comply with the requirements of the Contract Documents, Owner will compensate Engineer for additional services and deduct the amount paid from payment or payments to Contractor.

3.16 DIVISION OF WORK

- A. In accordance with the general conditions, contractor is responsible for dividing the work among the subcontractors and suppliers and for delineating the work to be performed by specific trades. Any mention of mechanical and/or plumbing contractor, control and/or electrical contractor are suggestions as to how the work may be divided. This is not a complete list of all the work. It is the contractor's responsibility that a complete and entire system is to be installed.

3.17 FIRE RATED WOOD

- A. All wood as specified within these construction documents (mechanical, plumbing, sprinkler plans and specifications) shall be of the fire rated type. PYRO-GUARD treated wood as manufactured by HOOVER treated wood products.

3.18 ADDITIONAL TRAINING

- A. In addition to all training specified herein, the contractor shall provide the additional training services to the owner:
 - 1. An "Owner Training Coordination Meeting" shall be the first training session and it shall be conducted by the Installing Contractor. This training session shall be conducted upon completion of construction and just prior to Owner Occupancy. This session shall be approximately be one hour long and consist of a tour of the facility to show the location, type, and brands of equipment, include a basic high level description of the system. This session shall conclude with Maintenance Foreman providing a list of equipment where they want additional training. This session has two functions as follows:
 - a. First, it allows maintenance foreman to become familiar with equipment location. This coupled with their general knowledge of Systems allows them to respond to and investigate potential warranty issues before turning over the issue to the contractor.
 - b. Secondly and at the conclusion of this session, the Maintenance Foreman, after having seen the equipment installed has the opportunity to determine if they want the

specified Owner training for each piece of equipment. The Maintenance Foremen shall make the decision based on staff knowledge. For example, the HVAC Crew may not want to sit through training because their entire staff sat through 5 prior trainings in the last 2 years for a particular piece of equipment. However, they may choose to have training if they have hired new technicians since last training.

2. The traditional "Owner Training" shall be conducted during the second training session. This session shall be conducted as the Final Punch List Item. It shall be not be scheduled until all equipment is completely operational, Testing and Air Balancing Work has been completed, and the HVAC Building Automation System has been completed and commissioned. This training Session shall include the following:
 - a. Basis of Design – To be conducted, via telephone, by Designing Engineer for Mechanical Systems including items like hydronic pumping configurations, unique system components, fresh air theory, etc.
 - b. Equipment Training – To be conducted by Vendor/Manufacturer's Rep for each piece of equipment requested during the Owner Training Coordination Meeting.
 - c. HVAC Building Automation Training – To be conducted primarily by the Installing Contractor and then EMS System Integrator.
 - d. Allow at least 2 hours for each system. Total training to be at least 40 ours due to the owner.
3. The vendors will then supply brief refresher training at approximately 6 months from the date of substantial completion. Allow at least 4 hours for each system.
4. The vendor will then supply in depth training at 10 months from the date of substantial completion. This training will include all maintenance and operation requirements of each piece of equipment and system and in depth training on control systems. Allow at least 8 hours for each system.
5. All training to be videotaped and supplied to owner & architect/engineer on DVD format.

3.19 FILTERS

- A. Construction Filters - Provide MERV 13 high efficiency filters, with rolled filter media clipped over return air grilles for course filtration. All filters to be replaced during construction as needed. Replace all filters after construction with an additional set to the owner.
 - a. The contractor is responsible for maintaining keeping the equipment, filters and ductwork clean during construction and that the mechanical system shall see minimal run time prior to owner's acceptance (for startup & testing/balancing purposes only). During construction, the contractor shall provide and maintain for the HVAC a minimum of a MERV 13 high efficiency filters with rolled filter media clipped over return air grilles for course filtration. All filters shall be replaced as needed during construction and with permanent filters upon completion of project. Condenser coils shall also be maintained as needed. If allowed to get dirty, the contractor shall clean all air handling units, condenser coils, ductwork, piping and all associated items at no cost to the Owner.
- B. Contractor to provide a complete list of permanent filters with the filter sizes, type, equipment being filtered and location of filter. Submit list to owner prior to substantial completion.

3.20 TRENCHING AND BACKFILLING OUTSIDE BUILDING SLAB

- A. Clearing and Grubbing - The Contractor shall clear and grub the surface areas and remove surface materials of whatever nature encountered, over the line of and to either side of the trenches where the piping systems are to be installed. Existing sidewalks, driveways or other cement or asphalt surfaces which are to remain and have been

damaged during excavating shall be repaired to match the adjacent work in material and finish.

B. Trenches:

1. Prior to any excavating or trenching, the Contractor shall contact the regional underground utilities notification program (Louisiana One Call) for assistance in securing the location of any underground utilities that may be affected by this work.
2. Trenches shall be dug so that pipe can be laid to the alignment, depth and slope indicated. Excavation shall be only so far in advance of the pipe laying as to reveal any obstructions, but never more than 100' in advance of the pipe installation unless specifically approved by the Architect/Engineer. Trenches shall be graded such that each section of pipe will rest upon the trench bottom for the full length of its barrel. Provide bell holes at each joint as required for this purpose.

C. Dewatering:

1. Remove any water which may be found or may accumulate in the trenches and excavations and shall perform the work necessary to keep them clear of water while the work is in progress, or as may be required for inspections. Use due vigilance and care so that no water originating on his work, or due to his work, which he is obligated to handle and dispose of under his contract, shall discharge or be discharged upon the work or into the trenches of another contract, unless by mutual agreement of parties affected. Should any dispute arise from this cause, the matter shall be referred to the Architect/Engineer for final settlement.

D. Bedding and Backfill:

1. Bedding and backfill material shall be river sand. Backfilling shall not begin until the pipe work to be covered has been inspected by the Architect/Engineer. The Architect/Engineer reserves the right to order any trench backfilled at any time after installation of pipe, if, in his opinion, the particular trench remaining open constitutes a public nuisance. Settlement of backfill in trenches excavated for work of this Division shall be the responsibility of this Division. Trenches shall be refilled as often as necessary to bring them back to required or original grades.
2. Bedding under pipe - Trenches shall be bedded by hand. A 6" layer of river sand shall be placed in the trench and compacted and graded prior to installing the pipe. After the pipe is installed, river sand shall be carefully placed in 3" layers on both sides of the pipe and compacted and graded by hand. The sand shall be deposited in the trench for its full width on each side of the pipe, fittings and appurtenances, simultaneously.
 - a. Backfilling to 1' above pipe - From the centerline of the pipe, fittings and appurtenances to a depth of 1' above the top of the barrel of the pipe, the trench shall be backfilled by hand or approved mechanical means with river sand. Use special care in placing this portion of the backfill so as to avoid injuring or moving the pipe or disturbing the pipe hangers. This part of the backfill shall be compacted by method approved by the Architect/Engineer.
 - b. Backfilling to grade - From 1' above the barrel of the pipe up to grade, the trench shall be filled with river sand. Backfill shall be compacted by methods specified in DIVISION 2 - SITEWORK or to 95% maximum density per ASTM D1557 (modified proctor). Where sheeting and bracing are removed from the trench or excavation as backfilling progresses, care shall be taken to insure that voids left by the withdrawn timbers are carefully and thoroughly compacted and that pipe hangers are left vertical and plumb.

3.21 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Excess fill taken from excavations shall, unless otherwise provided in the Contract Documents, be removed as soon as possible as work of this Division.

3.22 SUB-SURFACE OBSTRUCTIONS

- A. Care must be taken not to disturb, injure or remove any pipes, cables, conduits or other underground structures or utilities that are to remain. As work of this Division, shore-up and protect underground piping, conduit structures or utilities which may be endangered during the work and maintain such structures and utilities during construction. Sub-surface obstructions shall be uncovered in advance of construction so that the method of avoiding same may be determined before pipe laying reaches the obstruction.
- B. In the event subsurface structures, pipes, cables, conduits or utilities are broken or damaged in the execution of the work, the User Agency and proper authorities shall be notified and proper repairs shall be made, as work of this Division, to the satisfaction of the Architect/Engineer and authorities involved. Damage to persons or property caused by such breaks shall also be the responsibility of this Division. The change or rearrangement of any underground structures which may interfere with the construction of the work of this Division.

3.23 SHEETING AND SHORING

- A. Sheet piling and shoring shall be placed in excavations and trenches as required to suit the ground conditions and to properly and safely support the excavations and trench walls and any adjacent structures. Placement of the sheet piling and shoring in the trench shall not restrict the excavation and trench width specified in other Sections. Sheet piling and shoring for excavations and trenches less than five feet in depth may be of treated wood. Wood indicated to remain in excavations and trenches shall be treated type. Sheet piling and shoring for excavations and trenches greater than five feet in depth shall be of steel construction.
- B. The Contractor shall employ a Civil Engineer registered in the state of this project to design the steel sheet piling system required for excavations of five feet or greater. The Contractor shall submit one copy of the Engineer's sealed calculations and drawings to the Architect/Engineer for record and file purposes only. The Contractor shall be responsible for the design and construction of the sheet piling system.
- C. Unless otherwise instructed by the Architect/Engineer wood sheet piling, shoring and bracing shall be cut-off at an elevation of 24" below finished grade. The lower portion of the sheet piling and bracing below grade shall remain in the ground. If instructed by the Architect/Engineer to remove the wood or steel sheet piling and shoring it shall not be removed until backfilling is completed.

3.24 RESTRAINED JOINTS

- A. Restrained joints shall be provided for underground water mains 4" and larger and sewer force mains at each change of direction 11 ¼ degrees or greater and at tees. Restrained joints shall be installed per NFPA 24.

3.25 FRICTION LOSSES, ELECTRICAL RATINGS AND SPACE REQUIREMENTS

- A. The values of air and water friction losses, electrical current ratings and space requirements for various pieces of equipment, as contained in these specifications or as scheduled, are estimated values and sizes and have been used in obtaining specifications for equipment and for sizing ducts, pipe, electrical wiring and motor controls. Any necessary changes in any of these items resulting from values other than the estimated ones shown shall be the responsibility of the Contractor and shall be subject to the approval of the Architect/Engineer. The Contractor shall pay any costs for additional labor and material required including costs of any other Contractor involved. Should substitute equipment require different requirements from that shown on the drawings, the Contractor shall be responsible for the cost of the changes. Any such changes must be approved by the Architect/Engineer.

3.26 CHANGES TO PIPING OR DUCTS

- A. Should the Contractor desire to make changes in the routing or arrangement of piping or ducts, whether for his own convenience, to avoid conflict with the work of other trades, or to conform to local codes, such changes shall not be made without the prior approval of the Architect/Engineer.

END OF SECTION

12-10-25

SECTION 20 01 11 – ENVIRONMENTAL CONTROL SERVICES

PART 1 GENERAL

1.1 SUMMARY

- A. The purpose of the specification is to define the approved methods and equipment or the use of temporary dehumidification/air conditioning system during construction.
- B. The dehumidification system shall be part of the General Contract. Any extra hardware, components or accessories, i.e., duct work, temperature control, transformers, inlet/outlet transitions, etc. Shall be considered incidental with no separate payment for any of the above items.

1.2 SUBMITTALS

- A. Dehumidification supplier shall provide drawings showing equipment placement and sizes, air distribution and power cable routing.

PART 2 GENERAL

2.1 ENVIRONMENTAL CONTROLS

- A. Dehumidification / Air conditioning equipment shall be used to control the environment in the space 24 hours a day while interior finishes are being stored or installed.

2.2 TEMPERATURE CONTROLS

- A. Auxiliary heat, cooling and/ or insulation may be necessary to maintain the temperature at a level acceptable to the contractor performing the reconstruction inside the work space. This auxiliary equipment must be approved for use by the dehumidification/ Air conditioning equipment supplier and shall meet the following requirements.
 - 1. Heaters and refrigerant-type systems will be installed in the process air supply between the dehumidifier and the space as close to the space as possible.
 - 2. Only, electric, indirect gas fired and steam coil auxiliary heaters will be used. No direct fired space heaters will be allowed during the construction.
 - 3. Heaters will be equipped with controls that automatically turn the heater off if the airflow is interrupted or the internal temperature of the heater exceeds its designed temperature or that of the supply duct.
 - 4. Seal the area where dehumidification is introduced to allow the air to escape away from the entry point while maintaining a slight positive pressure unless dust from the operation is hazardous. The design of the filter system, if necessary, will be designed so that it does not interfere with the dehumidification equipment's ability to control the relative humidity and temperature parameters in that space. Do not re-circulate the air from the space or from filtration equipment back through the dehumidifier during reconstructions unless authorized by the dehumidification supplier.

2.3 SPECIFIED EQUIPMENT SIZE AND TYPE

- A. Style and size of equipment will be determined by the contractor. The style and size may vary depending on volume of air space needing to be controlled, time of year, containment of area, and any other requirement that may diminish the ability to control the environment.
 - 1. Basis of bid to be 250 square foot per ton of HVAC.

2.4 POWER

- A. The required electrical power will not be supplied by the owner. The necessary voltage and amperes needed for operation will be coordinated with the general contractor. The contractor is responsible for providing temporary power necessary to energize the dehumidification/ Air conditioner system.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The contractor shall install dehumidification/ Air conditioning equipment in accordance with manufacturer's written instructions and approved submittals.
- B. Dehumidification/ Air conditioning supplier will use flexible duct and temporary ducting to distribute the dry air through the controlled space. Distribution of dry air will be decided by the dehumidification supplier and the general contractor.
- C. Temporary power cord will be used to energize the dehumidifiers / Air conditioners.

END OF SECTION

12-10-25

SECTION 20 0115 – SPECIAL MECHANICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them. C. Work to Include:
 - 1. Welding Exhaust System
 - 2. Woodworking Dust Collection Exhaust System.

1.02 SUMMARY

- A. Perform all work under this heading, including the furnishing of labor, materials, equipment, and service necessary for and reasonably incidental to the proper completion of all mechanical work as shown on the drawings and herein specified.
- B. Visit and examine the job and confer with all authorities concerned in order to become familiar with all existing conditions pertinent to the work to be performed. No additional compensation will be allowed for failure to be so informed.
- C. Materials and equipment shall be new, except where otherwise indicated, of the best quality, with same brand or manufacturer for all similar material. D. Perform all work in a neat and workmanship manner.
- E. Regardless of titles and subdivisions herein employed, consider these specifications as an complete document with General Sections applying to all other sections. All bidders are cautioned to read entire specifications and to thoroughly familiarize themselves with all requirements thereto.

Division of Work: In accordance with the general conditions, contractor is responsible for dividing the work among the subcontractors and suppliers and for delineating the work to be performed by specific trades. Any mention of mechanical, sprinkler and/or plumbing contractor, control and/or electrical contractor are suggestions as to how the work may be divided. This is not a complete list of all the work. It is the contractor's responsibility that a complete and entire system is to be installed.

- F. The term Contractor refers collectively to the general contractor and his subcontractors, and does not distinguish between the parties. The General or Prime contractor is solely responsible to the Owner for coordinating all work between different trades. Any required work not included in subcontractor's contract will be performed at the General or Prime Contractor's expense.

1.03 QUALITY ASSURANCE

- A. Special systems shall be coordinated with other systems and trades to include but not be limited to: Electrical systems, structural and mechanical systems.
- B. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of Contractor's Work to the building structure and to the Work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the Work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer

of any discrepancy before performing any Work. Adjustments to the Work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.04 DELIVERY, STORAGE AND HANDLING

- A. All equipment, ductwork, and materials shall be delivered to the Project Site clean and sealed for protection.
- B. Take particular care not to damage the existing construction in performing Work. All finished floors, step treads and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the Project.
- C. Equipment and materials shall be protected from rust and dust/debris both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.
- D. All material affected by weather shall be covered and protected to keep the material free from damage while material is being transported to the Site and while stored at the Project Site.
- E. During the execution of the Work, open ends of all piping and conduit, and all openings in equipment shall be closed when Work is not in progress, and shall be capped and sealed prior to completion of final connections, so as to prevent the entrance of foreign matter.
- F. All equipment shall be protected during the execution of the Work. All ductwork and equipment shall be sealed with heavy plastic and tape to prevent build-up of dust and debris.
- G. All ductwork and air handling equipment shall be wiped down with a damp cloth immediately before installation to ensure complete removal of accumulated dusts and foreign matter.
- H. All plumbing fixtures shall be protected and covered to prohibit usage. All drains shall be covered until placed in service to prevent the entrance of foreign matter.

1.05 SUBMITTALS

- A. Shop Drawings and Submittal Data Required
 - 1. Submit to the Architect for review, immediately after award of contract, six (6) copies of complete descriptive information and dimensional data on all items of equipment, materials and accessories. Submit all shop drawings at one time. Piece meal submission shall not be acceptable.
 - 2. Coordination with electrical: Contractor to submit copy of any & all shop drawings that indicate electrical requirements to the project electrical engineer for electrical service & electrical load verification. Applicable to all mechanical items.

1.06 GUARANTEE AND SERVICE

- A. Guarantee all equipment, materials and workmanship for a period of one (1) year following date of acceptance.

1.07 Warranty period begins at date of substantial completion, not when contractor starts equipment. Figure in bid extending warranty to accomplish this.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Certain items in this Specification are listed by manufacturer and/or manufacturer's model number to establish general style, type, character and quality of the product desired. Similar items manufactured by other than those listed will be considered, providing submittals are made according to Pre-Bid Approval requirements of Instructions to Bidders.
- C. Where no manufacturer or model number is given, any product meeting performance or design criteria, or referenced trade association standard may be used and Pre-Bid Approval is not required.

2.02 WOODWORKING SHOP DUST COLLECTION SYSTEM

A. Dust Collector

- 1. Provided by owner, contractor installed.

B. Dust Collector After Filter

- 1. Provided by owner, contractor installed.

C. Duct System

- 1. The dust collection duct system shall be designed in accordance with good dust collection practices, in order for the dust collector to operate at its maximum possible efficiency. The Industrial Ventilation Manual of the American Conference of Governmental Industrial Hygienists, or other recognized reference material, is recommended as a guide to proper duct system design.
- 2. The system conveying velocities shall be designed for a nominal conveying velocity of 4000 feet per minute.
- 3. Exhaust system ductwork shall be constructed with materials suitable for the conditions of service and installed in a permanent and workmanlike manner.
- 4. All duct system pipe and elbows shall be galvanized steel. All fittings, such as collection hoods, and floor sweeps, shall be painted with a rust resistant finish. All exhaust system ducting shall be round. The interior of all ducts shall be smooth and free from obstructions, especially at joints.
- 5. All sheet metal pipes shall be constructed of the following minimum gauges: 3" - 6" diameter-24 GA; 7" -12" diameter-22 GA; 14" -24" diameter-20 GA.
- 6. Elbows shall have a centerline radius of 2.5 times the pipe diameter in sizes 3" to 12", and 2.0 times the pipe diameter in sizes 13" and larger. Elbows of either one piece or multiple gore construction are acceptable.
- 7. All branches shall enter the main at the large end of the transition at an angle not to exceed 45 degrees. Branch connections should be to the side or top of the main with no two branches entering directly opposite each other. "T" type branches are unacceptable.
- 8. All ductwork shall be rigidly supported, such that there shall be no unsupported span of ductwork greater than 10 feet. Additionally, it is recommended that branch drops to machine connections be rigidly supported.

9. Cleanouts are to be installed in horizontal runs of duct carrying dust-laden air every 12'0" on centers.
10. Adequate clearances shall be provided between ductwork and ceilings, walls, lights, and utilities, so as not to hinder installation, maintenance, or lighting quality.
11. All machine connections shall incorporate cut off blast gates.
12. All drops to terminate 5'0" above finished floor and be equipped with shut off blast gates.
13. Floor sweeps are to be manufactured from 20-gauge galvanized steel for strength and rigidity. A continuous piano hinge connect flip type door to the fitting.

2.03 SPARK DETECTION AND EXTINGUISHING SYSTEM

A. Provide spark detection & extinguishment system to National Fire Protection Association standards (NFPA), 69, 664, and 72 guidelines. The system shall be a single zone control system, as manufactured by Hansentek, Flamex or approved equal. All components shall be Factory Mutual (FM) approved. B. The System shall comprise of the following components:

1. The AN104 programmable microprocessor panel shall include programmable shutdown, built –in automatic and manual detector sensitivity checking. The system shall provide supervision on all input and output circuits. Fan shutdown relay shall be included, as well as alarm and trouble relays. The system shall have a battery backup power supply and Model #910 24 VDC alarm horn. System shall be interconnected with building fire alarm system.
 2. Two model #120-1 addressable infrared direct optic spark detectors with built-in test light for calibrated through the lens sensitivity checking & quick release brackets.
 3. Model #901-1 spray assembly with spring-loaded, chrome plated nozzle, 24VDC solenoid, water strainer, mounting flange and gasket.
- C. The spark detection and extinguishing system shall be installed indoors and located on and penetrating into a straight horizontal section of the main duct, in the area between the first branch and the dust collector. Based on an air & dust velocity of 4000 fpm in the main duct, the sensor (spark detector) to solenoid valve (spray nozzle) distance (SVD) must be a minimum of 20'. Allow for additional straight duct 1-1/2 duct diameter before and after the detectors & spray nozzle. Flow rate shall be a minimum of 19 GPM at 50 PSI. If this is not available, then a booster pump is required. Coordinate installation with sheet metal, plumbing and electrical contractor.
- D. System must be installed in accordance with the manufacturer's installation requirements, in the installation manual and tested before placing the system in operation.

2.04 SPARK DETECTION WATER BOOSTER PUMP SYSTEM

- A. A pressure booster pump system shall be supplied to provide sufficient pressure and flow requirements for the spark detection system. The system shall be the BPS-9X4 as manufactured by Hansentek, Flamex or approved equal. The pump shall turn on when the system water pressure drops to 70 PSI and turn off when the water tank pressure reaches 90 PSI thereby maintaining adequate water pressure for the extinguishment nozzles.
- B. The following equipment will be furnished complete and mounted on a stand:
1. Multi stage stainless steel pump with 1 phase 115VAC, 1 HP motor, Motor Control Contactor with thermal overload protection

2. 35 gallon controlled action diaphragm water reservoir tank
3. Pressure switch with pressure and dead band adjustments
4. Pressure gauge with PSI scales
5. 1" inlet with check valve and 1" discharge

2.05 WELDING EXHAUST SYSTEM

- A. Extraction Arms: Provide Monoxivent #15320 6" source capture flex extraction arms. Arms shall be internally supported and consist of four adjustable pivot joints on each arm. The flex arm shall be a vertical movement type with the ability to swivel from 180 to 360 degrees, depending upon the way the arms are positioned. Each arm consists of an all internal support structure, weld-proof hose, mounting brackets, and a collection hood. The Source Capture Arms shall be complete and shipped ready for assembly and mounting. Final arm adjustment is to be completed after installation.
- B. Construction: The internal support structure of the arm shall be constructed of tubular aluminum. The mounting brackets are of heavy gauge epoxy painted steel with special lubricated nylon rings and bearings. Each pivot point shall utilize friction disk pads to allow the arm to be set at the best tension, allow the unit to be user-friendly, and for the arm movement to be kept simple. The extraction arms shall be retractable telescopic type to allow for 4'-0" to 7'-0" telescopic movement and shall allow for movement from the left to right and towards the front. The extraction hose shall be Monoxivent #6000 fiberglass coated with flame retardant vinyl. The vinyl/fiberglass fabric shall include a supporting wire helix of vinyl coated spring steel permanently bonded for a continuous, uninterrupted inner and outer surface. The hose shall be rated for 275 to 300 degrees.
- C. Main trunk exhaust duct: Rigid stainless steel, Refer Section 23 3100.

2.06 CONE WELDING NOZZLE/HOOD

- A. Cone Welding Nozzle: The extraction hood shall be **Monoxivent #9102001**, and shall be constructed of high quality, impact resistant, high temperature polycarbonate/PVC material. The hood shall include a handle and damper. The hood opening shall be 12" oval design and offers both horizontal and vertical movement.
- B. HARDWARE: The arm shall include all necessary hardware. The supplied hardware shall include nylon locking nuts to assist in holding tension and allow for slight adjustments to the pivot point joints for easy and quick joint changes and settings. Contractor shall include all required to mount the arm and mounting bracket to a wall or column.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

END OF SECTION

12-10-25

SECTION 20 02 00 - MISCELLANEOUS MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

- A. The term Contractor refers collectively to the general contractor and his subcontractors, and does not distinguish between the parties. The General or Prime contractor is solely responsible to the Owner for coordinating all work between different trades. Any required work not included in subcontractor's contract will be performed at the General or Prime Contractor's expense.
- B. Contractor shall furnish and install complete operating systems including all equipment, materials and accessories indicated on the drawings, in the specification, or as required for a complete working system.
- C. All equipment shall be stored, handled, installed, tested, calibrated and placed in operation in strict accordance with the manufacturer's recommendations.
- D. Equipment manufacturer's representative shall be on site at the time of start up for all equipment. Equipment shall not be placed in operation until manufacturer's representative confirms that all system parameters are approved for start-up.
- E. Any additional work caused by prior approved equipment substitutions shall be at the Contractor's expense.
- F. All work shall be performed in accordance with the International Building Code. Miscellaneous construction materials required to meet code requirements shall be furnished and installed by the Contractor at the Contractor's expense regardless of whether or not such items are specifically detailed on the Contract drawings. The Contract Drawings are schematic in nature and are not intended to show every detail or component required for a complete working system and complete Code conformance.
- G. Contractor shall provide any field wiring and auxiliary equipment or component required by equipment manufacturer's installation instructions and detailed wiring and control diagrams for proper interlocking and safe operation of the equipment. Contractor shall provide cooling water piping, control power supply, and any other utilities or auxiliary components required for proper operation.
- H. All equipment drain connections, etc. shall be piped full size to nearest floor or hub drain. Minimum drain line size shall be 1-1/4".
- I. Provide adequate clearances around all equipment in accordance with manufacturer's recommendations for proper service, maintenance, and operation of the equipment.
- J. Provide OSHA approved belt and coupling guards on all rotating equipment.
- K. Any modification of construction details shown on the contract drawings which are necessary to suit actual equipment certified dimensional data or field conditions shall be approved by the Architect. The Contractor will not receive any additional compensation for minor changes in construction details required to accommodate job site conditions, equipment dimensions, etc. A complete job and good workmanship are required.
- L. All openings through walls, floors and roof provided for equipment, piping or conduit shall be properly framed, caulked, and flashed to insure water tightness and weather protection. Provide fire stop sealant system in accordance with code requirements.
- M. All steel materials used for construction shall be stainless steel, painted steel, or galvanized steel. Bare steel will not be acceptable under any circumstances.
- N. Contractor shall provide fire dampers, smoke dampers, smoke detectors and firestats as shown on the drawings and as required by Code.
- O. Vibration mountings shall be installed under mechanical equipment to protect the finished installation from objectionable noise and vibration. Flexible connections shall be installed in piping and duct work systems where necessary to prevent transmission of vibrations and noise.
- P. Where there is a conflict between information shown on contract drawings, specifications Code requirements or industry standards, etc., the strictest and most conservative interpretation shall

govern. In the event of a discrepancy between new and existing materials, Contractor shall assume the material to be new. If any item is indicated to be new any place on the drawings or in the specifications, the item in question shall be include in the Contractor's bid as new equipment or material.

- Q. Contractor shall not furnish, install, or utilize any equipment, products, or product components that contain any amount of asbestos material in any form.
- R. The Architect will have the authority to order minor changes in the work not involving an adjustment in the Contract Sum or the Contract Time and not inconsistent with the intent of the Contract Documents in accordance with AIA Document A201-1976.
- S. All shop drawings and product data submittals shall include a written, signed statement of total compliance with the Contract Documents. All product data shall be manufacturer's published data. Approval of shop drawings does not relieve the Contractor of responsibility to comply with the Contract Documents. NO SUBSTITUTIONS OR VARIATIONS WILL BE ACCEPTED EXCEPT AS CLARIFIED BEFORE THE BID DATE BY ADDENDUM.
- T. Coordination with electrical: Contractor to submit copy of any & all shop drawings that indicate electrical requirements to the project electrical engineer for electrical service & electrical load verification. Applicable to all mechanical items.
- U. All materials for new work shall be new and not used.
- V. All multi-blade dampers used in HVAC systems shall be U.L. listed and certified to meet U.L. Standard 555S, Class 1 leakage.
- W. Fire Rated Wood: All wood as specified & mentioned within these construction documents (mechanical, plumbing, sprinkler plans and specifications) shall be of the fire rated type. PYRO-GUARD treated wood as manufactured by HOOVER treated wood products.
- X. All exhaust and fresh air penetrations through sidewalls shall be a minimum 10'-0" above adjoining grade.
- Y. ADDITIONAL CLOSE DOCUMENTS: Contractor to provide a set of plans shows valve schedule & valve location on plans (full size set, 24"x36 plans). Plans to have valve type, manufacturer and model #. Also provide replacement part contact information for each valve.
- Z. The contractor shall submit to the mechanical engineer, as soon as feasible after award of the contract, equipment room layouts at a scale not less than 1/4" = 1'-0" showing the layout of the actual equipment to be used and all necessary clearances. This drawing is to comprehensive of all trades as to eliminate conflicts. The contractor will be responsible to verify all access for maintenance as required by the manufacturer.
- AA. All sprinkler heads shall be located in center of ceiling tiles where applicable. Any relocation of heads shall be at contractors expense in order to center heads in tile. Sprinkler head layout, if shown, is a guide only, contractor shall add sprinkler heads as required to meet all requirements of NFPA 13 and 2001.
- BB. Maintain a minimum 5'-0" horizontal separation between building drain or building sewer and underground water service piping per section 608.3 of International Plumbing Code (current edition). Should sewer and water pipe cross, the water pipe shall be installed above the sewer a minimum of 12".
- CC. Not used.
- DD. This Section shall apply to all work in Division 20, 21, 22 and 23.

1.02 DRILLING FLOOR SLABS AND WALLS

- A. Holes through the concrete floor slabs and masonry walls for chilled water and drain piping shall be made with rotary masonry core bits. Diamond tip cutters are recommended, but not required.
- B. The use of a jack hammer or any other impact tool for drilling or coring is prohibited.
- C. Layout the hole locations, pipe diameters including insulation and furring around pipes before drilling any holes for the pipes. Drill a small pilot hole and check the floor slab from the bottom to be sure that the pipes will miss all beams and joists.

- D. Water pipe insulation shall be continuous through the holes. Heating water and drain pipe insulation shall be interrupted at the holes to permit minimum size holes through the floor slabs.
- E. The annular space around floor penetrations shall be packed with rated fire proofing material.

1.03 CONCRETE FASTENERS

- A. Fastenings set into concrete to support pipe, air handlers and other mechanical equipment shall be steel or malleable iron expansion shields set in proper size drilled holes. Do not exceed the manufacturer's rated pull out load. The manufacturer's rated load must be based on a factor of safety of 5 or else the allowable load must be reduced to give a factor of safety of 5. Self drilling Rawl Saber Tooth or Phillip Red Heads may be used. Anchors using lead, plastic or shields of any material other than steel or malleable iron shall not be used.
- B. Powder actuated fasteners, Hilti or Ramset, may be used for loads applied with a factor of safety of 5 but not more than 300 pounds for the largest size. The powder charge shall be found by trial and shall be the smallest charge that gives full insertion into the concrete. These fasteners may be used for ductwork and small pipe.
- C. Suitably located existing inserts which were cast into the concrete at the time of construction may be reused.

1.04 PROTECTIVE COATING FOR UNDERGROUND PIPING

- A. Underground pipe and fittings including the portion through the floor shall be protected against corrosion by application of protective coatings.
- B. Prior to coating, pipe and fittings shall be cleaned of all rust, scale, dirt, and oil.
- C. Pipes and fittings shall be given a wash coat of epoxy primer having a dry film thickness of 1.5 - 2.0 mils. Over the primer apply two coats of coal-tar base epoxy coating, each having a dry film thickness of 6 mils.
- D. Coatings shall have a holiday test using a 1/2" spark. Recoat any areas not passing test.
- E. Provide for all underground metal piping up from grade.
- F. 2-Part coal-tar epoxy to be Carboline 300M or prior approved equal.

1.05 EMS (TEMPERATURE CONTROLS) CONDUIT AND BOXES

- A. UNDERGROUND EMS CONDUIT: Rigid Nonmetallic Conduit (RNMC): Schedule 40, rigid polyvinylchloride, rated for 90 degrees C conductors, with pull string, solvent cement connectors and couplings. Nonmetallic strap hangers allowing thermal expansion movement. Conduit to meet NEMA TC-2; fittings to meet NEMA TC-3. Expansion Coupling: Nonmetallic to compensate for thermal expansion.
- B. EMS CONDUIT WITHIN BUILDING: Shall be hot dipped galvanized rigid steel conduit. All conduits shall be new and shall bear the inspection label of the Underwriter's Laboratories, Inc. Metallic conduit shall be hot-dipped galvanized. Fittings for conduit shall be an approved type specially designed and manufactured for their purpose. Rigid metal conduit fittings, bushings, and other components shall be galvanized. Setscrew connector fittings shall not be permitted. All fittings for rigid steel or aluminum conduit shall be threaded and coupled unless specifically approved otherwise by the Engineer.
- C. Pull Boxes: Communication/EMS ground mounted pull boxes shall be polymer concrete, ANSI/SCTE 77 2002 – Tier 22 rated, provide dimensions indicated on the drawing. Open bottom. Cover to be labeled "Communications". Secure cover with stainless steel standard hex head bolts. Covers shall be traffic rated. ALL PULL BOXES TO BE SIZED IN ACCORDANCE TO NEC (NATIONAL ELECTRIC CODE).
- D. Stainless Steel EMS Enclosure: NEMA 3R enclosure (UL 508A Listed). Manufactured from Type 304 16 gauge stainless steel; 16 gauge doors and 14 gauge bodies, Minimum-width body flange provides maximum body opening, Pre-cut gland plate openings in the bottom of the enclosure with a seal to ensure protection, External formed 90 degree body flange, Door opens 210 degrees, Mounting holes in back of body for direct mounting or for optional external mounting brackets, Type 316 stainless steel hinge pins, Corner-formed doors are easily removed by pulling clip-style hinge pins, Quarter-turn latches furnished with 3mm double-bit

insert, Seamless foam-in-place gasket, Self-grounding latch system with double seal, Grounding stud on the body, Full-sized galvanized steel back panel included, Bonding provision on the door, Furnished hardware kit includes: gasketed gland plates and hardware, grounding hardware and sealing washers for wall-mounting holes, Three-point latching, Finish: Door and body have smooth #3 brushed finish. Hoffman medium GL66 series stainless steel wall mount enclosure.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Fasteners of the type set into concrete by drilling shall be self drilling Rawl Saber Tooth or Phillips Red Heads.
- B. Powder actuated fasteners shall be Hilti or Ramset.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Follow manufacturer's instructions and use setting tools procured from the manufacturer of the drilled-in anchors to expand the shields.
- B. Underground EMS conduit to be installed in strict accordance with National Electric Code with pull boxes at every fourth bend, no more that three (3) turns without installation of pull box. Provide pull boxes at every 200' and at all changes of direction.

END OF SECTION

12-10-25

SECTION 20 0213 - BASIC PIPING

PART 1 GENERAL

1.01 GENERAL

- A. Scope
 - 1. This section covers the minimum basic requirements of above ground piping systems. For details refer to APPLICABLE SECTIONS below.
- B. Codes
 - 1. The work performed shall comply with the applicable codes of ANSI, NFPA and the current edition International Plumbing Code.

PART 2 PRODUCTS

2.01 PIPING, FITTINGS AND VALVES

- A. Materials shall be in accordance with the Line Specifications appended to the APPLICABLE SECTIONS of these specifications.

2.02 HANGERS

- A. Refer to Section 20 05 29: HANGERS AND SUPPORT DEVICES.

PART 3 EXECUTION

3.01 GENERAL

- A. Connections, re-routing, and tie-ins to existing utilities shall be approved by and scheduled with the proper authorities to assure uninterrupted service throughout the facility. The Contractor shall be responsible for locating existing utility lines and will plan the relocation work so that service interruptions shall be of minimum duration.
- B. Pipe shall be accurately cut to insure square ends and to measurements established at the site and shall be worked into place without springing or forcing, properly clearing all openings and equipment.
- C. High points of the systems, other than refrigerant, shall be vented and low points provided with plugged drains, one-half inch (1/2") in size.
- D. Fittings shall be used for all changes of direction or branch take-offs in the piping system except where specifically shown otherwise on the drawings. Mitering pipe to form elbows, cutting into straight runs to form tees, or any similar construction, is not permitted.
- E. Dielectric joints shall be installed at all joining of dissimilar metals except valves.
- F. Bushings for changes in line size shall not be permitted unless specifically indicated on the drawings.
- G. Cutting or other weakening of structural members to facilitate piping installation will not be permitted unless approved by the Architect.
- H. Piping shall not be used to support equipment, connected or otherwise, unless the plans and specification require such installation. When necessary, adequate temporary supports shall be installed during erection so as not to over-stress piping, or equipment to which piping is connected. Except as indicated on drawing details or required by other limiting conditions, all piping and equipment within buildings shall be entirely out of the way of equipment, lighting fixtures, doors, windows and other openings. Overhead piping in buildings shall be run in the most inconspicuous positions and parallel to the walls of the structures unless otherwise indicated on the drawing.
- I. Adequate clearances shall be provided from walls, ceilings and floors to permit the assembly of joints. All control valves shall have ample clearance for disassembly without disturbing equipment or other piping.
- J. Pipe sleeves shall be provided where pipes pass through masonry or concrete walls, roofs and partitions. Sleeves in outside walls in floor and roof slabs, shall be zinc-coated steel pipe

unless otherwise specified. Sleeves in partitions shall be sheet steel of 26 gage minimum. Space between pipe, or insulation and sleeve shall not be less than 1/4 inch. Sleeves shall be held securely in proper position and location. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions or slabs.

- K. Take down joints shall be installed at all connections to equipment and fixtures; at all points where it is necessary to disconnect piping for repairs or maintenance; and on the control side of valves on branches and risers.
- L. Start-up strainers shall be installed up stream and adjacent to all items of equipment. They shall be in service and cleaned periodically for ten full days of operation and then permanently removed from the system.
- M. Painting and identification of piping, valves, hangers and supports shall be in accordance with SECTION 20 01 00 - GENERAL PROVISIONS. All exposed piping shall be painted and only black steel piping in concealed spaces shall be painted.

3.02 HANDLING AND STORAGE

- A. Pipe and fittings shall be handled in such a manner as to prevent damage such as bending of metal pipes or cracking and breaking of plastic pipes. Care shall also be taken to keep both inside and outside free from dirt.
- B. Plastic pipe shall be stored on racks with a minimum support spacing of three feet if delivered loose and if delivered in lifts, the lifts shall not be stacked more than three high
- C. Fittings shall be kept free from dirt and stored indoors.
- D. Solvents cements and primers for plastic pipe shall be handled and stored and the empty containers disposed of in a manner that provides the maximum safety to personnel and property.

3.03 INITIAL CLEANING

- A. Minimum requirements for internally cleaning of piping systems shall consist of removing "loose" foreign materials such as scale, sand, weld spatter particles, cuttings, chips, etc. from inside of assembly by any suitable means such as a mechanically driven rotary cleaning tool or wire brush, etc; blowing out all loosened particles with dry compressed air; and inspecting the inside of pipe assembly for cleanliness.

3.04 SOLDERED JOINTS

- A. The outside surface of the pipe where engaged in the fitting and the inside surface of the fitting in contact with the pipe shall be cleaned to a bright surface with an abrasive material before soldering. Apply a thin coating of flux to both the pipe and interior of the fitting before telescoping the two parts together.
- B. Care shall be taken in the heating of the joints so that the solder will flash and provide a full solid joint.

3.05 THREADED JOINTS

- A. Threaded joints shall be the American Standard Taper Pipe Thread (NPT), and shall conform to ANSI B 2.1. Pipe threads shall be cut sharp and smooth, and threading dies and taps shall have a threading stop to prevent overcutting the thread length. Power threading equipment dies shall have a 5 negative front rake when set on plastic pipe. Hand threading dies for plastic pipe shall have a 5 to 10 negative front rake.
- B. In threading plastic pipe a tapered plug shall be inserted in the end of the pipe to provide support and prevent distortion to the pipe in the threaded areas. The liberal use of an external lubricant shall be used while threading.
- C. After cutting and threading, the pipe shall be end-reamed to full internal pipe diameter. Before applying sealant, thread shall be wiped clean of cuttings and grit.
- D. Thread tape sealant shall be used, applied on male threads only, and shall be PTFE type, Caulking of threaded joints to stop or prevent leaks shall not be permitted.

- E. Where galvanized pipe has been threaded and connected, the exposed threads at couplings, fittings and appurtenances shall have a coat of corrosion resistant paint applied.

3.06 SOLVENT CEMENTED - PLASTIC

- A. Apply primer to the pipe and freely in the socket keeping surface wet and applicator wet and in motion 5 to 15 seconds. Avoid puddling in the socket. Apply primer a second time to the fitting socket.
- B. For checking penetration, scratch or scrape a few thousandths of the primed surfaces away. Repeated applications to either or both surfaces may be necessary. Weather conditions affect priming action. In cold weather more time is required for proper penetration.
- C. Apply a full even layer of cement on the pipe O.D. for a distance slightly greater than the depth of the socket of the fitting. Coat the fitting socket with a medium layer, avoiding puddling. On belled end pipe, do not coat beyond the socket depth or allow cement to run beyond the bell. Put a second full even layer of cement on the pipe O.D. Cement layers must be without void and sufficient to fill any gap in the joints.
- D. Immediately upon finishing cement application and before it starts to set, insert the pipe to the full socket depth while rotating the pipe or fitting a 1/4 turn to insure complete and even distribution of the cement. Hold joint together for a minimum of 10 to 15 seconds to make sure that pipe does not move or back out of the socket.
- E. For pipe sized 6" and larger, a joining crew consisting of two men is required and the following additional steps necessary:
 - 1. Rotation of the pipe in the fitting may be omitted.
 - 2. Hold joint together for 1 to 3 minutes depending on pipe size.
 - 3. As an aid for joining in these larger sizes, it is recommended that a come-along or pipe joining tool be used.
- F. Immediately, after joining and before joint is set, gently place it back onto a level surface, wipe off all excess cement from the circumferences of the pipe and fitting.
- G. When the atmospheric temperature is above 90 F to avoid excessive evaporation of the solvent from the cement just prior to joining use one or a combination of the following:
 - 1. Shade or shelter the joint surfaces from direct exposure to the sun's rays for at least one hour prior to joining and during the joining process.
 - 2. Make cement joints during early morning hours.
 - 3. Apply cement quickly. On 6" and larger pipe, it is recommended that two men apply cement to pipe surface while the third applies it to the fitting socket.
 - 4. Join pipe to fittings as quickly as possible after applying cement.
- H. All potable water pipes, pipe related products, and materials that join or seal pipes conform to ANSI/NSF 61.
- I. All solvent cements and primers used to join and seal PVC materials shall comply with the requirements of ANSI/NSF 14.

3.07 PIPE SUPPORTS

- A. Refer to Section 23 05 29: Hangers and Support Devices

3.08 ORDINARY CLEANING

- A. Before cleaning a system such items as safety valves, level controls, orifice plates, strainers, rupture discs, all instruments not tagged or marked with a test pressure and all other items which may be damaged by the cleaning-flushing operation, shall be removed from the line.
- B. Prior to testing all piping systems shall be cleaned and purged to the satisfaction of the Architect. The purge point for liquid and gas piping systems shall be lowest and highest points respectively in the system unless otherwise specified. The Contractor shall exercise due care in filling, flushing, purging, venting and draining piping systems. The Contractor shall be responsible for damage resulting from excess vacuums when draining piping systems.

- C. All piping systems shall first be purged with compressed air at a pressure not greater than half of the system operating pressure. Purge duration shall continue until there is no visible discharges from openings or 10 minutes, whichever is greater.
- D. All piping systems shall secondly be purged with the flow medium of the system. Flushing shall continue for 5 minutes or until the discharge is free of particulate matter, whichever is greater.

3.09 TESTING

- E. The contractor shall furnish all test gauges, accurate relief valves to prevent over test-pressuring, the test medium, piping of the test medium, and where required, the necessary pumping device to develop and maintain the proper test pressure. Test gauges shall be supplied by the contractor and shall have dial diameters of at least 6 inches with scale capacity for test pressures. The gauge used on any test shall have a scale capacity of as close as possible to twice the specified test pressure using standard dials. All test gauges shall be checked on a dead-weight tester or shall be compared against a certified master gauge.
- F. The Contractor shall be responsible for the removal of water used in testing from all piping systems including attached vessels. Where ditches or temporary lines to ditches are necessary, the Contractor shall provide same, and after use, such ditches or lines shall be removed, leaving the area in its original or equal condition as determined by the Engineer.
- G. During hydrostatic testing, provision shall be made for the venting of trapped air at all high points and other places in the system where air pockets may occur.
- H. A safety or relief valve may be used at the pressure source to protect systems under test. Pressure applied on any system shall not exceed the specified test pressure by any amount and any damage resulting from neglect of this requirement shall be the responsibility of the Contractor.
- I. All the piping of the plumbing system shall be tested with water or air. After the plumbing fixtures have been set and their traps filled with water, the entire drainage system shall be submitted to final tests. The pressure has reached all parts of the system.
- J. The water test for the plumbing system shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest openings and the system filled with water to point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section be filled with water, but no section shall be tested with less than a ten foot head of water. In testing successive sections at least the upper ten feet of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet of the system) shall have been submitted to a test of less than a ten foot head of water. The water shall be kept in the system, or in the portion under test for at least fifteen minutes before inspection starts; the system shall then be tight at all points.
- K. The air test for the plumbing system shall be made by attaching an air compressor or testing apparatus to any suitable opening and after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of five pounds per square inch or sufficient to balance a column of mercury ten inches in height. This pressure shall be held without introduction of additional air for a period of at least fifteen minutes.
- L. The potable water system in its entirety or sections shall be tested in strict provisions of the International Plumbing Code, Current Edition.
- M. SMOKE TEST - Contractor to smoke test all sewer vent piping prior to wall being closed up. For all CMU block walls smoke test to be performed when walls are 50% formed up.
 - 1. When smoke testing a sanitary sewer system it is helpful to partially block off the section of sewer to be tested from the city main service line. This can be done by using a pneumatic sewer plug or rubber balloon for sealing off the building connections from main lines. Completely blocking the line can cause water to back up and prevent smoke from escaping through defects. Smoke testing may not be done after rain or when ground water is unusually high as this may also prevent detection of defects.
 - 2. Smoke is created using either a smoke bomb or liquid smoke. Smoke bombs are lit and placed on a grate or in a holder on top of each fan, while liquid smoke is injected into the

fan via a heating chamber. The fans create a pressure differential that forces the smoke into the sewer at a pressure just above atmospheric. With properly installed plumbing, the traps will prevent the smoke from entering the building and redirect it out the plumbing vents. Defective plumbing systems or dry traps will allow smoke to enter the inside of the building.

3. The area around the section being tested is searched for smoke plumes. Plumes coming from plumbing vents or the interface between the fan shroud and cleanout rim are normal; however, smoke plumes outside of the cleanout rim are not. Plumes are marked, usually with flags, and defects are noted using measurements from stationary landmarks like the corners of the building. The plumes or markers may also be photographed.
4. Procedure: Equipment Required for building connections and laterals:
 - a. Smoke bomb cartridges
 - b. Electric blower producing 180 CFM @ 1.3 static pressure is recommended.
 - c. Pneumatic sewer plug or rubber balloon for sealing off the building connections from main lines.
 - d. Vent cap with open center hole to restrict the flow of air and smoke.
5. Building Connections
 - a. It is not absolutely necessary to have the building line blocked off from the main, but doing so will increase test efficiency. In most cases there is a cleanout opening through which a plug or balloon can be inserted between the opening and the main, and then inflated. A length of windshield hose or similar type tubing can be attached to the balloon to facilitate inflation. Vents can be partially blocked allowing the air/smoke mixture to flow through the plumbing system.
 - b. Connect the blower to the line at a cleanout and start introducing the smoke through the intake side. NOTE: A properly sized blower is important. Use of a blower with lesser capacity will not generate sufficient pressure to disclose all faults in a line and a blower with too great a capacity may blow water from traps.
 - c. Check the interior of the building for smoke. Any smoke should be quickly ventilated by opening doors and windows. Notations should be made of leak locations. Next the yard should be checked for smoke and the location of any smoke marked for later correction of faults.
 - d. Smoke will leave no visible residue to damage interior of buildings. It is irritating to breathe, but any irritation will quickly disappear once exposure has ceased. Of course special precautions should be taken with persons having respiratory problems of any kind.
 - e. All buildings connected to the lines being tested should be checked for smoke. If a concentration of smoke is present, occupants should be evacuated and the building ventilated. If unvented, smoke will settle out of the air without leaving residue.

END OF SECTION

12-10-25

SECTION 20 0413 - ELECTRICAL PROVISIONS FOR MECHANICAL WORK

PART 1 GENERAL

1.01 SCOPE

- A. Extent of electrical provisions to be provided as mechanical work is indicated in other Division-23 sections, on drawings, and as further specified in this section.
- B. Types of work normally recognized as electrical but provided as mechanical, specified or partially specified in this section, include but are not necessarily limited to the following:
 - 1. Motors for mechanical equipment.
 - 2. Starters for motors of mechanical equipment.
- C. Refer to Division 23 sections for specific individual mechanical equipment.
- D. Refer to other Division 23 sections for specific individual mechanical equipment electrical requirements.
- E. Refer to Division 26 sections for junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.02 QUALITY ASSURANCE

- A. Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections. Comply with applicable requirements of Division 26 sections for electrical work of this section which is not otherwise specified.
- B. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology herein. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.03 SUBMITTALS

- A. Concurrently, with submittal of mechanical products listing submit separate listing showing rating, power characteristics, application and general location of every motor to be provided with mechanical work. Submit updated information promptly when and if initial data is revised.
- B. Coordination with electrical: Contractor to submit copy of any & all shop drawings that indicate electrical requirements to the project electrical engineer for electrical service & electrical load verification. Applicable to all mechanical items.

PART 2 PRODUCTS

2.01 GENERAL - DIVISION OF WORK

- A. In accordance with the general conditions, contractor is responsible for dividing the work among the subcontractors and suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the work may be divided. It is the responsibility of the contractor to ensure a complete and working system. This is not a complete list of all the work:
 - 1. GENERAL: The Mechanical Contractor shall furnish to the Electrical Contractor for installation, all the motors, motor starters, start-stop switches, pilot lights, etc., for each piece of motor driven equipment unless shown otherwise.
 - 2. The Electrical Contractor shall install all motor starters, start-stop switches and pilot lights as furnished by the Mechanical Contractor. The Electrical Contractor shall also do all power wiring, and electrical termination's required for the installation of such mechanical equipment. Control Contractor shall be responsible for providing all control wiring.
 - 3. The Electrical Contractor shall furnish and install all equipment interlocking power wiring and the control contractor shall be responsible for installing control wiring as described in the control section. The Mechanical & General Contractor shall be responsible for coordinating and checking out all work to provide a complete system in working order, coordination to occur prior to bid.
 - 4. All electrical equipment shall have the UL label and shall meet the standards of the National Electrical Code and NEMA Rated, I.E.C. is not acceptable.

2.02 MOTOR AND MOTOR CONTROLLERS

- A. Motors shall be provided to meet the requirements of the driven equipment. Motors shall be selected to be non-overloading and capable of normal scheduled operation without operating in

the service factor range. Unless required otherwise, three phase motors shall be squirrel-cage induction type, with copper windings, designed for a 40 C rise from 40 C ambient, have minimum Class B insulation and unless required otherwise, have NEMA design B normal starting torque. Motors are to be open drip-proof for indoor applications and totally enclosed fan cooled for outdoor or wet applications.

1. Provide shaft grounding rings for all motors that are to be used with variable frequency drives.
- B. All motors shall be high power factor, premium energy efficient type with a minimum 1.15 service factor and minimum 0.85 full load power factor. Motor efficient shall meet or exceed that values listed in the attached table when tested in accordance with NEMA test standards MG112.53a, IEE Test Procedure 112, Method B, using accuracy improved by segregated loss measurements
- C. Motors controlled by VFD's shall comply with NEMA MG1, Part 31, Definite Purpose Inverter Fed Motors. (Withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater).
- D. Starters for single phase motors which are not automatically started shall be manual type with melting alloy thermal overload protection and pilot light. Starters for automatically controlled single phase motors shall be magnetic type with NEMA rated AC magnetic contractor, melting alloy thermal overloads and pilot light.
- E. Starters for three phase motors 15 horsepower and below shall be combination type starter/disconnect, full voltage non reversing (FVNR), with magnetic NEMA rated contractors rated for horsepower of motor served, adjustable trip magnetic circuit breaker disconnect (motor circuit protector) capable of being padlocked in the open position, 10K AIC minimum fault rating with higher rating when necessary, due to available fault levels. Starters shall have a fused 100VA minimum control transformer (120V, unless required otherwise), HOA switch, push to test operating pilot light, solid state overload relays set for actual motor nameplate full load amps, phase failure and phase reversal protection relay, minimum two N.O. and two N.C. auxiliary contacts and terminal blocks factory prewired for field wiring. Starter shall be housed in a NEMA 1 enclosure for indoor locations and NEMA 3R enclosure for outdoor or wet locations.
- F. Starters for motors 20 horsepower and above shall be soft start type or variable frequency drives.

Motor Efficiency at full load

HP	Nominal	Nominal	Nominal
1	82.5	82.5	80.0
1 ½	84.0	84.0	87.5
2	84.0	84.0	87.5
3	86.5	90.2	89.5
5	89.5	89.5	89.5
7 ½	89.5	91.7	91.7
10	90.2	91.7	91.7
15	91.0	93.0	92.4
20	92.4	93.6	92.4
25	93.0	94.1	93.6
30	93.6	94.1	93.6
40	93.6	94.5	94.1
50	93.0	94.5	94.1
60	93.6	95.4	95.0
75	94.5	95.4	95.9
100	94.5	96.2	95.4
125	95.0	95.4	95.4
150	94.5	96.2	95.8
200	95.0	96.2	95.4

2.03 SOFT START STARTERS

- A. Refer to 23 04 14 MOTOR STARTERS Specification.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 HP and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Deliver starters and wiring devices which have not been factory-in-stalled on equipment unit to electrical Installer for installation.
- C. Install power and control connections for motors to comply with NEC and applicable provisions of Division 26 sections. Install grounding where non-grounded isolation of motor is indicated.

END OF SECTION

12-10-25

SECTION 20 0516 - PIPING EXPANSION COMPENSATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

- A. Perform all Work required to provide and install the following piping expansion compensation equipment as required with supplementary items necessary for their proper installation. Contractor shall provide manufacturers engineering drawings during the submittal phase of project locating the expansion loops/joints along with required sizes and anchor points.
 - 1. Flexible pipe connectors.
 - 2. Expansion joints and compensators.
 - 3. Pipe loops, offsets, and swing joints.
- B. Perform all Work required to provide and install the following piping expansion compensation equipment with supplementary items necessary for their proper installation.
 - 1. Flexible pipe connectors.
 - 2. Expansion joints and compensators.
 - 3. Pipe loops, offsets, and swing joints.

1.03 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. MIL-E-17814E-Expansion Joints, Pipe, Slip-Type, Packed.

1.04 QUALITY ASSURANCE

- 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. Domestic Hot Water: Base expansion calculations on 50-degrees F. installation temperature to 140-degrees F., plus 30 percent safety factor.

1.05 SUBMITTALS

- A. 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.

- B. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation. Indicate alignment, guide locations, quantities, spacing, etc.
- C. Operation and Maintenance Data: Include adjustment instructions, warranty.
- D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience.
- E. Not used.

1.06 EXTRA MATERIALS

- A. Provide two (2) 12-ounce containers of packing coverage for leak-free performance of expansion joints.

1.07 WARRANTY

- A. Provide a five (5) year warranty including coverage for leak-free performance of expansion joints.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS

- A. Certain items in this Specification are listed by manufacturer and/or manufacturer's model number to establish general style, type, character and quality of the product desired. Similar items manufactured by other than those listed will be considered, providing submittals are made according to Pre-Bid Approval requirements of Instructions to Bidders.
- B. Where no manufacturer or model number is given, any product meeting performance or design criteria, or referenced trade association standard may be used and Pre-Bid Approval is not required.
- C. Flexible Pipe Connectors:
 - 1. Hyspan Model Series 3505.
 - 2. Pathway Model Xpress FF with anchor foot.
- D. Expansion Joints – Steel Piping:
 - 1. Hyspan Model 3501 series.
 - 2. Pathway Model Xpress FF with anchor foot.
- E. Expansion Joints – External Ring:
 - 1. Hyspan Model Series 5500.
 - 2. Pathway Model Flexway CT.
 - 3. Flexonics Model TCS-R.
- F. Pipe Alignment Guides:
 - 1. Anvil Model Fig. 255.
 - 2. Piping Technology & Products Model Fig. 6.
 - 3. Hyspan Model Series 9500.

4. AAA Technology Model Fig. 295.

2.03 FLEXIBLE PIPE CONNECTORS

- A. Copper Piping - Domestic Water:
 1. Pathway Model Xpress FF with anchor foot.
 2. Exterior Sleeve: Braided bronze or stainless.
 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 4. Joint: As specified for pipe joints.
 5. Size: Use pipe-sized units.
 6. Maximum offset: 3/4 inch on each side of installed centerline.

2.04 EXPANSION JOINTS

1. Not used.

2.05 ACCESSORIES

- A. Pipe Alignment Guides:
 1. Two (2) piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
 2. Provide and install alignment guides at expansion joints per manufacturer's requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
 1. Accomplish structural Work and provide equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints, and provide corrugated bellows type expansion joints where indicated on Drawings or required.
 2. Provide pipe anchors as shown on the Drawings and/or as required to facilitate proper operation of pipe guides. Install anchors in compression. Weld anchors to pipe and to building structure
 3. Provide pipe guides so that movement takes place along axis of pipe only. Guide sizes shall be the nominal pipe size with insulation. Guides shall not carry dead weight load on pipe and are not intended to take the place of the required pipe supports and rollers.
 4. Construct spool pieces to exact size of flexible connection for future insertion.
 5. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.
 6. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor the other end. Install in a horizontal plane unless indicated otherwise.
 7. Rigidly anchor pipe to building structure where shown or 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.

3.02 TESTING

- A. Prepare and Start-up systems under provisions of Section 20 01 00 and Division 21,22,23.
- B. Provide inspection services by flexible pipe manufacturer's representative for final installation.
- C. Certify that installation is in accordance with manufacturer's recommendations and that connectors are performing satisfactorily. Notify Owner's Project Manager at least five (5) calendar days prior to the inspection.

END OF SECTION

12-10-25

SECTION 20 05 29 - HANGERS AND SUPPORT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. Work Included
 - 1. Hangers and supporting devices for all mechanical piping.

1.3 SUBMITTALS

- A. General: All submittals comply with the requirements of Division 23 Section 230001 - GENERAL PROVISIONS
- B. Product Data: Data shall be submitted on the following items:
 - 1. Hangers and supporting devices to be used.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all hangers and rods, turnbuckles, angles, channels and other structural supports to support the piping systems.
- B. Pipe hangers, hanger rods, trapeze type hangers, upper attachments and other supports shall be selected based on pipe size (plus insulation of pipes specified to be insulated) and the weight of the medium being transported or the medium used for testing, whichever is heavier. For sprinkler piping, in addition to the pipe and water, allow a minimum of 250 pounds applied at the point of hanging.
- C. Rods for pipe hangers shall be carbon steel. Rod size shall be:

Pipe Size	Standard Hanger Rod Diameter	Fire Protection Hanger Rod Diameter
½" - 2"	3/8"	
2 ½" - 3"	½"	
4" - 5"	5/8"	in accordance with NFPA 13
6"	¾"	
8" - 12"	7/8"	
14" - 16"	1"	
18"	1 1/8"	
20" & larger	1 1/4"	

- D. All ferrous metal pipe hangers, except copper plated hangers, and concrete inserts shall be provided with a factory-applied coat of rust inhibiting paint.
- E. Pipe hangers for suspending the following horizontal non-insulated piping shall be sized to fit directly around the pipe and protective shield.
 - 1. Sanitary Sewer & Vent Piping.
 - 2. Fire Water Piping.
 - 3. Natural Gas Piping.
- F. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit around the pipe, pipe insulation and pipe insulation protective shields:
 - 1. Refrigerant piping.

2. Condensate drain piping from HVAC units.
 3. Waste piping from drinking fountains.
 4. Waste piping receiving condensate from HVAC units.
 5. Domestic cold water piping.
 6. Domestic hot water and hot water circulating piping.
 7. Roof Drain Piping
- G. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit around the pipe, pipe insulation and pipe insulation protective saddle:
1. Not used.
- H. All supporting equipment with the exception of springs in spring isolation hangers shall be designed with a minimum factor of safety of five based on the ultimate tensile strength of the material.

2.2 PIPE SUPPORTS FOR SUSPENDED HORIZONTAL PIPING

SYSTEM	PIPE MATERIAL	PIPE SIZE	HANGER NUMBER
Natural Gas	Steel	All Sizes	I
Domestic Cold & Hot Water	Copper	All Sizes	IV
Soil, Waste, & Vent	PVC	All Sizes	V
Soil, Waste, & Vent	Cast Iron	All Sizes	I
Fire Protection	Steel	6" & Larger	I
Fire Protection	Steel	4" & Smaller	VI
Refrigerant (Insulated)	Copper	All Sizes	IV
Refrigerant (Uninstalled)	Copper	All Sizes	IV
Miscellaneous Drains	Steel	All Sizes	I
	Copper	All Sizes	IV
Condensate Drains	Copper	All Sizes	IV
Relief Valve Discharge	Copper	All Sizes	IV

- A. Hanger numbers listed in schedule above shall be the following types:
1. Hanger Number I: Clevis hanger, steel.
 2. Hanger Number II: Adjustable split ring hanger, malleable iron.
 3. Hanger Number III: Adjustable swivel clevis roller hanger with black cast iron roller and carbon steel yoke and cross bolt.
 4. Hanger Number IV: Clevis hanger, copper plated steel.
 5. Hanger Number V: Clevis hanger, plastic coated steel.
 6. Hanger Number VI: Adjustable band hanger, steel.

- B. Hanger numbers listed above shall be:

HANGER NUMBER	ELCEN	CARPENTER & PATERSON	ITT GRINNELL	B-LINE SYSTEMS	MICHIGAN HANGER CO.
I	12	100	260	83100	400
II	--	240	104	-----	111
III	14x	16	---	83111	612
IV	312	100CT	CT-65	83104CT	402
V	---	100 PVC	---	83100C	420
VI	89	800	70	83170	100

C. Upper Attachments:

1. Steel Construction

- a. For suspending pipes from steel beams, upper attachments shall be beam clamps and shall be:
 - Michigan Hanger Co. No. 364
 - B-Line System Fig. 83055
 - Carpenter & Patterson Fig. 268
- b. For suspending joints from bottom chord of steel bar joists, upper attachments shall be C-clamps with retaining clips and shall be:
 - ITT Grinnell Fig. 87
 - B-Line Systems Figs. 8351, 83362, and 83363
- c. For suspending pipes from the top chord of steel bar joists, upper attachments shall be top-of-beam C-clamps and shall be:
 - B-Line Systems Fig. 83034
 - ITT Grinnell Fig. 62
 - Elcen No. 236L
 - Carpenter & Paterson Fig. 192

2. Concrete Construction

a. New Construction

- 1. For suspending pipe in concrete construction, upper attachments shall be adjustable type concrete inserts. Where weight to be supported by an insert is 300 lbs. or more, install two No. 3 steel reinforcing bars, each 3 ft. long, through the yoke of the insert. Concrete inserts shall be:
 - ITT Grinnell Fig. 281
 - B-Line Systems Fig. 82500
 - Michigan Hanger Co. No. 355
 - Elcen No. 86
 - Carpenter & Paterson Fig. 75

b. Existing Construction

- 1. Not used.

2.3 PIPE SUPPORTS FOR FLOOR SUPPORTED HORIZONTAL PIPING

A. General

- 1. Pipe supports for horizontal piping supported on concrete floors and on concrete bases shall be adjustable pipe saddle support with U-bolt and screwed floor flange. Bolt floor flange to floor and bases utilizing all bolt holes. Adjustable pipe saddle supports shall be steel and shall be:
 - B-Line Systems Fig. 83090
 - Carpenter & Paterson Fig. 125
 - Elcen No. 49
- 2. Pipe supports for horizontal piping in trench below floor level shall be adjustable pipe roller stands. Base shall be bolted to the trench floor utilizing all bolt holes. Adjustable pipe roller stands shall be steel and cast iron and shall be:
 - B-Line Systems Fig. 83118

- Carpenter & Paterson Fig. 40
- Elcen No. 20
- ITT Grinnell Fig. 274
- Michigan Hanger Co. No. 619

2.4 PIPE SUPPORTS FOR VERTICAL PIPING

- A. Supports for vertical piping shall be riser clamps sized to fit directly around the pipe.
1. Riser clamps shall be steel and shall be:
 - B-Line Systems Fig. B3373
 - Carpenter & Patterson Fig. 126
 - Elcen No. 39
 - ITT Grinnell Fig. 261
 - Michigan Hanger Co. No. 510
 2. Offset pipe clamps shall be steel and shall be:
 - B-Line Systems Fig. B3148
 - Carpenter & Paterson Fig. 179
 - Elcen No. 44
 - Michigan Hanger Co. No. 700
 3. Clamps for copper tubing shall be copper plated.

2.5 PIPE INSULATION PROTECTIVE SHIELDS AND SADDLES FOR HORIZONTAL PIPING

- A. Shields shall be galvanized sheet metal type. Shields shall be 180 degrees type at all pipe hangers, except on trapeze hangers, pipe rack and on floor supported horizontal pipe shields shall be 360 degrees type. Shields sizes shall be:

<i>Pipes 2 in and smaller - -</i>	<i>18 gage x 12" long</i>
<i>Pipes 2 ½ in. thru 6" - -</i>	<i>16 gage x 18" long</i>
<i>Pipes 8 in. and longer - -</i>	<i>14 gage x 24" long</i>

- B. Saddles shall be steel and shall be:

<u>INSULATION THICKNESS</u>	<u>ELCEN</u>	<u>CARPENTER & PATERSON</u>	<u>ITT GRINNELL</u>	<u>B-LINE SYSTEMS</u>	<u>MICHIGAN HANGER CO</u>
1"	251	351	160	B3160	630
1 ½"	252	352	161	B3161	631
2"	253	353	162	B3162	632
2 ½ "	254	354	163	B3163	633
3"	255	355	164	B3164	634
4"	256	356	165	B3165	635

2.6 FACTORY - FABRICATED FRAMING CHANNELS AND FITTINGS

- A. Factory fabricated framing channels and fittings shall be used for:
1. Constructing pipe racks for supporting multiple horizontal pipes where indicated on the drawings.
 2. Constructing trapeze type hangers for suspending multiple horizontal pipes where indicated on the drawings.
 3. Securing vertical exposed water service drops for hose bibbs and wall hydrants.

4. Securing vertical exposed compressed air service drops for compressed air outlets.
5. Securing vertical exposed gas service drops for gas outlets and equipment.
- B. Framing channels and fittings shall be provided with factory applied baked enamel finish.
- C. Galvanized pipe clamps, including bolts and nuts, shall be provided with the framing channels and shall be used for securing pipes to channels, except pipe roller type supports shall be provided for pipes 2 ½ inches and larger for hot water heating, pipe roller supports shall include rollers, ½ inch diameter axle, nuts and angle brackets. Pipe clamps on insulated pipes shall fit around pipe, pipe insulation and pipe insulation protection shield. Pipe roller supports on insulated pipes shall be sized to fit around pipe saddles.
- D. Framing channels and fittings shall be:
 - Michigan O-Strut System
 - B-Line Systems B-Line's Strut System
 - Unistrut Metal Framing System

2.7 DIELECTRIC ADAPTERS/SEPARATORS

- A. Dielectric adapters/separators shall be provided between copper and iron pipe connections and between ferrous and non-ferrous piping or equipment or between dissimilar metals.

PART 3 EXECUTION

3.1 HORIZONTAL PIPE SUPPORT INSTALLATION

- A. Spacing of hangers and supports shall be as follows:
 1. Cast iron pipe shall be supported at not more than four (4) feet intervals and near each hub or coupling & at base of all risers.
 2. Copper Tubing:

<i>Sizes ½" thru 1-½":</i>	<i>Piping supported from structural member of structure shall be at each member or 4'0" on centers, all sizes.</i>
<i>Sizes 2" & Larger:</i>	<i>Piping supported from structural member of structure shall be at each member or 4'0" on centers, all sizes.</i>
 3. Steel Pipe:

<i>All Sizes:</i>	<i>Any piping supported from structural member of structure shall be at each member or 4'0" on centers, all sizes.</i>
- B. Additional hangers shall be provided adjacent to all valves and fittings size 8" and larger.
- C. Intermediate pipe supports shall be provided between building structural members so as not to exceed maximum support spacing hereinbefore specified.
 1. In filler type concrete construction, intermediate angle supports shall be fastened to concrete joists or beams. In no case shall angle supports be fastened in floor slabs or in roof slabs. Intermediate supports shall be fastened to concrete slabs. Intermediate supports shall be fastened to concrete with concrete inserts or concrete anchors.
 2. In steel construction, intermediate supports shall be welded to steel beams and to steel joists. In no case shall supports be attached to roof purlins, roof decks, or permanent metal forms.

3. In steel construction, install additional supports as recommended by Structural Engineer due to loading capacity of structure.

3.2 UNDERGROUND PIPING

- A. Piping underground shall be laid on a firm bed of minimum 6" pea gravel for its entire length, provide minimum 6" cover of pea gravel. Refer to pipe trench detail.
 1. Figure in bid backfilling with pea gravel. Should pipe manufacturer recommended riversand in lieu of pea gravel, then the contractor shall comply with the manufacturer's recommended installation guidelines and provide a credit back to the owner.

3.3 VERTICAL PIPE SUPPORT INSTALLATION

- A. Supports for all pipes shall fit directly around the pipe. On insulated pipes, the support shall be insulated and provided with vapor barrier as specified for pipe insulation .
- B. Vertical pipes passing through floors shall be provided with a riser clamp at each floor. Riser clamps shall have steel lugs, 1/4" thick x 2" high x 1 1/2" long, welded to the clamp arms so that clamp does not come in contact with the pipe sleeve; the lugs shall support the clamp from the floor.
- C. Where distance between floors is 15 ft. or more, in addition to the riser clamps, vertical pipes shall be provided with offset pipe clamps anchored to walls at the approximate midpoint between floors.
- D. Exposed to sight vertical service drops to hose bibbs, and wall hydrants, and misc. outlets shall be supported with not less than two equally spaced sections of factory-fabricated framing channel with standard pipe clamps. Channel section shall be 8" long and shall be fastened to wall with not less than two spring wing toggle bolts.
- E. Copper tubing supported by channel framing shall be provided with a lead sleeve to isolate the pipe from the framing channel and the pipe clamp.
- F. Contractor to provide pipe supports for all domestic cold/hot water piping drops within walls to fixtures/equipment. Pipe clamp to be Anvil CT-138R copper plated split tubing clamp, provide 3/8" threaded rod as required to nearest wall framing member, provide 3/8" female threaded rod zinc-plated baseplate (Anvil 128R) fastened to wall framing member. Provide a minimum of one (1) support assembly at each drop in addition to copper plated holdrite system.

3.4 CONCRETE INSERTS AND ANCHORS

- A. In filler type concrete construction, inserts and anchors shall be installed in joists or beams only. Install inserts in sides of joists or beams.
- B. In framed type concrete construction, inserts and anchors shall be installed for all piping.

3.5 SHIELD AND SADDLE INSTALLATION

- A. Shields shall be installed at all pipe hangers in horizontal insulated piping, as noted in section 2.1,F above.
- B. Not used.

3.6 EXTERIOR PIPE SUPPORT COATINGS

- A. All exterior pipe supports are to receive a brush painted, 2 layers, cold zinc galvanizing paint for exterior use.

END OF SECTION

12-10-25

SECTION 20 0530 - PRE-ENGINEERED ROOFTOP SUPPORTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Portable, pre-engineered , rooftop support systems for:
 - 1. Piping
 - 2. Ducting
 - 3. HVAC equipment, Condensing Units
 - 4. Plumbing equipment
 - 5. Walkways, Crossovers, Stairs & Ramps
 - 6. Platform Systems
 - 7. Seismic and High-Wind application
- B. Portable rooftop walkway and platform system.

1.2 RELATED SECTIONS

- A. Section 07 00 00 - Thermal & Moisture Protection.
- B. Section 07 71 00 - Roof Specialties.
- C. Section 07 72 00 - Roof Accessories.
- D. Section 07 72 46 - Roof Walkways.
- E. Section 07 76 00 - Roof Pavers.
- F. Section 20 05 29 - Hangers & Support Devices
- G. Division 22 - Plumbing.
- H. Division 23 - Heating, Ventilating & Air Conditioning (HVAC).
- I. Section 23 33 00 - Duct Accessories.
- J. Division 26 - Electrical.

1.3 REFERENCES

- A. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM D 1929 - Standard Test Method for Determining Ignition Temperature of Plastics.
- D. MSS SP-58 - Pipe Hangers and Supports -- Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.
- E. MSS SP-69 - Pipe Hangers and Supports -- Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.

1.4 SYSTEM DESCRIPTION

- A. Support piping on roof with an engineered, prefabricated PHP System designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases, made of high density, polypropylene plastics with UV Protection, a HDG structural steel frame, and suitable pipe hangers for the application. Nuts, threaded rods and washers shall be HDG, spring nuts, and bolts for spring nuts, will be electro-plated. System shall be custom designed to fit piping and conduit to be installed, and the actual conditions of service. Pipe supports shall be manufactured by PHP Systems/Design i.e. Portable Pipe Hangers (see 2.2 A).
- B. Support ductwork on roof with an engineered, prefabricated PHP Duct System designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases, made of high density, polypropylene plastics with UV Protection, and a

HDG structural steel frame. Nuts, threaded rods and washers shall be HDG, spring nuts, and bolts for spring nuts will be electro-plated. System shall be custom designed to fit the load requirements. Duct supports shall be manufactured by PHP Systems/Design i.e. Portable Pipe Hangers (see 2.2 B).

- C. Support elevated walkway systems routed across the roof with an engineered, prefabricated PHP Walkway System, designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases made of high density, polypropylene plastics with UV Protection, a galvanized structural steel frame, walkway planking, and handrail if required. Nuts, threaded rods and washers shall be HDG, spring nuts, and bolts for spring nuts will be electro-plated. System shall be custom designed to fit the load requirements. Walkway Systems shall be manufactured by PHP Systems/Design i.e. Portable Pipe Hangers.
- D. Manufacturer to provide Louisiana Licensed structural engineer stamped submittals as to ensure supports meet wind load requirement 136mph ASCE 7-10/IBC 2012, Exposure B, Building Risk Category III. Penetration of roofing for fastening support to roof deck shall be allowed to meet these wind load requirements. **Refer to Structural Drawing Sheets for structural design criteria.**

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Submit for all products proposed for use, describing physical characteristics and method of installation.
- C. Shop Drawings: Show installation layout, sizes of units, and details of installation.
- D. Verification Samples: Actual samples of bases, each type of support, hanger, and fasteners; and not less than 12 inches of framing members.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing pipe support systems, with a minimum of eight years of documented experience.
- B. Installer Qualifications: Company approved by manufacturer with not less than five years of experience in installation of piping support systems.
- C. References: Submit list of references comprising not less than 10 installations that have been in use for a minimum of five years. Include contact name and phone numbers for each reference.
- D. Pre-Installation Meeting: After approval of submittals, but before beginning installation, conduct a meeting at the project site attended by the Architect, Contractor, Owner's Representative, installers of roofing, and mechanical and electrical piping, to be installed on pipe support systems.
 - 1. Purpose of meeting is to describe in detail the installation process and to establish agreement, coordination, and responsibilities.
 - 2. Contractor to prepare detailed meeting report and distribute copies to the Architect and all attendees.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials to project site in manufacturer's original packaging, marked with manufacturer's name, product model names and catalog numbers, identification numbers, and other related information.
- B. Store materials under cover until needed for installation.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Warranty: Portable Pipe Hangers 5 year limited warranty to repair/replace any products that are structurally defective in material or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: PHP Systems/Design i.e. Portable Pipe Hangers; 5534 Harvey Wilson Drive, Houston, Texas 77020. ASD. Tel: (800) 797-6585. Fax: (713) 672-1170. www.phpsd.com. Email: info@phpsd.com. Miro, or prior approve equal.
- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 APPLICATIONS

- A. Support pipes, conduit, cable trays, and ducting, a minimum of 6 inches above roof surface.
 - 1. Support Spacing to meet wind load requirements.
 - 2. For Ductwork: Portable Pipe Hanger Model number PPH-D – Goal Post style.
 - 3. For Ductwork: Portable Pipe Hanger Model number PPH-D – Enclosed style.
 - 4. Provide the following accessories for PSE Custom and Other Applications.
 - a. On Sloped Roof Surfaces, where slope exceeds 1/4 inch per foot: provide base with swivel for slope adjustment. Note: PHP approved bracing required when using base with swivel.
 - b. Un-insulated Piping: Roller support or clevis hanger.
 - c. Insulated Piping: Band hanger supported from horizontal channel or clevis hanger with Insulation Protection Shield.
 - d. Conduit: Band hanger supported from horizontal channel.
 - e. Bracing required when using base with swivel; when pipe exceeds 24 inches above roof, or when thermal expansion of pipe is great.
- B. Walkway, Crossover & Equipment Platform Access: Elevated walkway systems shall be manufactured by PHP Systems/Design i.e., Portable Pipe Hangers.
 - 1. Support Spacing to meet wind load requirements.
 - 2. Bases High Density Polypropylene plastics with additives for UV protection.
 - 3. Substructure: 12 gauge back-to-back channel G-1012A, or approved equal supported directly from the bases.
 - 4. Grating: Mill-galvanized carbon steel in accordance with ASTM A525:
 - a. Gauge 18-ga. steel
 - b. Section Width: 12 inches
 - c. Channel Height: 2 inches
 - d. Flange Options: FM
 - e. Flange Options: MM
 - f. Surface Condition: MG-traction grip
 - 5. Handrail: 12 gauge, 1-5/8 inch channel G-5812, or approved equal.
 - 6. All substructures and handrails shall be galvanized steel. Spring nuts, and bolts for spring nuts will be electro-plated.
- C. Attachment of Base to Roof Surface for Seismic and High Wind Applications.
 - 1. Adhesive attachment to roof surface.

2.3 MATERIALS

- A. Portable Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations, or flashings, and without causing damage to the roofing membrane.
 - 1. Design system using high density, high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing of 1-5/8 inch B22TH or 1-7/8 inch BTS22TH for support.

2. Custom design system to fit piping, conduits, equipment, or walkways to be installed and actual conditions of service and loading.
 3. Piping Supports: Provide suitable hangers and supports.
 4. Duct and Equipment Supports: Factory fabricated to support exact duct sizes and equipment to be installed.
 5. Walkways and Platforms: Provide galvanized slotted metal grating, in configurations as indicated, and tubular handrails where indicated.
- B. Bases: Injection molded high density, high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
1. Moisture Content: Negligible.
 2. Shrinkage/Swelling Due to Moisture: Negligible.
 3. Density: 55.8 lb/cu ft.
 4. Insect Resistance: No known insect damage potential.
 5. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid) No visual or physical change apparent.
 6. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
 7. Sized as required by loading conditions and as indicated on the drawings.
 8. Shop fabricated with inserts for square tubing or threaded rods as required.
 9. Color: Integral black color as molded.
 10. Bases for Mechanical Attachment: Sealant chamber around penetration point, with injection port for sealing after fastening; beveled lip for sealant bead around entire diameter.
 11. Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.
- C. Steel Framing:
1. Channel Types: 1-5/8 inch B22TH or 1-7/8 inch BTS22H, as required for loading conditions.
 2. Thickness: 12 gage.
 3. Form: Roll-formed 3-sided or tubular channel, perforated with 9/16 inch holes at 1-7/8 inch centers on three sides.
 4. Finish: Hot dip galvanize in accordance with ASTM A 123 after fabrication, free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets, and other surface blemishes.
 5. Do not use tubing or tube steel.
- D. Stainless Steel Framing:
1. Channel Types: 1-5/8 inch or 1-7/8 inch, as required for loading conditions.
 2. Thickness: 12 gage.
 3. Form: Roll-formed 3-sided or tubular channel.
 4. Finish: Mill finish.
 5. Do not use tubing or tube steel.
- E. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
1. Fabricated of carbon steel where framing is carbon steel; fabricated of stainless steel where framing is stainless steel; finished same as framing.

2. Sizes 2-1/2 inch and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
 3. Sizes 3 inch and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
- F. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
1. Carbon Steel: Hot-dip galvanized in accordance with ASTM A 153/A 153M.
 2. Stainless Steel: Mill finish.
 3. For Mechanical Fastening to Deck: On wood and steel decks, use bolts with steel plate to attach to deck; on concrete decks use threaded rods and adhesive anchors, with rod embedded at least 1-3/4 inches into concrete.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that roofing system is complete and that roof surfaces are smooth, flat, and ready to receive work of this section.
- B. Verify that roof surface temperature is at minimum 60°F for proper adhesive performance.

3.2 PREPARATION

- A. Clean surfaces of roof in areas to receive portable support bases.
 1. Sweep loose gravel from gravel surfaced roofs.
 2. Remove dirt, dust, oils, and other foreign materials.
- B. Use care in handling portable support system components during installation, to avoid damage to roofing, flashing, equipment, or related materials.

3.3 INSTALLATION

- A. Pipe, Duct, Cable, and Equipment Support Systems
 1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducting, and conduit; whether or not all required devices are shown.
 2. The use of wood for supporting piping is not permitted.
 3. Provide support spacing so deflection of piping does not exceed 1/240 of span.
 4. Install framing at spacing indicated, but in no case at greater than 8 feet on center.
 5. Accurately locate and align bases.
 - a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive, if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach, if required by code.
 - e. Where applicable, replace gravel around bases.
 6. Set framing posts into bases and assemble framing structure as indicated.
 7. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.
- B. Duct Support Systems
 1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducting, and conduit, whether or not all required devices are shown.
 2. Accurately locate and align bases.

- a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive, if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach, if required by code.
 - e. Where applicable, replace gravel around bases.
- 3. Place pre-assembled support onto bases, attaching framing post to base bracket with 1/2 inch bolts provided, and adjust as needed. Support shall be adjustable to maintain existing elevation and slope.
- 4. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.
- C. Walkway, Crossover & Equipment Platform Access
 - 1. Install substructures at spacing indicated, but not greater than 5 feet on center.
 - 2. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all structures.
 - 3. Accurately locate and align bases.
 - a. Consult manufacturer of new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive, if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach, if required by code.
 - e. Where applicable, replace gravel around bases.
 - 4. Set legs of substructures into bases as indicated.
 - 5. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.
 - 6. Layout and fasten planking to substructures.
 - 7. Where handrails are required, install as follows:
 - a. Install intermediate rails without tightening.
 - b. Make minor adjustments as needed, such as spacing of substructures to accommodate intermediate handrails, and install hold-downs.
 - c. Secure intermediate handrails and install top handrails.

3.4 FIELD QUALITY CONTROL

- A. Provide a factory-trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the manufacturers design and installation requirements. Provide results of inspection to architect/engineer in writing of inspection.

3.5 CLEANING AND PROTECTION

- A. Remove all packaging, unused fasteners, adhesive and other installation materials from the project site.
- B. Remove adhesive from exposed surfaces of supports and bases, and leave the work area in clean condition.
- C. Provide protection as required, leaving the work area in undamaged condition at the time of completion of work.

END OF SECTION

12-10-25

SECTION 20 05 33 - ELECTRIC HEAT TRACING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division I Specifications section, apply to work of this section.

1.02 DESCRIPTION OF WORK

- A. Extent of electric heat tracing work is indicated by drawings and the requirements of this section. Provide electric heat tracing as follows:
 - 1. At Backflow preventers.
 - 2. At plumbing system utilities/piping located in areas subject to freezing.
 - 3. At fire water piping located in areas subject to freezing.

1.03 QUALITY ASSURANCE

- A. Manufacturer's: Firms regularly engaged in manufacture of electric heat tracing cables, of types and sizes required, whose products have been in satisfactory use in similar service.
- B. Installer: Qualified with successful installation experience on projects with electric heat tracing cable similar to that required for projects.
- C. NEC Compliance: Comply with NEC (NFPA No. 70) applicable to installation of electric heat tracing cables.
- D. UL Compliance: Provide electric heat tracing cables which are UL-listed and labeled.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's data on electric heat tracing cables.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Protect electric heat tracing cables from damage during shipping and handling.
- B. Store electric heat tracing cables in original cartons and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

PART 2 PRODUCTS

2.01 ELECTRIC HEAT TRACING CABLE

- A. Electric Heat Tracing Cable: The self-regulating heater shall consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating, to be used directly on plastic pipe, and to be cut to length in the field. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket.
- B. Regulation: In order to provide energy conservation and to prevent overheating, the heater shall have a self-regulating factor of at least 90 percent. The self-regulating factor is defined as the percentage reduction, with thermostatic control, of the heater output going from 40-degrees F. pipe temperature operation to 150-degrees F. pipe temperature operation.
- C. Electrical: The heater shall operate on line voltage of 120 volts without use of transformers.
- D. Capacity: The heater shall be sized in accordance to the following table. The required heater output rating is in watts per foot at 50-degrees F. (heater selection based on minimum 1" fiberglass or equivalent insulation on metal piping).

<u>PIPE SIZE</u>	<u>MINIMUM AMBIENT- 10 DEGREES F.</u>
4 inch or less	5 watt
5 inch or 6 inch	8 watt
8 inch	2 strips - 5 watt
10 to 14 inch	2 strips - 8 watt

- E. Accessories: Power connection and end seal kits components shall be applied in the field.
- F. Controls: The system shall be controlled by an ambient sensing thermostat set a 40-degrees F.
- G. Pump Installation: For pump installation utilize heater designated for 6" pipe.
- H. Manufacturer's:

Chromalox	Series RTSR
Pyrotenax	Series SR
Raychem	Series 8XC

PART 3 EXECUTION

3.01 INSTALLATION

- A. Apply the heater linearly on the pipe under insulation after piping has been successfully pressure tested. Apply "electric traced" signs to the outside of the thermal insulation.
- B. Install in strict accordance with manufacturer's recommendations.

3.02 TESTS

- A. After installation and before and after installing the thermal insulation, subject heat to testing using a 1000 VDC megger. Minimum resistance shall be 20 megaohms regardless of length. Replace faulty cable.

END OF SECTION

12-10-25

SECTION 20 0548 - VIBRATION ISOLATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.01 GENERAL

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Work Included:
 - 1. Isolation Pads
 - 2. Spring Isolators
 - 3. Spring Hangers
 - 4. Inertia Bases

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - General Provisions.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Spring Hangers
 - 2. Vibration Isolators
 - 3. Inertia Bases

PART 2 PRODUCTS

2.01 SOLE SOURCE

- A. All isolators and bases shall be from same manufacturer.

2.02 DEFLECTION

- A. All spring isolators shall have 1" min. deflection unless otherwise specified.

2.03 TYPE I ISOLATORS

- A. Type I Isolators shall be neoprene waffle embossed pads with crossed double ribs. A steel shim plate shall be provided between the two layers. Pads shall be molded using oil resistant 25,000 PSI tensile strength neoprene. Pads shall be:

Kinetics Noise Control	NPD Series
Amber Booth	NP-NR Series
Mason Industries	WMW Series

2.04 TYPE II ISOLATORS

- A. Type II Isolators shall be double deflection neoprene type designed for loading in both shear and compression. Isolator shall be one piece molded assembly with ribbed base plate and top. Isolators shall be:

Kinetics Noise Control	RD Series
Amber Booth	NRV Series
Mason Industries	ND Series

2.05 TYPE III ISOLATORS

- A. Type III Isolators shall be free-standing, un-housed, laterally stable steel springs incorporating leveling bolts and 1/4" thick ribbed neoprene isolation pads. The spring shall have a lateral spring stiffness, and shall be designed to provide 50% overload capacity over 5000 lbs. Springs shall be welded to the top and bottom load plate assemblies. Isolators shall be:

Kinetics Noise Control	FDS Series

Amber Booth	SW Series
Mason Industries	SLFH Series

2.06 TYPE IV ISOLATORS

- A. Type IV Isolators shall be vertically restrained steel springs incorporating leveling blots, 1/4" thick ribbed noise isolation pads, and steel housing. Springs shall be designed to provide 50% overload capacity over 5000 lbs. Springs shall be welded to the top and bottom load plates assemblies. Assembly for outdoor installation shall be hot dipped galvanized after fabrication. Isolators shall be:

Kinetics Noise Control	FLS Series
Amber Booth	CT Series
Mason Industries	SLR Series

2.07 TYPE V ISOLATORS

- A. Type V Isolators shall be combination spring and neoprene hangers, incorporating double deflection neoprene noise and vibration pads in series with the springs, all encased in welded steel brackets. Springs shall be designed for 50% overload capacity, and shall accommodate rod misalignment over a 30 degree arc. Brackets shall be designed to carry 50% overload without failure. Isolators shall be:

Kinetics Noise Control	SRH Series
Amber Booth	BSR Series
Mason Industries	DNSH Series

2.08 TYPE VI THRUST RESTRAINTS

- A. Type VI Thrust Restraints shall be un-housed, laterally stable steel spring with 1/4" thick ribbed neoprene isolation pad in a steel frame. Spring shall be designed to provide 50% overload capacity over 5000 lbs. Units shall be factory set for thrust anticipated and adjusted in the field for a maximum 1/4" movement. Unit shall be provided with two rods and angle brackets for mounting. Thrust restraints shall be:

Kinetics Noise Control	HSR Series
Mason Industries	WB Series

2.09 TYPE VII STRUCTURAL STEEL BASE

- A. Type VII Structural Steel Base shall have isolator support brackets and pre-packed and drilled anchor bolt holes. Isolators support brackets shall be welded to structural steel bases shall be rigid, distortion free and mounted on Type III Isolators - six isolators per base minimum. Bases shall be:

Kinetics Noise Control	SFB Series
Amber Booth	SW Series
Mason Industries	WFSL Series

2.10 TYPE VIII INERTIA BASES

- A. Type VIII Bases shall be reinforced concrete inertia bases, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating pre-located equipment anchor bolts, 1/2" diameter reinforcing bars (nominal 8" centers each way) and recessed isolator mounting brackets to reduce the mounting height of the equipment but yet remain within the confines of the base. The thickness of the base shall be a minimum of 1/12th of the longest span of the base, but not less than 6 inches. Where inertia bases are used to mount pumps, the bases shall be wide enough to support piping elbows. Anchor bolts for supporting equipment shall be welded to the reinforcing bars. Bases shall be:

Kinetics Noise Control	CLB Series
Amber Booth	CPF Series

PART 3 EXECUTION**3.01 INSTALLATION**

- A. All isolation products shall be installed in accordance with the manufacturer's installation instructions.
- B. All spring-mounted equipment shall be leveled.
- C. Type II isolators shall be bolted to the floor or base and to the equipment or equipment base.
- D. Type III isolators shall be bolted to the floor or base and to the equipment and base.
- E. Type IV isolators shall have the bottom plate bolted to the structure and the top plate tack welded to the equipment rails in four places.
- F. Type V isolators shall have jam nuts on the top and bottom rods to prevent movement of nuts.
- G. Type VI thrust restraint shall have angle brackets welded or bolted to equipment, duct or structure, as applicable.
- H. Type VII and VIII bases shall be bolted to the equipment.

3.02 ISOLATION SCHEDULE

- A. Isolators and bases shall be installed on equipment and piping as indicated on schedule below:

ITEM	ISOLATOR	BASE	NOTES	MIN. DEFLECT.
AIR HANDLERS	I I	----	2	1.50 IN.
FAN	V	----	----	0.75 IN.
CONDENSING UNITS	I	----	----	

- B. Schedule Notes:

1. Provide additional vibration isolators as recommended by equipment manufacturers.
2. Not used.
3. Spring vibrations isolators not required if AHU unit fan internally isolated (factory fabricated) and AHU equipped with uniform equipment rail and piping serving these AHU's. Provide type I isolators in lieu of type III if fan is internally isolated.
4. Not used.

END OF SECTION

12-10-25

SECTION 20 05 53 - IDENTIFICATION OF PIPING, VALVES AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. Work Included:
 - 1. Valve Tags
 - 2. Pipe Bands
 - 3. Equipment Labels

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - *GENERAL REQUIREMENTS*, AND Section 200100- *GENERAL PROVISIONS*.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Valve Tags
 - 2. Pipe Bands

1.4 QUALITY ASSURANCE

- A. Standards:
 - 1. American National Standards Institute (ANSI):
 - a. Standard A13.1, The Scheme for Identification of Piping Systems, 1981 Edition.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe identification shall comply with ANSI A13.1.

2.2 VALVE TAGS

- A. Valve tags shall be 18 gauge (minimum) brass with 1 1/4" (minimum) height and width. Identification letters and numbers shall be stamped in tag and shall be filled with black enamel paint. Valve tags shall be:

Emedco	CB/W Series
Seton	Valve Tags
Brady	Valve Tags

- B. Valve tag shape and designations shall be as indicated in Table I, hereinafter.

2.3 PIPE BANDS

- A. Pipe identification bands shall be snap-on type with clear polyester exterior surface. Bands shall be of size, color and background as outlined in Table II and III, hereinafter, with directional flow arrows and legends. Identification bands on pipe or coverings 5 1/2" or less in diameter shall have stainless steel spring fasteners. Pipe identification bands shall be:

Seton / Setmark	SNA / STR
Series Brady	Snap-on Series

- B. Contractor has option to use Seton Custom Opti-Code Self-Adhesive Pipe Markers in lieu of snap on labels, Seton style M4154. Secure with additional cable tie (minimum two (2) per label).

2.4 EQUIPMENT LABELS / TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved white letters on black contrasting background color. Tag size minimum 1 ½ inch (40 mm) wide, length as required, with lettering minimum 3/4" tall.

2.5 TAPE

- A. Identification tape shall be vinyl pressure sensitive type with adhesive backing. Tape width shall be a minimum of 2". Tape shall be color to match pipe identification band background. Tape shall be:

Emedco	T100 Series
Seton	PST Series
Brady	Tape

2.6 CABLE TIES

- A. Cable ties for valve tag attached shall be self-locking nylon ties. Cable ties shall be:

Thomas & Betts	Ty-Rap-Nylon
Ideal	Double Lock Cable (Plain Head)
Efcor	Sure-Ty Self-Locking Cable Ties

2.7 VALVE CHART

- A. Valve chart shall be typed listing of all valve tags. List shall include identification number, valve location in system (e.g., water heater, chilled water pump, etc.) And its function (e.g., shut-off, balancing, drain, etc.). Chart shall be mounted in a wooden frame with glass cover. Chart shall be mounted where shown on the drawings.

2.8 IDENTIFICATION

- A. Valve tags shall be installed at all shut-off, balancing, metering, and drain valves in the following systems:

TABLE 1 - VALVE TAGS

<u>SYSTEM</u>	<u>SHAPE</u>	<u>IDENTIFICATION NUMBER</u>
Natural Gas	Octagonal	NG - 1, 2, 3, ...
Domestic Cold Water	Hexagonal	CW - 1, 2, 3, ...
Domestic Hot Water	Hexagonal	HW - 1, 2, 3, ...
Domestic Hot Water Circulation	Hexagonal	HWC - 1, 2, 3, ...
Domestic Tempered Water	Hexagonal	TW - 1, 2, 3, ...
Domestic 110 degrees F Hot Water	Hexagonal	110 - 1, 2, 3, ...
Domestic 140 degrees F Hot Water	Hexagonal	140 - 1, 2, 3, ...
Fire Sprinkler	Rectangular	AS - 1, 2, 3, ...

- B. Pipe identification shall comply with ANSI A13.1 - 1981 Standard entitled "Scheme for Identification of Piping Systems." Pipe identification bands shall be installed on piping at each valve, each piece of equipment, each change of direction, wall penetration, each branch take-off, and at a maximum spacing of 15 feet on exposed straight run piping. Pipe bands shall be installed on systems indicated below. Install on all piping exposed in mechanical rooms & above all ceiling, all piping to receive labels & directional flows arrows.

TABLE II - BAND AND LETTER SIZE

<u>PIPE OR PIPE COVERING</u>	<u>WIDTH OF BAND</u>	<u>LETTER & NUMBER SIZE</u>
<u>DIAMETER (inches)</u>	<u>(Inches)</u>	<u>(inches)</u>
3/4 to 1 1/4	8	1/2
1 1/2 to 2	8	3/4
2 1/2 to 6	12	1 1/4
8 to 10	24	2 1/2
Over 10	32	3 1/2

TABLE III - BAND COLORING

<u>PIPE</u>	<u>BAND</u>	<u>LETTERING</u>	<u>LETTER COLORING</u>
Natural Gas (Inside Buildings)	Safety Yellow	NATURAL GAS	Black
Gas Valves on Interior to be painted	Meter Gray		
Natural Gas (Outside Building)	Meter Gray	NATURAL GAS	Black
Gas Valves on exterior to be painted	Safety Yellow		
Refrigerant Suction	Yellow	REF. SUCTION	Black
Refrigerant Liquid	Yellow	REF. LIQUID	Black
Domestic Cold Water	Green	DOM. COLD WATER	White
Domestic Hot Water	Yellow	DOM. HOT WATER	Black
Domestic Hot Water Circulation	Yellow	CIRCULATION WATER	Black
Domestic Tempered Water	Green	TEMPERED WATER	White
Domestic 110 degree Water	Yellow	110 - HOT WATER	Black
Domestic 140 degree Water	Yellow	140 - HOT WATER	Black
Fire Sprinkler	Red	SPRINKLER - FIRE	White

- B. Equipment identification labels with 2" high letters shall be installed on the following equipment:

TABLE IV - EQUIPMENT LABELS

<u>ITEM</u>	<u>BAND</u>	<u>LETTERING</u>	<u>LETTER COLORING</u>
AHU's, VRF Units, Domestic Hot Water Heaters, Etc. & Misc. Mech/Plumbing/Fire Suppression Equipment.	Yellow	See Equipment Schedules	Black

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valve tags shall be attached to the handwheel with cable ties.
- B. Plastic pipe bands shall be wrapped around pipe or pipe covering under pressure so that no gaps or wrinkles occur. Bands on pipe or pipe covering 6" or smaller shall overlap and adhere to themselves. Bands on pipe or pipe covering larger than 6" shall be further secured at both ends with tape. Tape shall overlap and adhere to itself.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

- D. Install tags with corrosion resistant chain.
- E. Install plastic pipe markers in accordance with manufacturer's instructions.
- F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- H. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify valves in main and branch piping with tags or numbered plastic nameplates.
- K. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 15 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.

3.2 PAINTING

- A. All surfaces requiring painting shall be left clean by the Mechanical Subcontractor. All painting shall be done by the General Contractor's painting Subcontractor. All exposed piping, grilles, or fans, in building or on roof will be painted. All insulated piping to be covered in color coated PVC Jackets, color to be determined by Owner. If owner has no preference, color to be same as band color in schedule. Paint pipe, equipment, hangers and accessories in Equipment Rooms including covering and foundations with two (2) coats of approved paint after thoroughly cleaning. Equipment having factory finish shall be touched up and given one (1) additional coat of machinery enamel color as selected. The above shall be done by the General Contractor. See Section PAINTING SECTION.
 - 1. Gas Piping will be painted using a high quality solvent based paint. Aerovoe "Direct to Metal" or approved equal paint. For all gas pipes located outside of a building or in an area exposed to the general public, pipes, meters and regulators will be painted Meter Gray with Key Valves painted Safety Yellow. For mechanical rooms, above ceilings and other inaccessible areas, the pipe will be painted safety yellow and gas valves and regulators will be painted meter gray. The contractor may use the exterior gray color in gyms or other similar conditions where aesthetics is a concern, coordinate with architect prior to painting. All new and existing gas piping shall be painted.
- B. All piping throughout project (HVAC, Plumbing, & Sprinkler) shall be identified with pipe markers with directional arrows. The color code shall be as per Table III above. Labels should appear every 10'-0" and at all changes in direction.
- C. Provide color coded PVC jackets, piping labels, & directional flow arrows on all insulated plumbing piping within mechanical rooms. PVC jacket color to match band color as specified in Table III within these specifications. Fire water piping to receive piping labels.

END OF SECTION

12-10-25

SECTION 20 07 00 - PIPE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping Insulation
- B. Jackets and Accessories

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Section 20 05 29 - Hangers and Support Devices

1.03 RELATED SECTIONS

- A. Section 20 01 00 - General Provisions

1.04 REFERENCES

- A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- C. ASTM C195 - Mineral Fiber Thermal Insulation Cement.
- D. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
- E. ASTM C449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.
- F. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- G. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- H. ASTM C547 - Mineral Fiber Performed Pipe Insulation.
- I. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
- J. ASTM C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.
- K. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing.
- L. ASTM C591 - Rigid Preformed Cellular Urethane Thermal Insulation.
- M. ASTM C610 - Expanded Perlite Block and Pipe Thermal Insulation.
- N. ASTM C640 - Corkboard and cork Pipe Thermal Insulation.
- O. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- P. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
- Q. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
- R. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
- S. ASTM E84 - Surface Burning Characteristics of Building Materials.
- T. ASTM E96 - Water Vapor Transmission of Materials.
- U. NFPA 255 - Surface Burning Characteristics of Building Materials.
- V. UL 723 - Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
- C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.06 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, and UL 723.

1.07 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 01600.
- B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cement.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 GLASS FIBER

- A. Manufacturers:
 - 1. Knauf - ASJ - SSL
 - 2. Owen Corning 25 ASJ/SSL
- B. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' value: ASTM C335, 0.23 at 75 degrees F.
 - 2. Minimum Service Temperature: -20 degrees F.
 - 3. Maximum Service Temperature: 850 degrees F.
 - 4. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket:
 - 1. ASTM C921, white kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Transmission: AST E96; 0.02 perm inches.
 - 3. Secure with self sealing longitudinal laps and butt strips.
 - 4. Secure with white vapor barrier tape and vapor barrier mastic.
 - 5. Provide bonds for identification per Section 15190 Requirements.
- D. Tire Wire: 16 gage stainless steel with twisted ends on maximum 12 inch centers.
- E. Indoor Vapor Barrier Finish
 - 1. Manufacturers:
 - a. Childers Model CP-30
 - b. Manville Model Insulkote
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- F. Outdoor Vapor Barrier Mastic
 - 1. Manufacturers:
 - a. Childers Model CP-30
 - b. Manville Model Insulkote
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- G. Fittings:

1. Mitered segments of insulation held in place with white vapor barrier tape and Zeston 25/50 PVC, knauf 25/50 rated PVC, pre-molded insulated fitting covers.

2.02 CELLULAR GLASS

- A. Manufacturers:
 1. Pittsburgh Model Foamglass
 2. Corning Model Foamglass
- B. Insulation: ASTM C552.
 1. 'K' value: 0.40 at 75 degrees F.
 2. Maximum Water Vapor Transmission: 0.1 perm.
- C. Vapor Barrier Jacket: Similar to Glass Fiber.
- D. All joints to be caulked and glued with a vapor barrier sealant as per manufacturer's recommendations.

2.03 POLYURETHANE FOAM

- A. Insulation:
 1. 'K' value: ASTM 518; 0.14 at 75 degrees F.
 2. Minimum Service Temperature: -250 degrees F.
 3. Maximum Service Temperature: 250 degrees F.
 4. Maximum Moisture Absorption: ASTM D2842; 0.054 percent by volume.
 5. Moisture Vapor Transmission: 1.26 perm inches.
 6. Maximum Flame Spread: ASTM E84; 20.
 7. Connection: Waterproof vapor barrier adhesive.

2.04 CELLULAR FOAM

- A. Manufacturers:
 1. Armstrong Armaflex 25/50.
 2. Aerotube 25/50.
- B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 1. 'K' value: ASTM C177 or C518; 0.27 at 75 degrees F.
 2. Minimum Service Temperature: 0 degrees F.
 3. Maximum Service Temperature: 220 degrees F.
 4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent (pipe) by volume, 1.0 percent (sheet) by volume.
 5. Moisture Vapor Transmission: ASTM E96; 0.20 perm inches.
 6. Maximum Flame Spread: ASTM E84; 25.
 7. Maximum Smoke Developed: ASTM E84; 50.
 8. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive
 1. Manufacturers:
 - a. Armstrong 520
 - b. Manville Elastomeric Adhesive
 2. Air dried, contact adhesive, compatible with insulation.

2.05 JACKETS

- A. PVC Plastic
 1. Manufacturers:
 - a. Proto

- b. Zeston
- 2. Jacket: ASTM C921; One piece molded type fitting covers and sheet material. See color chart in Section 15190 for jacket colors.
 - a. Minimum Service Temperature: -20 degrees F.
 - b. Maximum Service Temperature: 140 degrees F.
 - c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - d. Maximum Flame Spread: ASTM E84; 25.
 - e. Maximum Smoke Developed: ASTM E84; 50.
 - f. Thickness: 30 mil.
 - g. Connections: Brush on welding adhesive.
 - h. Fitting covers with inserts supplied by the manufacturers.
- 3. Covering Adhesive Mastic:
 - a. Manufactures:
 - 1. Proto PVC Glue.
 - 2. Zeston PVC Glue.
 - b. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: .020 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: ½ inch; 0.015 inch thick aluminum.
- C. Stainless Steel Jacket: Type 304 stainless steel.
 - 1. Thickness: 0.010 inch.
 - 2. Finish: Smooth.
 - 3. Metal Jacket Bands: ½ inch wide; 0.010 inch thick stainless steel.

2.06 AIR HANDLING UNIT ROOMS

- A. Finish and install over entire areas of walls/doors at occupied spaces of air handling rooms/elevator equipment rooms 2" thick acoustical type fiberglass hullboard insulation 3# density, applied over Stick-Klips 12" on center. Stick-Klips shall be applied to wall with Construction Adhesive. Acoustical material shall be applied over Stick-Klips with duct linear adhesive spotted between pins. Joints to be sealed with fiberglass lagging tape.
- B. Manufacturer:
 - 1. Nautica IMO PFG Acoustic Board as manufactured by RB, LLC.

2.07 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' ("ksi") value: ASTM C518, 0.29 at 75 degrees F.
 - 2. Maximum service temperature: 250 degrees F.
 - 3. Maximum moisture absorption: 0.20 percent by volume.
 - 4. Density: 0.75 lb/cu ft.
- B. Vapor Barrier Jacket
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.04 perm.
 - 3. Secure with pressure sensitive tape.
- C. Vapor Barrier Tape

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

D. Tie Wire: Annealed steel, 16 gage.

2.08 PLENUM RATED INSULATION

- A. Contractor to provide plenum rated insulation. Insulation to have a flame spread index of not more than 25 and a smoke developed index of not more than 50. Manufacturer to be Morgan Thermal Ceramics PlenumWrap+ or prior approved equal. Insulation shall be listed to UL 1887, NFPA 262 (UL910), and ASTM E84. PlenumWrap+ core blanket shall be manufactured using Morgan Thermal Ceramics's patented Superwool fiber, a 2000F rated, non-combustible, alkaline-earth silicate wool with low biopersistence. Insulation shall be OPL (Intertek) Listed, and be part of both OPL's and UL's Listing and Follow-up Service Programs to ensure the consistent quality essential to the critical nature of this life-safety application. Install in strict accordance with manufacturer's recommendations.

1. Thickness: 1/2"

2.09 APPROVED MANUFACTURERS

- A. Johns Manville, Knauf, DOW, Owens Corning

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. On exposed piping, locate insulation and cover seams in least visible locations.
- C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature.
 1. Provide vapor barrier jackets, factory applied or field application.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
 3. Finish with glass cloth and vapor barrier adhesive.
 4. PVC fitting covers shall be used.
 5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 6. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. For insulated pipes conveying fluids above ambient temperature:
 1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 3. Finish with glass cloth and adhesive.
 4. PVC fitting covers shall be used.
 5. For hot piping conveying fluids below 140 degrees F, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- E. Inserts and Shields:
 1. Application: All piping.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert Location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert Material: ASTM C640 cork or other heavy density insulating material suitable for the planned temperature range.
- F. Finish insulation at supports, protrusions, and interruptions.
- G. For plumbing pipe exposed in mechanical equipment rooms, garage, or in exposed finished spaces, finish with color coded PVC jacket and fitting covers. Color to be as indicated in Section 230553 - Identification of Piping, Valves and Equipment.
- H. For exterior applications, provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- I. Not used.
- J. All Plumbing piping to have PVC color coded jacket within mechanical rooms.

3.03 TOLERANCE

- A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.04 GLASS FIBER INSULATION SCHEDULE

<u>SYSTEMS</u>	<u>PIPE SIZE (inch)</u>	<u>THICKNESS (inch)</u>
1. Domestic Hot Water	½" thru 1-1/4"	1"
2. Domestic Hot Water	1-1/2" & Larger	1-1/2"
3. Domestic Cold Water	All	1"

Note: 1. All piping exterior to building (above grade, excluding refrigerant piping) shall be covered in 16 mil aluminum jacket with premolded aluminum fittings, no PVC (Zeston) fittings allowed.

2. All Plumbing piping to have PVC color coded jacket within mechanical rooms.

3.05 CELLULAR FOAM INSULATION SCHEDULE

<u>SYSTEMS</u>	<u>PIPE SIZE (inch)</u>	<u>THICKNESS (inch)</u>
1. Water Piping (exposed to weather)	½" - 4"	1"
2. Condensate Drain Lines	All Sizes	1"
3. Refrigerant Piping	All Sizes	1"

Note: 1. All piping exterior to building (above grade, excluding refrigerant piping) shall be covered in 16 mil aluminum jacket with premolded aluminum fittings, no PVC (Zeston) fittings allowed.

2. All insulated refrigerant lines exterior to building to receive two (2) coats of Aerocel Aerocoat pure acrylic emulsion paint. Allow 4 hours drying time in between coat applications.

3. All Plumbing piping to have PVC color coded jacket within mechanical rooms.

4. Insulate suction & vapor lines on VRF systems in strict accordance with VRF manufacturer recommendations.

3.06 CELLULAR GLASS INSULATION SCHEDULE

A.	SYSTEMS PIPE	SIZE (inch)	THICKNESS (inch)
	1. Not used.		

3.07 PLENUM RATED INSULATION SCHEDULE

<u>SYSTEMS</u>	<u>PIPE SIZE (inch)</u>	<u>THICKNESS (inch)</u>

1. Sanitary Sewer Waste Piping	All Sizes	1/2"
2. Sanitary Sewer Vent Piping	All Sizes	1/2"
3. Roof Drainage Piping	All Sizes	1/2"

**All noncompliant ASTM E84 piping within return air plenum shall receive 1/2" thick plenum rated insulation.*

3.08 LAVATORY P-TRAP AND SUPPLY LINES

- A. Insulate P-trap, tailpiece and water supplies on all lavatories with Truebro Model 102, Handi Lav-Guard, Bocar "Trap Wrap" or approved equivalent insulating system.
- B. All wall hung lavatory's are to come with Truebro Lav-Shield in lieu of Lav-Guard, no exception.

3.09 PIPE SUPPORTS

- A Contractor shall insulate down minimum 12" for all pipe supports in direct contact with HVAC water piping with same material and jacket as pipe insulation.

3.10 WASTE LINE P-TRAPS

- A. P-traps receiving HVAC condensate and associated horizontal waste lines shall be insulated with fiberglass ductwrap insulation with aluminum foil vapor barrier. Insulation shall be sealed at all seams and joints.

3.11 FLEXIBLE GLASS FIBER PIPE INSULATION SCHEDULE

<u>LOCATION</u>	<u>THICKNESS (inch)</u>	<u>FINISH</u>
1. Roof Drain Piping (Horizontal run only) and Bottom of Roof Drains	1 1/2"	Foil Faced

END OF SECTION

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SECTION 20 21 16 - PIPING SPECIALTIES

PART 1 GENERAL

1.01 GENERAL

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Work Included:
 - 1. Piping specialties for plumbing and HVAC systems.

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Strainers
 - 2. Pressure Reducing Valves
 - 3. Air Vents
 - 4. Dielectric Adapters
 - 5. Thermometer and Test Wells
 - 6. Pressure Gauges and Gauge Cocks
 - 7. Triple Duty Valve
 - 8. Suction Diffuser
 - 9. Expansion Tank

1.04 QUALITY ASSURANCE

- A. Standards
 - 1. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels.
 - 2. American Society for Testing and Materials (ASTM):
 - a. Standard A53, Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
 - b. Standard A74, Cast Iron Soil Pipe and Fittings.

PART 2 PRODUCTS

2.01 STRAINERS

- A. All strainers, except those installed as integral part of equipment, shall be the product of a single manufacturer.
- B. Y-Type Strainers:
 - 1. Strainers 2 inches and smaller shall be iron-body with screwed end connections and screwed plug in blow-off. Strainers shall be rated for 400 pounds minimum and 250 pounds minimum SWP. Screens for water and steam service shall be 20 mesh model. Strainers shall be:

Keckley	Style B
Metraflex	Style S
Mueller	No. 11-FCB
Spirex Sarco	Type IT
 - 2. Strainers 2 1/2 inches and larger shall be iron-body with 125-pound flanged end connections for installation between 150-pound raised face slip-on weld flanges. Strainers shall be rated for 175-pound minimum WOG and 125-pound minimum SWP. Strainers

shall have blow-down connection which shall be provided with full size gats valve. Strainers shall be equipped with perforated baskets or perforated baskets lined with mesh screens. Strainer screens and baskets shall be stainless steel in accordance with the following:

<u>Size</u>	<u>Service</u>	<u>Perforation Diameter</u>
2-1/2", 3"	Water	.033"
	Air or Gas	.009"
4", 5"	Water	1/8"
	Air or Gas	.033"
6", 8"	Water	1/8"
	Air or Gas	3/64"
10", 12"	Water	1/4"

Strainers shall be:

Schade Davis	No. 78M
McAlear	No. 528-8
Keckley	Style D
Metra Flex	Series M1
Mueller	No. 751 to 12", No. 752 14" & larger
Spirex Sarco	Type C1-125

C. Basket Strainers: Not Used.

2.02 PRESSURE REDUCING VALVES

- A. Pressure reducing valves shall be field adjustable with outlet pressure set as specified hereinafter or as indicated on drawings.
- B. All internal parts subject to wear shall be replaceable without removing the pressure reducing valve from the piping.
- C. For Heating and Air Conditioning:
 1. Not used.
- D. For Plumbing Systems
 1. Type "A" pressure reducing valves for water service shall be diaphragm actuated type with bronze body and 150 psi (minimum) working pressure. Valves shall have an adjustable outlet pressure range of not less than 10-35 psi. Valves shall be:

Watts U5LP
A.W. Cash Type E Series 3
 2. Type "B" pressure reducing valves for water service shall be diaphragm actuated type with bronze body and 150 psi (minimum) working pressure. Valves shall have an adjustable outlet pressure range of not less than 35 to 75 psi. Valves shall be:

Watts No. 223-S Series
A.W. Cash Type E Series 3
 3. Type "C" pressure reducing valves for compressed air service shall be diaphragm actuated type with an adjustable outlet pressure range of not less than 0 to 200 psi. Valves shall be:

Watts No. 199 Series
A.W. Cash Type E-55 Series
 4. Plumbing contractor shall provide pressure reducing valve at dishwasher prior to connection to hot water line.

2.03 AIR VENTS

- A. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; working pressure; operating temperature; with discharge connection and inlet connection. Air vents shall be:
- Armstrong No. 71
Hoffman No. 78
Thrush No. 8
Taco No. 424
- B. Manual Air Vent: Bronze body and nonferrous internal parts; working pressure; operating temperature; manually operated with screwdriver or thumbscrew; with discharge connection and inlet connection.

2.04 DIELECTRIC ADAPTERS

- A. Dielectric adapters shall be the union type for pipes 2" in size and smaller and flanged type for pipes 2-1/2" in size and larger. Adapters shall have a working pressure of 250 psi for union type and 175 psi for flanged type. The insulating gasket shall have an operating range of 40°F to 240°F and shall limit the galvanic corrosion to a maximum of 1% of the short circuit current.

2.05 THERMOMETER AND TEST WELLS

- A. Thermometers:
1. Thermometers shall be the blue-reading spirit-filled adjustable angle type. Thermometer shall be adjustable to any angle through a 180° arc and shall be provided with a locking device.
 2. Thermometers shall have V-cast aluminum case with baked enamel separable sockets and where installed on insulated pipes, sockets shall be extension neck type to provide for 2" thick insulation.
 3. Thermometer scale range shall be
 - a. Not used.
 - b. Chilled Water System - 0-100°F
 - c. Domestic Water Systems - 30-240°F
 - d. Not used
 4. Thermometers shall be:

Weksler Adjust-Angle Series Type AA-5
Trerice Adjustable Angle Series Type BX
Weiss Vari-Angle Series Type BS
- B. Test Wells:
1. Test wells shall be for use with engraved stem thermometers. Test wells shall be brass and shall be provided with cap and chain with gasket for sealing when not in use.
 2. Wells installed in insulated pipes shall be extension neck-type to provide for 2" thick insulation.

2.06 PRESSURE GAUGE AND GAUGE COCKS

- A. Pressure Gauges
1. Gauges shall be flangeless type and shall have 4-1/2 dials, cast aluminum cases, stainless steel rotary gear movements, phosphor bronze bourdon tubes, forged brass rod sockets and tips, 1/2% accuracy of scale range, Plexiglass dial covers, safety blow-out disc and 1/4 inch lower connections.
 2. Gauges in pump suction line shall be the compound type. Gauges in all other locations and discharge shall be the plain pressure type.
 3. Range for pressure gauges shall be selected so that the normal operating point for each application falls in the approximate midpoint of the gauge range. Shop drawings shall indicate ranges.
 4. Gauges shall be:

Weksler Type AA1
Trerice No. 500X Series
Weiss Series PG

B. Gauge Cocks:

1. Gauge cocks shall be brass lever handle type. Gauge cocks shall be:

Weksler Type A
Trerice No. 880
Weiss type LC

2.07 TEMPERATURE/PRESSURE TEST FITTINGS

- A. Fittings shall be the combination temperature pressure test type with brass body, self-sealing EPDM gasket, threaded connections and cap. Temperature/Pressure Test Fittings shall be:

Pete's Plug	
Sisco	P/T plug
Fairfax	Test plug

2.08 PIPE SLEEVES

A. Pipe Sleeves

1. Sleeve size shall be such as to provide an annular space of the sleeve and the passing pipe or pipe insulation.
2. Sleeve material shall be as follows:
 - a. In walls below grade: Schedule 40 black steel pipe, ASTM A53.
 - b. In concrete floors on grade: Service weight cast-iron pipe, ASTM A74.
 - c. In walls and partitions above grade: 20-gauge galvanized sheet steel with lock-type longitudinal seams.
 - d. In concrete floors above grade: 20-gauge galvanized sheet steel with lock-type longitudinal seams.
 - e. In concrete roofs: Service weight cast-iron pipe, ASTM A74.

2.09 FLOOR, WALLS AND CEILING PLATES

- A. Escutcheons shall be chrome-plated steel plates, hinged type with set screw.
- B. Escutcheons for chrome-plated connections at plumbing fixture shall be as specified under the plumbing fixtures.

2.10 FLEXIBLE CONNECTIONS

- A. Provide flexible rubber, single arch connection in piping to all pumps, etc., as shown on plans complete with control rods. Flexible connections shall be constructed with Nitrile (Buna N) tube, neoprene cover; zinc plated steel flange and steel bead flange retainer.
- B. Joints shall be rated for a maximum of 210 psig and 240° F for sizes 1 1/2 thru 12. Flexible connectors shall be manufactured by Metraflex "Metrashpere" or Southeastern Hose #SEMC, Twin Hose approved equal.

2.11 EXPANSION TANKS

- A. Not used.
- B. Thermal Expansion Tank (Plumbing Systems)
1. Furnish and install as shown on drawings a pre-charged steel thermal expansion tank with a fixed FDA approved butyl bladder. The tank shall have a top NPT stainless steel system connection and a charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 150 psi working pressure.
 2. Thermal expansion tank to limit the pressure of the water being heated to no more than 80 pounds per square inch as required per section 613.2 of the International Plumbing Code (Current Edition)

3. Tanks shall be:

Wessels TTA Series

TACO, Bell & Gossett

2.12 AIR AND DIRT SEPARATORS

- A. Not used.

2.14 TRIPLE DUTY VALVES

- A. Not used.

2.15 AUTOMATIC FILL VALVE

- A. Not used.

2.16 HYDRONIC COIL VALVE PACKAGE

- A. Not used.

2.17 AUTOMATIC FLOW CONTROL VALVES

- A. Not used.

2.18 DOMESTIC WATER MULTI-TURN FLOW CONTROL VALVE

- A. General: Contractor shall provide and install certified low lead multi-turn flow control valves at all locations as specified in the construction documents.
- B. Multi-Turn Flow Control Valves – Low Lead:
1. Manual Flow Control devices shall be Multi-turn balancing type accurate to at least $\pm 5\%$.
 2. MFCV $\frac{1}{2}$ " – 1" shall be forged DZR Lead Free brass Y-pattern globe style with (2) pressure/temperature test ports, visual turns indicator, locking handle tag, and rated at 600 PSI WOG, 325 degrees F. Valves shall be available with NPT connections; like Nexus UltraMB™ (Model MBNL.)
 3. Valve shall contain less than 0.25% lead content by weight on wetted surfaces in accordance to NSF-61 for hot and cold potable water service, and shall be certified to meet to the requirements of NSF-372.
 4. Provide extended pressure and temperature test plugs and handles.
 5. Valve shall carry a LIFETIME product warranty.
 6. Approved Manufacturers: a. Nexus Valve, Inc. or prior approved equal.
 7. Balance to Flow Rate (GPM) as noted on Plumbing Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. All equipment shall be installed where indicated on the drawings and shall be installed in accordance with manufacturer's instructions.
- B. Unless otherwise indicated on the drawings, thermometers and pressure gauges shall be installed no higher than 8 feet above finished floor. Final position of each thermometer and pressure gauge shall be such that it is readable from the floor.
- C. Pipe sleeves in walls, partitions and roofs and in floors on grade shall be cut flush with each surface except where clamping flanges are used. Sleeves through floors above grade shall be cut flush with the underside of the floor and shall extend 1" above the top side of the floor. Where pipes penetrate existing slabs above grade, install a 2" high concrete water dam around pipe.
- D. Except where otherwise specified, pipes passing through concrete and masonry walls, concrete and masonry partitions, concrete floors and roofs, and fire rated gypsum board or plaster partitions shall be provided with pipe sleeves which shall be installed at the time of construction of walls, partitions, floor or roof. Sleeves are not required for water and waste connections through a wall or partition to an individual fixture not for cast-iron pipe through concrete slab on grade. Sleeves shall not be installed in structural members except where specifically indicated or approved by the Architect. The annular spaces between pipe and sleeve and between insulation and sleeve, including drain pipes at water closets, shall be sealed. In addition,

penetrations through fire-rated walls and partitions and through floors above grade shall be packed solid with Fiberglass insulation behind a backup material and sealant.

- E. A strainer shall be provided on the inlet side of each pressure reducing valve. Pressure reducing valves provided with an integral strainer do not require a separate strainer.
- F. Air vents shall be installed at all high points in piping systems and elsewhere as indicated on the drawings. Inlet of each vent shall be equipped with pet cock to provide for manual operation. Provide U-Tube on air vent discharge made of soft drawn copper tubing.
 - 1. Provide manual air vents at all high points of system, including each branch of the piping system.
 - 2. Provide automatic air vents at high point of system within mechanical room and as shown on plans.
 - 3. All air vents installed above ceilings shall be manual type.
- G. Dielectric adapters shall be installed between copper and iron pipe connections and between ferrous and non-ferrous metal piping or equipment.
- H. Test wells shall be installed above the horizontal so as to hold oil and wells shall be filled with oil.
- I. Pressure gauges shall be connected to the piping system with threaded brass pipe and screwed brass fittings. Install gauge cock on inlet pipe to gauge. All gauges used on services exceeding 200°F shall be mounted on a brass pigtail siphon.
- J. Where exposed piping, bare or insulated, passes through floors, walls and ceiling, except in Mechanical rooms, escutcheons shall be provided.
- K. Contractor shall use domestic water multi-turn flow control valves to balance the domestic hot water system.
- L. Expansion tank shall be mounted as indicated on the drawing.
- M. Not used.
- N. All sanitary sewer piping routed up thru grade beams shall be down within cast iron pipe sleeve one pipe size larger than service pipe. Pack annular space between cast iron pipe and service piping with closed cellular foam insulation.

END OF SECTION

12-10-25

SECTION 21 03 03 - AUTOMATIC SPRINKLER SYSTEM

PART 1 GENERAL

1.1 GENERAL

- A. The General Conditions of the Contract and Supplementary Conditions of the Contract shall govern the work under this Section of the specifications. The Contractor is specifically directed to refer to said conditions.
- B. It is understood that these specifications, and the accompanying drawings, complete apparatus, fully erected and in successful operating condition. All work must be preformed in the best and most substantial manner.
- C. These specifications are intended to provide complete, and in proper operation, all sprinkler system piping, equipment, heads, valves, controls, and accessories, all as specified herein or shown on the accompanying drawings, or reasonably implied in either. The building shall be provided with complete coverage sprinkler system for the spaces designated on the drawings classification as required. System shall consist of calculated sprinkler systems unless indicated otherwise. Verify all pertinent criteria. The systems shall conform to layout shown and meet all requirements of agencies listed under "REGULATIONS AND STANDARDS" below. Refer to plans and specifications for additional information.

1.2 SYSTEM LAYOUT:

- A. Where plans indicate layout of system components, the layout shall be verified to comply with "REGULATIONS AND STANDARDS" and shall be revised if required to comply. All layout routes, pipe sizes, head locations, etc. are to be used as a guide, it shall be the sprinkler contractor's ultimate responsibility to design and size the sprinkler system in strict accordance with NFPA 13. Revisions shall be at Contractor's expense. Any such revisions shall be verified with the Architect.

1.3 ELECTRICAL WORK:

- A. See "COORDINATION".

1.4 SPRINKLER SYSTEM CONTRACTOR:

- A. It is intended that the work under this section is to be preformed by a qualified Fire Protection Piping Systems Contractor regularly engaged in this type of work. The Contractor is to hold a current license to perform this work and be certified by the State Fire Marshal. All documents shall bear this certification.

1.5 REGULATIONS AND STANDARDS:

- A. It is the intention of these specifications and the accompanying drawings, that all elements and features of the fire protection system shall be in accordance with the standards of the National Fire Association (NFPA), the State Fire Marshal, all applicable building codes, Owner's Insurance Agency and Property Insurance Association of Louisiana whether so indicated or not. NFPA standards are on file in office of Architect and may be examined at the Contractor's request.
- B. MANUFACTURER'S OR TRADE NAMES: Where the plans or specifications mention the names of manufacturers or the products of specific manufacturers, it is intended that the contractor shall furnish the item or items as specified. Products of manufacturers that are not mentioned shall be subject to prior review by the Architect and shall in any case mentioned shall be subject to prior reviews by the Architect as stated in Instruction to Bidders, page 1B-3, Paragraph 3.3 substitutions.

1.6 SHOP DRAWINGS AND SUBMITTAL DATA:

- A. Within fifteen (15) days of award of the contract, the contractor shall submit six (6) copies of system piping shop drawings and six (6) copies of manufacturer's data and descriptive literature and drawings for all equipment and materials. Additionally, provide a reproducible (sepia) copy of the system piping shop drawings. All drawings, literature and data on all equipment shall be submitted at the same time; this material shall contain complete layout, capacity data, dimensions and other pertinent information necessary for the Architect/Engineer to properly review and evaluate the

item that necessary to meet the requirements for submittal to the State Fire Marshall.

- B. The contractor shall obtain approval of agencies listed under "REGULATIONS AND STANDARDS" before submitting to the Architect, except that the date for State Fire Marshal's review shall be submitted to the Architect prior to submitting to the Fire Marshal. All required review fees and applicable requirements shall be by the contractor. No item of equipment or material shall be place on order until Final Review comments have been received from the Architect. See "DRAWINGS" below.

1.7 ORDINANCES, RULES AND REGULATIONS:

- A. All material and construction shall conform to the requirements of all building, plumbing and sanitary codes and laws in force in the locality in which the work is to be done. All materials and construction shall also conform to the rules and regulations listed above under "REGULATIONS AND STANDARDS".

1.8 DRAWINGS:

- A. The contractor shall submit detailed drawings for all sprinkler system showing exact locations and sizes of all elements in the system before fabrication is begun. Architect shall have the prerogative of changing the position or configuration of these systems without changing the total scope of work involved to comply with "REGULATIONS AND STANDARDS".
- B. Drawings shall provide the following data and catalog cuts:
 - 1. Project name and locations.
 - 2. Roof and ceiling construction.
 - 3. Water supplies and sizes.
 - 4. Make and type of sprinklers.
 - 5. Number of sprinklers on each riser and total per fire area.
 - 6. Make, type, model and size of alarm check valves, etc.
 - 7. Location of all risers, mains, lines, etc.
 - 8. Cutting length of pipe.
 - 9. Crosses, Tees, riser nipples and size.
 - 10. Type hangers and spacing.
 - 11. Hydraulic calculations.
 - 12. Siamese fire department connection.
 - 13. Underground sprinkler supply riser co-ordinate with foundation drawings.
 - 14. Valves.
 - 15. Inspection test stations.
 - 16. Location of spare sprinkler head cabinets and quantities to be provided of each type of head.

1.9 GUARANTEE:

- A. The contractor shall guarantee all materials and workmanship under this contract for a period of one (1) year from date of final acceptance of his work and shall repair or replace any such defective materials and workmanship without cost to the Owner.
- B. The guarantee shall include complete service, including adjustment service and inspection, during the guarantee period as required by agencies listed under "REGULATIONS AND STANDARDS".

1.10 EXTRA STOCK:

- A. Provide extra sprinkler heads under provisions of NFPA 13.
- B. Provide suitable wrenches for each head type.
- C. Provide metal storage cabinet in sprinkler riser room & fire pump room.

PART 2 PRODUCTS

2.1 GENERAL:

- A. Furnish and install in a neat workmanlike manner, all required to provide a complete, properly operating installation. All piping and accessories shall conform to standards as applicable.
- B. Run piping parallel with the lines of the building, unless specifically shown or noted otherwise. All pipe, fittings, valves, etc., shall have sufficient clearance from other work to finish at least 1/2 inch from other work or finished covering of other piping.
- C. Provide all necessary hangers, anchors, thrust blocks, etc., to properly support and protect piping system, as required by agencies listed under "REGULATIONS AND STANDARDS".
- D. Under no circumstances is the contractor to attach to or support from any bar joist bridging. Any supports to the bar joists or any structural systems are to be approved by the Engineer. All supplement angle or channel iron required to support equipment of this specification is to be furnished by the contractor and is to be independent of any other supports.

2.2 SLEEVES AND PLATES:

- A. Wherever pipes pass through concrete slabs, furnish and install sleeves, properly located for the work.
- B. Use sleeves of sufficient size to allow the specified pipe covering to pass through the sleeves and finish sleeves flush with walls and ceiling.
- C. Sleeves shall be galvanized steel not lighter than 24 gauge.
- D. Seal spaces between sleeve and pipe. Use packing device or material for UL rating to match rating of wall or floor/ceiling as rated under UL File R9658.

2.3 ESCUTCHEONS:

- A. Where pipes passing through floors, walls or ceiling exposed to view in finished areas, provide pressed steel split plates which cover the opening and fit snugly to pipe.

2.4 SPRINKLER HEADS:

- A. Temperature rating on fusible links to suite specific hazard area with minimum margin of safety 50-degrees F.
- B. Sprinkler heads installed under suspended finished ceilings (unless noted here-in- after) shall be fully-recessed type with cover plate with custom color finish. Sprinkler heads installed under solid/sheetrock finished ceilings (unless noted here-in-after) shall be fully-recessed type with cover plate with custom color finish. Extended coverage sprinkler heads to be allowed based on approval of aesthetics of sprinkler head by architect/owner.
- C. For exposed areas, provide standard upright type with chrome finish. In mechanical rooms, janitors closet, etc. finish may be brass.
- D. For Sidewall applications, provide sidewall type with chrome plated finish and escutcheons.
- E. Dry pipe sprinkler heads shall be the closed, automatic type with spray deflector, fusible link and white finish.
- F. All sprinkler heads shall be Underwriter's Laboratories and Factory Mutual Labeled.
- G. All sprinkler heads to be quick response type.
- H. All porches to be protected with dry type sidewall heads.
- I. Maximum Security Sprinkler Heads: Provide maximum security sprinkler heads in all areas that are noted as security areas per the architectural documents, concrete ceilings, impact resistant gypsum board ceilings, & as noted on sprinkler documents. TYCO RAVEN Series (quick response) w/ escutcheon assembly or prior approved equal). White finish.

1. Provide & install TYCO model 1780 retaining flange at all pipe drops to maximum security sprinkler heads.
- J. Provide chrome-plated wire cages, including attachment devices, in areas with upright heads.
 1. Wire cages shall be heavy duty type & UL listed for use with respective sprinkler head.

2.5 SPRINKLER VALVE STATION:

- A. Provide approved automatic valve station with OS&Y shutoff valve, alarm valve, main alarm check valve, with variable pressure trimming, including water pressure gauges, retard chamber, alarm test line with valve, drain lines with valves, outside water alarm, etc.
- B. Wet pipe alarm check valve shall be designed for vertical installation. Valve shall have cast iron body with all surfaces in contact with water non-ferrous. Valve shall be UL Listed or FM Approved, iron body, bronze mounted, variable pressure type with retarding chamber. Provide basic trimmings for alarm test by-pass, gages, drain connections, mounting supports for retarding chamber, and drip funnel. Provide pressure sensitive alarm switch to actuate the fire alarm system.
- C. Water Motor Alarm: Provide alarms of the approved weatherproof and guarded type, to sound locally on the flow of water in such sprinkler system to which it is connected. Mount alarms on the outside of the outer walls of each building, at a location indicated on the plans.
- D. Inspector's Test Connection: Provide test connections about 6 feet above the floor for each sprinkler system equipped with an alarm device and locate at the hydraulically most remote part of each system. Provide test connection piping to a location where the discharge will be readily visible and where water may be discharged without damage.
- E. Main Drains: Provide drain piping to discharge at safe point outside each building. Provide auxiliary drains as required by NFPA 13.
- F. Flow Switches: Flow switch shall be paddle type, designed for direct immersion in water and vertical and horizontal pipe mounting. Switch shall be normally open type with two single pole, double throw switches, pneumatic retard (adjustable), and 120 volt power. Switch shall be UL and Factory Mutual labeled.
- G. Supervisory Switches: Valve supervisory switches shall be designed for valve mounting, vertical and horizontal. Switch shall be normally closed type capable of detecting any motion from the valve full open position. Switch shall be UL labeled. Provide at fire water backflow preventer.
- H. Dry Pipe Valve: UL Listed, flanged, iron body. Provide basic trimmings for alarm test by-pass, pressure switches, gages, drain connections, drip funnel, accelerator and necessary pipe, fittings and accessories required to provide a complete installation.

2.6 SIAMESE FIRE DEPARTMENT CONNECTIONS:

- A. Provide wall & remote mounted siamese fire department connection with chrome plated finish, local fire department threads, dust caps and chains, 3/4" automatic drip, marked "SPRINKLER - FIRE DEPARTMENT CONNECTION" (on chrome plated placard with raised chrome letters. Contractor shall co-ordinate with local Fire Department to match their size and type threads. FDC to be sufficient to provide flow required by sprinkler system design.

2.7 VALVES, PIPING AND FITTINGS:

- A. Refer to Section 210516: Fire Protection Piping.

2.8 AUTOMATIC VALVES AND FLOW SWITCHES:

- A. Automatic valves and flow switches shall have bodies of brass or bronze, threaded, for

- 150 lbs. pressure, electrically operated, 110 volts, UL Listed.
- B. Automatic valves shall be solenoid operated, 110 volts. Valves shall remain open upon loss of power
 - C. Water Flow Indicators: The Sprinkler Contractor shall furnish and install all electrical wiring required in connection with sprinkler system. A 120 volt electric water flow indicator shall be installed in the main sprinkler supply to each individual zone. This shall include wiring from each of the indicators to connect with individual zones in the building fire alarm panel.

2.9 FIRE HYDRANTS:

- A. Refer to Civil Engineering Documents.

2.10 AIR SUPPLY SYSTEM

- A. Air supply system for dry pipe sprinkler system compressed air system.
- B. Provide air compressor specifically approved for a dry sprinkler system with UL Listed or FM Approved dry valves. Compressor shall maintain the required operating pressure on the dry system. Provide a 120-volt electrical connection with disconnect, compressor to be hard wired (plug in to outlet not acceptable).
- C. Provide an automatic air pressure maintenance device to automatically reduce pressure and supply air to the sprinkler system at a set requirement. Air maintenance device shall include pressure regulator, 1/2" valve bypass, relief valve, pressure gage, air supervisory pressure switch and pipe, fittings, valves and accessories necessary to provide a neat, compact and complete operable system.
- D. Air compressor serving the dry pipe sprinkler system shall be inline pipe mounted high volume type, single unit, electric motor driven, ASME rated horizontal receiver tank, air pressure operated electric switch, motor, motor starter, safety valves, check valves, automatic tank drain, muffler filter, belt guard, and controls capable of required free air delivery from 0 to 40 psig within 30 minutes of start.

2.11 STANDPIPE VALVE CABINET (FIRE RATED) AND ACCESSORIES:

- A. Not used.

PART 3 EXECUTION

3.1 DESIGN:

- A. The sprinkler systems shall be designed as required for occupancies specified by experienced personnel with competency in the execution of such work. Sprinkler system design shall be performed only by engineers licensed by the State of Louisiana. Provide the following:
 - 1. Wet pipe systems for all areas.
 - a. New construction, contractor to provide wet pipe sprinkler system, light hazard, (0.10 gpm/sq/ ft/ over the most remote 1500 sq. ft.), except kitchen, storage room(s), mechanical rooms, breakrooms, and janitors closets (Refer to NFPA 13) which shall be ordinary hazard, group 2 (0.15 gpm/sq/ ft/ over the most remote 1500 sq. ft.).
 - b. Contractor to design system with a mandatory 15 pound cushion.
 - c. The following occupancies and areas have been taken from NFPA 13 for the convenience of the contractor. It is the contractors responsibility to design the sprinkler system in accordance with the most current version of NFPA 13.

Light Hazard Occupancies

Churches, Clubs, Eaves & Overhangs (made of combustible material), Educational, Hospitals, Institutional, Libraries, except large stack rooms, Museums, Nursing or Convalescent homes, Offices (including data processing), Residential, Restaurant Seating Areas, Theaters & Auditoriums (excluding stages and prosceniums), Unused Attics

Ordinary Hazard, Group 1

Automobile parking and showrooms, Bakeries, Beverage Manufacturing, Canneries, Dairy products manufacturing and processing, Electronic plants, Glass and glass products manufacturing, Laundries, Restaurant service areas, kitchen, storage room(s), mechanical rooms, breakrooms, and janitors closets.

Ordinary Hazard, Group 2

Cereal mills, Chemical plants (ordinary), Confectionery products, Distilleries, Dry cleaners, Feed mills, Horse stables, Leather goods manufacturing, Libraries (large stack rooms), Machine shops, Metal working, Mercantile, Paper and pulp mills, Paper process plants, Piers and wharves, Post offices, Printing and publishing, Repair garages, Resin application area, Stages, Textile manufacturing, Tire manufacturing, Tobacco products manufacturing, Wood machining, Wood product assembly.

- B. Contractor to provide additional sprinkler heads under any obstructions, overhangs, ductwork, equipment, etc. 4'0" and wider. Contractor to provide sprinkler heads in all exterior overhangs required to protect window walls, above and below.
- C. Contractor to provide any and all sprinkler heads for water curtains required at all rated walls containing glass to maintain designated rating.
- D. All sprinkler heads shall be located in the center of suspended ceiling tile.
- E. Sprinkler contractor shall include in his bid the backflow preventer with isolation valve as required by Department of Health and include pressure drop in hydraulic calculations. Backflow preventer to be located on site, refer to architect/engineer for exact location. It shall be sprinkler contractor responsibility to co-ordinate all facets of system not just inside building for a complete system. Contractor to
- F. Sprinkler contractor shall co-ordinate routing of piping with mechanical and electrical. Contractor can assume that there will be conflicts and shall include in his bid for these possibilities. No additional compensation will be allowed regarding this matter.
- G. Sprinkler contractor to refer to architectural reflected ceiling drawings for fully concealed heads to be custom colored to match color of respective metal/wood panel ceilings.
- H. Contractor shall provide dry type heads in freezer and cooler.
- I. Provide wire guards for all sprinklers heads located in storage rooms if head located less than 8'0" from finished floor.
- J. All sprinkler piping shall be located above ceilings and below sheetrock (underneath side of floor joist assembly).
- K. Due to the complexity of the ceiling heights, sprinkler contractor shall include a preliminary submittal of routing of main sprinkler piping for Architect/Engineers approval prior to submitting final drawings to Fire Marshal.
- L. Sprinkler contractor shall co-ordinate routing of piping with mechanical and electrical. Contractor can assume that there will be conflicts and shall include in his bid for these possibilities. No additional compensation will be allowed regarding this matter.
- M. Sprinkler piping shall be protected from freezing during the lay-a-way period.
- N. The design shall comply with NFPA 13 (latest editions), codes, standards, and

recommended practices. No extra charges will be approved for changes to drawings, piping, etc. required to conform to NFPA 13 to be used.

- O. Sprinkler system shall be design on basis of latest available flow test available.
- P. NFPA rules and regulations governing the design shall be scrupulously adhered to specifically, NFPA 13 of the National Fire Codes shall govern the design of the sprinkler system.
- Q. Piping shall be installed in accordance with NFPA Chapter 13.
- R. Co-ordinate all sprinkler alarm/supervisory tie-in connection points with fire alarm contractor prior to bid, whether shown on drawings or not. General contractor to coordinate with sprinkler contractor & fire alarm contractor prior to bid as to ensure a complete and working system.
- S. All sprinkler heads located in coolers, freezers and storage area with ceiling heights of eight (8) feet or less shall be protected with basket type cages.
- T. Provide sprinklers at top of stairwell, all floors, & underneath first floor intermediate landing as per NFPA 13.
- U. Provide cage guards for all upright heads in exposed areas.
- V. Not used.
- W. Testing & Training to be in accordance with NFPA 25.
- X. Provide hose cabinets as per NFPA.
- Y. Not used.
- Z. Provide sprinklers at top & bottom of elevator shafts per NFPA with smoke & heat detectors.

3.2 INSTALLATION:

- A. Run piping concealed above furred ceiling and in joists to minimize obstructions. Expose only heads.
- B. Coordinate sprinkler piping routing and heads with all trades.
- C. Protect sprinkler heads against mechanical injury.
- D. Sprinkler heads location indicated on plans is to be used as a guide only, exact location and numbered to be based and determined by design of sprinkler system, any additional heads required shall be installed as part of the contract with no additional compensation.
- E. Provide additional heads which may be required for coordinated ceiling pattern, without additional cost, even though number of heads may exceed code minimum requirements.
- F. Include all costs of shop drawings review and approval from authorities in price.
- G. Locate outside alarm on wall of building adjacent to siamese department connections and/or as noted on drawings.
- H. Provide where directed cabinet containing required number of spare heads as per NFPA 13, of each type, along with wrench suitable for each type of head.
- I. Provide flow switch on leaving side of main valve and monitoring switch on main valve. Flow switch shall sense flow and sound appropriate zone of fire alarm system monitoring switch on each main valve; when valve is started to its "closed" position shall indicate trouble on appropriate zone of fire alarm system and sound local audible alarm. Wiring between flow switches and monitoring switches and fire alarm system shall be provided and coordinated by sprinkler contractor, fire alarm contractor and electrical contractor.
- J. Furnish and install sprinkler zone valves and flow switches where indicated on the drawings for the zoning of the system. Each of these devices shall be connected into the fire alarm system as indicated for the main valve, including local alarming.
- K. Provide all test and drain valves as required for system.
- L. Support sprinkler piping in accordance with NFPA 13.
- M. Provide new water service as shown on the drawings, incur all costs, fees, permits,

etc.

- N. Paint all exposed sprinkler piping, color selection to be by architect in field during construction.
- O. All branch pipe connections to sprinkler heads are to be made with swing joints.

3.3 COORDINATION:

- A. All interlock and signal wiring runs to the annunciator panel will be furnished and installed by the Fire Detection Contractor and as part of the Electrical Work.
- B. This contractor shall provide for all switches and interlocking devices on all valves as required.
- C. The sprinkler contractor is to provide plans to fire alarm contractor as to ensure all valve, sensors devices, are monitors and have power. General contractor to ensure a complete and working system.
- D. Sprinkler contractor to coordinate with fire alarm contractor prior to bid, general contractor to ensure a complete and working system per NFPA.

3.4 UNDERGROUND PIPING:

- A. Underground fire protection system piping shall be installed in accordance with the requirements of NFPA 24, Private Fire Service Mains and Their Appurtenances. Provide concrete thrust blocking at each change of direction of the piping and at all tees, plugs, and caps in accordance with NFPA 24. Where thrust blocking is impractical, fittings with a mechanical joint retainer gland, approved for the piping material utilized, may be used in lieu of thrust blocking.

3.5 ADDITIONAL CLOSE OUT DOCUMENTS

- A. Provide a copy of NFPA 25 with sprinkler system close out documents.

3.6 THIRD PART REVIEW

- A. The sprinkler contractor shall have his design reviewed , approved, and stamped by a Louisiana Licensed Mechanical Engineer. Third party review & approval to be performed prior to submitting to design team.

3.7 SYSTEM TESTING AND FLUSHING

- A. Testing, cleaning, flushing and inspection shall be done in accordance with NFPA requirements.
- B. The installing Contractor shall complete and sign the appropriate Contractor's Material and Test Certificates included within NFPA 13 and 14.

3.8 TRAINING

- A. Contractor shall provide for the service of a competent, trained and experienced agent to instruct and acquaint the Owner with the proper functioning, operation and maintenance of the fire protection systems and all installed components.

END OF SECTION

12-10-25

SECTION 21 0516 - FIRE PROTECTION PIPING

PART 1 – GENERAL

1.1 GENERAL

A. Pipe, fittings, valves, and connections for installation of sprinkler as indicated on drawings.

1.2 RELATED SECTIONS

A. Section 200100 - General Provisions.

B. Section 200529 - Hangers and Support Devices.

C. Section 210303 - Automatic Sprinkler System

1.3 REFERENCES

A. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.

C. ANSI/ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

D. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.

E. ANSI/ASME B16.9 - Factory-made Wrought Steel Butt welding Fittings.

F. ANSI/ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.

G. ANSI/ASME B16.25 - Buttwelding Ends.

H. ANSI/ASME B36.10 - Welded and Seamless Wrought Steel Pipe.

I. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.

J. ANSI/ASTM A135 - Electric-Resistance-Welded Steel Pipe.

K. ANSI/ASTM A47 - Malleable Iron Castings.

L. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.

M. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

N. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

O. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

1.4 QUALITY ASSURANCE

A. Sprinkler Systems: Perform work to NFPA 13.

- B. Welding Materials and Procedures: Perform to ASME Code.
- C. Valves: Bear UL or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers, with labeling in place.
- 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.

PART 2 PRODUCTS

2.1 SPRINKLER, ABOVE GROUND

- A. Steel Pipe: ASTM A53; ANSI/ASTM A135; ASME B36.10; Schedule 40 black and galvanized, in strict accordance to NFPA 13. All piping 1" to 2-1/2" is to be schedule 40 black steel. All piping 3" and larger to be schedule 40 black steel. Dry Sprinkler System Piping to be galvanized schedule 40. Drain piping to be schedule 40 galvanized steel with screwed galvanized malleable iron fittings. All sprinkler piping, valves, & fittings shall have a working pressure of 200psi, minimum.
 - 1. Steel Fittings: ANSI/ASME B16.9, wrought steel, butt welded; ANSI/ASME B16.25, butt weld ends; ASTM A234, wrought carbon steel and alloy steel; ANSI/ASME B16.5, steel flanges and fittings; ANSI/ASME B16.11, forged steel socket welded and threaded.
 - 2. Cast Iron Fittings: ANSI/ASME B16.1, flanges and fittings; ANSI/ASME B16.4, screwed fittings.
 - 3. Malleable Iron Fittings: ANSI/ASME B16.3, screwed type. ANSI/ASTM A47.
 - 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts (security type), nuts, and washers; galvanized for galvanized pipe.

2.2 GATE VALVES

- A. Up to and including 2 Inches : Bronze body, bronze trim, rising stem, handwheel, inside screw, single wedge or disc, threaded ends.
- B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, single wedge, flanged ends.

2.3 GLOBE OR ANGLE VALVES

- A. Up to 2 Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, screwed ends, with backseating capacity, repack able under pressure.
- B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.4 BALL VALVES

- A. Up to and including 2 Inches: Bronze or Stainless steel one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle, and balancing stops, threaded ends.
- B. Over 2 Inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, or gear drive handwheel for sizes 10 inches and over, flanged.

2.5 BUTTERFLY VALVES

- A. Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, handwheel and gear drive and integral indicating device ,and built-in tamper proof switch.
- B. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, wafer or lug ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch.

2.6 CHECK VALVES

- A. Up to and including 2 Inches: Bronze swing disc, screwed ends.
- B. Over 2 Inches: Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.
- C. Iron body, bronze trim, stainless steel spring, renewable composition disc, screwed, wafer or flanged ends.

2.7 DRAIN VALVES

- A. Bronze compression stop with hose thread nipple and cap.
- B. Brass ball valve with cap and chain, hose thread.

2.8 UNDERGROUND PIPING

- A. Underground fire protection system piping shall be installed in accordance with the requirements of NFPA 24, Private Fire Service Mains and Their Appurtenances. Provide concrete thrust blocking at each change of direction of the piping and at all tees, plugs, and caps in accordance with NFPA 24. Where thrust blocking is impractical, fittings with a mechanical joint retainer gland, approved for the piping material utilized, may be used in lieu of thrust blocking.
- B. Piping: Ductile-iron Pipe (DIP), AWWA C 106, with fittings complying with AWWA C 110 and rubber gaskets complying with AWWA C111 or polyvinylchloride (PVC) C-900 for fire service, 200 psi, UL listed.
- C. Fire water service piping Riser into building: Riser to be AMES Series IBR stainless steel riser (type 304) with end cap. UL listed, FM approved. Designed to meet NFPA 24-2007 section 10.6.5. AWWA C900 Inlet/DIP with AWWA C606 outlet.
- D. Where applicable, Pipe stubbed up from grade for remote mounted pedestal fire department connection shall be schedule 40 galvanized pipe above ground (coated and wrapped per NFPA 24).

2.9 VALVE TAGS

- A. Brass plate, integral legible 1/4" high die-stamped identification.
- B. Provide chain looped thru tag and valve wheel for each valve.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, NFPA 24 for service mains.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- G. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- H. Do not penetrate building structural members unless indicated.
- I. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- J. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- K. Install valves with stems upright or horizontal, not inverted.
- L. Provide gate, ball or butterfly valves for shut-off or isolating service.
- M. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- N. All underground piping shall be installed a minimum 36" below grade.
- O. Provide brightly colored, metallic-core, non-deteriorating, minimum 2" wide identification ribbon tape set 24" below finished grade, directly above piping. Install tracer wire on all non-metallic pipe.

END OF SECTION

12-10-25

SECTION 21 2200 - CLEAN-AGENT FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1. Scope

- A. This specification outlines the requirements for a "total flood" clean agent fire suppression system with automatic detection and control. the work described in this specification includes all engineering, labor, materials, equipment and service necessary, and required, to complete and test the suppression system.

1.2. Applicable Standards and Publications

- A. The design, equipment, installation, testing and maintenance of the clean agent suppression system shall be in accordance with the applicable requirements set forth in the latest edition of the following codes and standards:
 - 1. National fire protection association (nfpa) standards:
 - NFPA 2001 clean agent fire extinguishing systems
 - NFPA 70 national electric code
 - NFPA 72 national fire alarm code
 - 2. Factory mutual systems (fm) publications
 - Factory mutual approval guide
 - 3. Underwriters laboratories, inc. (ul) publication
 - Fire protection equipment directory with quarterly supplements
 - 4. National electrical manufacturers association (nema) publication
 - Enclosures for industrial controls and systems
 - 5. U.S. environmental protection agency, protection of stratospheric ozone 59 fr 13044 (snap)
 - 6. Requirements of the authority having jurisdiction (ahj), state and local codes in force at time of award of contract
- B. The standards listed, as well as all other applicable codes, standards, and good engineering practices, shall be used as "minimum" design standards.

1.3. Requirements

- A. The suppression system installation shall be made in accordance with the drawings, specifications, and applicable standards. Should a conflict occur between the drawings and specifications, the specifications shall prevail.

1.4 Exclusions

The work listed below shall be provided by others, or under other sections of this specification:

- A. 120 vac power supply to the system control panel
- B. Interlock wiring and conduit for shutdown of HVAC, dampers and/or electric power supplies, relays or shunt trip breakers

1.5. Quality assurance

- A. Manufacturer
 - 1. The manufacturer of the suppression system hardware and detection components shall be iso 9001 registered.
 - 2. The name of the manufacturer shall appear on all major components.
 - 3. All devices, components, and equipment shall be the products of the same manufacturer, or supplied by the same manufacturer.
 - 4. All devices, components, and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
 - 5. All devices and equipment shall be ul listed and/or fm approved.
 - 6. Locks for all cabinets shall be keyed alike.
- B. Installer

1. The installing contractor shall be trained by the supplier to design, install, test, and maintain fire suppression systems.
2. The installing contractor shall employ a nicet certified special hazard designer, level ii or above, who will be responsible for this project.
3. The installing contractor shall be an experienced firm regularly engaged in the installation of automatic clean agent, or similar, fire suppression systems, in strict accordance with all applicable codes and standards.
4. The installing contractor must have a minimum of ten (10) years experience in the design, installation, and testing, of clean agent, or similar fire suppression systems. a list of systems of a similar nature and scope shall be provided on request.
5. The installing contractor shall show evidence that his company carries a minimum \$2,000,000.00 liability and completed operations insurance policy. these limits shall supersede limits required in the general conditions of the specifications.
6. The installing contractor shall maintain, or have access to, a mobile clean agent recharging station capable of recharging system on site. the installing contractor shall provide proof of his ability to recharge the largest clean agent system within 24 hours after a discharge. include the amount of bulk agent storage available.
7. The installing contractor shall be an authorized stocking distributor of the clean agent system equipment so that immediate replacement parts are available from inventory.
8. The installing contractor shall show proof of emergency service available on a twenty-four-hour-seven-day-a-week basis.

C. Submittals

1. The installing contractor shall submit the following design information and drawings for approval prior to starting work on this project:
 - A) Field installation layout drawings having a scale of not less than 1/8 in. = 1 ft.-0 in. or 1:100 detailing the location of all agent storage tanks, nozzles, pipe runs, including pipe sizes and lengths, control panel(s), detectors, manual pull stations, abort stations, audible and visual alarms, etc.
 - B) Auxiliary details and information such as maintenance panels, door holders, special sealing requirements, and equipment shutdown.
 - C) Separate layouts, or drawings, shall be provided for each level, (i.e.; room, sub floor, and above ceiling) and for mechanical and electrical work.
 - D) Electrical layout drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detector mounting.
 - E) Provide an internal control panel wiring diagram which shall include power supply requirements and field wiring termination points.
 - F) Separate drawing providing symbol legend and identifying all symbols used.
 - G) Annunciator wiring schematics and dimensioned display panel illustration shall be provided. (optional device.)
 - H) Complete hydraulic flow calculations, from a ul listed computer program, shall be provided for all engineered clean agent systems. calculation sheet(s) must include the manufacturer's name and ul listing number for verification. the individual sections of pipe and each fitting to be used, as shown on the isometrics, must be identified and included in the calculation. total agent discharge time must be shown and detailed by zone.
 - I) Provide calculations for the battery stand-by power supply, taking into consideration the power requirements of all alarms, initiating devices, and auxiliary components under full load conditions.
 - J) A complete sequence of operation shall be submitted detailing all alarm devices, shutdown functions, remote signaling, damper operation, time delay, and agent discharge for each zone or system.

2. Submit drawings, calculations and system component sheets for approval to the local fire prevention agency, owner's insurance underwriter, and all other authorities having jurisdiction before starting installation. submit approved plans to the architect/engineer for record.

PART 2 - SYSTEM REQUIREMENTS

2.1 System Description and Operation

- A. The system shall be a total flood sapphire fire suppression system supplied by Ansul incorporated. FE-25 & FM-200 systems are approved.
- B. The system shall provide a Novec 1230 minimum design concentration of 4.2% by volume for class a hazards and a minimum of 5.85% by volume for class b hazards in all areas and/or protected spaces, at the minimum anticipated temperature within the protected area. system design shall not exceed 10% for normally occupied spaces, adjusted for maximum space temperature anticipated, with provisions for room evacuation before agent release.
- C. The system shall be complete in all ways. it shall include a mechanical and electrical installation, all detection and control equipment, agent storage containers, novac 1230 agent, discharge nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, advisory signs, functional checkout and testing, training and any other operations necessary for a functional ul listed sapphire clean agent suppression system.
- D. Provide two (2) inspections during the first year of service: inspections shall be made at 6-month intervals commencing when the system is first placed into normal service.
- E. The general contractor shall be responsible for sealing and securing the protected spaces against agent loss and/or leakage during the 10-minute "hold" period.
- F. The system(s) shall be actuated by a combination of ionization and photoelectric detectors installed for maximum area coverage of 250 sq. ft. (23.2 m) per detector, in both the room, under floor and above ceiling protected spaces. if the airflow is one air change per minute, photoelectric detectors only shall be installed for maximum area coverage of 125 sq. ft. (11.6 m) per detector. (ref. nfpa no. 72.)
- G. Detectors shall be cross-zoned detection requiring two detectors to be in alarm before release.
- H. Automatic operation of each protected area shall be as follows:
 1. Actuation of one (1) detector, within the system, shall:
 - A) Illuminate the "alarm" lamp on the control panel face.
 - B) Energize an alarm bell.
 - C) Transfer auxiliary contacts, which can perform auxiliary system functions such as: operate door holder/closures on access doors; transmit a signal to a fire alarm system; shutdown hvac equipment.
 - D) Light an individual lamp on an optional annunciator.
 2. Actuation of a 2nd detector, within the system, shall:
 - A) Illuminate the "pre-discharge" lamp on the control panel face.
 - B) Energize a pre-discharge horn/strobe device.
 - C) Shut down the hvac system and/or close dampers.
 - D) Start time-delay sequence (not to exceed 60 seconds).
 - E) System abort sequence is enabled at this time.
 - F) Light an individual lamp on an optional annunciator.
 3. After completion of the time-delay sequence, the sapphire clean agent system shall discharge and the following shall occur:
 - A) Illuminate a "system fired" lamp on the control panel face.
 - B) Shutdown of all power to high-voltage equipment.

- C) Energize a visual indicator(s) outside the hazard in which the discharge occurred.
 - D) Energize a "system fired" audible device. (optional)
4. The system shall be capable of being actuated by manual discharge devices located at each hazard exit. operation of a manual device shall duplicate the sequence description above except that the time delay and abort functions shall be bypassed. The manual discharge station shall be of the electrical actuation type and shall be supervised at the main control panel.

2.2 Material and Equipment

A. General requirements

1. The sapphire clean agent system materials and equipment shall be standard products of the supplier's latest design and suitable to perform all functions intended. When one or more pieces of equipment must perform the same function(s), they shall be duplicates produced by one manufacturer.
2. All devices and equipment shall be u.l. listed and/or fm approved.
3. Each system shall have its own supply of clean agent.
4. The system design can be modular, central storage, or a combination of both design criteria.
5. Systems shall be designed in accordance with the manufacturer's guidelines.
6. Each supply shall be located within the hazard area, or as near as possible, to reduce the amount of pipe and fittings required to install the system.
7. The clean agent shall be stored in sapphire clean agent storage tanks. tanks shall be super-pressurized with dry nitrogen to an operating pressure of 360 psi @ 70 °f (24.8 bar at 21 °c). tanks shall be of high-strength low alloy steel construction and conforming to nfpa 2001.
8. Tanks (master) shall be actuated by either a resettable electric actuator or by pneumatic means from a nitrogen cartridge located in the releasing device. explosive devices shall not be permitted.
9. Each tank shall have a pressure gauge and low pressure switch (optional) to provide visual and electrical supervision of the container pressure. the low-pressure switch shall be wired to the control panel to provide audible and visual "trouble" alarms in the event the container pressure drops below 290 psi (20 bar). the pressure gauge shall be color coded to provide an easy, visual indication of container pressure.
10. Tanks shall have a pressure relief provision that automatically operates before the internal nominal pressure exceeds 730 psi (50 bar).
11. Engineered discharge nozzles shall be provided within the manufacturer's guidelines to distribute the novac 1230 agent throughout the protected spaces. the nozzles shall be designed to provide proper agent quantity and distribution. nozzles shall be available in 1/2 in. through 2 in. pipe sizes. each size shall be available in 180° and 360° distribution patterns.
12. Distribution piping and fittings shall be installed in accordance with the manufacturer's requirements, nfpa 2001, and approved piping standards and guidelines. all distribution piping shall be installed by qualified individuals using accepted practices and quality procedures. all piping shall be adequately supported and anchored at all directional changes and nozzle locations.
 - A) All piping shall be reamed, blown clear and swabbed with suitable solvents to remove burrs, mill varnish and cutting oils before assembly.
 - B) All pipe threads shall be sealed with teflon tape pipe sealant applied to the male thread only.

B. Agent

1. The fire suppression agent shall be 3m™ novac™ 1230 fire protection fluid manufactured by 3m company, st. paul, mn or their approved supplier.

2. Agent shall not contain any hydrofluorocarbons (hfc).
- C. Control panel
1. The control panel shall be an autopulse releasing panel supplied by ansul incorporated.
 2. The detection control system and its components shall be ul listed and fm approved for use as a local fire alarm system with releasing device service.
 3. The control system shall perform all functions necessary to operate the system detection, actuation, and auxiliary functions.
 4. The control system shall include battery standby power to support 24 hours in standby and 5 minutes in alarm.
 5. The control system shall be microprocessor based, utilizing a distributed processing concept. a single microprocessor failure shall not impact operation of additional modules in the system.
 6. The control system shall be capable of supporting cross zoned detection.
 7. The control system shall supply integrated 2.0 amp (minimum) power supply circuitry.
 8. Each control system shall contain four (4) initiating circuits:
 - A) Each circuit shall be capable of class a (style d) or class b (style a) operation.
 - B) Each circuit shall be capable of operating up to fifteen (15) approved detectors or thirty (30) detectors per system.
 - C) Each circuit shall be capable of monitoring contact devices configured for manual release, manual alarm, system abort, trouble input or auxiliary (non-fire) input.
 9. Each control system shall contain release circuits for activation of a fire suppression system(s):
 - A) Each circuit shall be capable of class b (style y) operation.
 - B) Each circuit shall be rated for a minimum of 1.5 amp @ 24 vdc.
 10. Each control system shall contain two (2) indicating appliance circuits for annunciation:
 - A) Each circuit shall be capable of class a (style b) or class b (style y) operation.
 - B) Each circuit shall be rated for a minimum of 1.5 amp @ 24 vdc.
 11. Each control system shall provide an auxiliary power supply rated for 2 amps @ 24 vdc.
 12. Each control system shall provide two (2) spst relays: one for common alarm and one for common trouble. four (4) additional programmable relays can be added to each control system by adding a relay module.
- D. Detectors
1. The detectors shall be spaced and installed in accordance with the manufacturer's specifications and the guidelines of nfpa 72.
 2. The ionization detector shall be an ansul model.
 3. The photoelectric detector shall be an ansul model.
- E. Manual release (electric)
1. The electric manual release shall be a dual action device which provides a means of manually discharging the suppression system when used in conjunction with the detection system.
 2. The manual release shall be an ansul model.
 3. The manual release or manual pull station shall be a dual action device requiring two distinct operations to initiate a system actuation.

4. Manual actuation shall bypass the time delay and abort functions and shall cause all release and shutdown devices to operate in the same manner as if the system had operated automatically.
 5. Manual release shall be located at each exit from the protected hazard.
- F. Abort station (optional)
1. The optional abort station shall be the "dead man" type and shall be located next to each manual release.
 2. The abort station shall be an ansul model.
 3. The abort station shall be supervised and shall indicate a trouble condition at the control panel, if depressed, and no alarm condition exists.
 4. "Locking" or "keyed" abort stations shall not be permitted.
- G. Audible and visual alarms
1. Alarm audible and visual signal devices shall operate from the control panel.
 2. The alarm bell, alarm horn, and horn strobe devices shall be an ansul model.
 3. The visual alarm unit shall be an ansul strobe device.
 4. A strobe device shall be placed outside, and above, each exit door from the protected space. provide an advisory sign at each light location.
- H. Caution and advisory signs
- Signs shall be provided to comply with nfpa 2001 and the recommendations of the sapphire equipment provider.
1. Entrance sign: (1) required at each entrance to a protected space.
 2. Manual discharge sign: (1) required at each manual release station.
 3. Flashing light sign: (1) required at each flashing light over each exit from a protected space.
- I. System and control wiring
1. All system wiring shall be furnished and installed by the contractor.
 2. All wiring shall be installed in electrical metallic tubing (emt), or conduit, and must be installed and kept separate from all other building wiring.
 3. All system components shall be securely supported independent of the wiring. runs of conduit and wiring shall be straight, neatly arranged, properly supported, and installed parallel and perpendicular to walls and partitions.
 4. The sizes of the conductors shall be those specified by the manufacturer. color-coded wire shall be used. all wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors. final terminations between the control panel and the system field wiring shall be made under the direct supervision of a factory-trained representative.
 5. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the national electrical code, article 725 and article 760, except as otherwise permitted for limited energy circuits, as described in nfpa 72. wiring installation shall meet all local, state, province, and/or country codes.
 6. The complete system electrical installation and all auxiliary components shall be connected to earth ground in accordance with the national electrical code.

PART 3 - TESTING AND DOCUMENTATION

3.1 System Inspection and Checkout

After the system installation has been completed, the entire system shall be checked out, inspected, and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and nfpa standards.

- A. All containers and distribution piping shall be checked for proper mounting and installation.
- B. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.

- C. The complete system shall be functionally tested, in the presence of the owner or his representative, and all functions, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.
- D. Each detector shall be tested in accordance with the manufacturer's recommended procedures and test values recorded.
- E. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc. shall function as required and designed.
- F. Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

3.2 Training Requirements

- A. Prior to final acceptance, the installing contractor shall provide operational training to each shift of the owner's personnel. each training session shall include control panel operation, manual and (optional) abort functions, trouble procedures, supervisory procedures, auxiliary functions and emergency procedures.

3.3 Operation and Maintenance

- A. Prior to final acceptance, the installing contractor shall provide four (4) complete operation and maintenance instruction manuals to the owner. all aspects of system operation and maintenance shall be detailed, including piping isometrics, wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s) illustrating control logic and equipment used in the system. checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

3.4 As-Built Drawings

- A. Upon completion of each system, the installing contractor shall provide four (4) copies of system "as-built" drawings to the owner. the drawings shall show actual installation details including all equipment locations (ie., control panel(s), agent container(s), detectors, alarms, manual pull station(s) and abort switch(s), etc.), as well as piping and conduit routing details. show all room or facilities modifications, including door and/or damper installations completed. one (1) copy of reproducible engineering drawings shall be provided reflecting all actual installation details.

3.5 Acceptance Test

- A. At the time "as-built" drawings and maintenance/operations manuals are submitted, the installing contractor shall submit a "test plan" describing procedures to be used to test the control system(s). the test plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed. the tests shall demonstrate that the operational and installation requirements of this specification have been met. all tests shall be conducted in the presence of the owner and shall not be conducted until the test plan has been approved.
- B. The tests shall demonstrate that the entire control system functions as designed and intended. all circuits shall be tested: automatic actuation and manual actuation, hvac and power shutdowns, audible and visual alarm devices, and manual override of abort functions. supervision of all panel circuits, including ac power and battery power supplies, shall be tested and qualified.
- C. A room pressurization test shall be conducted in each protected space to determine the presence of openings, which would affect the agent concentration levels. the test(s) shall be conducted using the retro-tec corp. door fan system, or equivalent, with integrated computer program. all testing shall be in accordance with nfpa 2001.
- D. If room pressurization testing indicates that openings exist which would result in leaks and/or loss of the extinguishing agent, the installing contractor shall be responsible for coordinating the proper sealing of the protected space(s) by the general contractor or his sub-contractor or agent. the general contractor shall be responsible for adequately sealing all protected space(s) against agent loss or leakage. the installing contractor shall inspect all work to ascertain that the protected space(s) have been adequately and properly sealed.

the suppression system installing contractor shall be responsible for the success of the room pressurization tests. if the first room pressurization test is not successful, in accordance with these specifications, the installing contractor shall direct the general contractor to determine, and correct, the cause of the test failure. the installing contractor shall conduct additional room pressurization tests, at no additional cost to the owner, until a successful test is obtained. copies of successful test results shall be submitted to the owner for his record. upon acceptance by the owner, the completed system(s) shall be placed into service.

3.6 System Inspections

- A. During the one-year warranty period, the installing contractor shall provide two (2) inspections of each system installed under this contract. the first inspection shall be at the six-month interval, and the second inspection at the 12-month interval. Inspections shall be conducted in accordance with the manufacturer's guidelines and the recommendations of nfpa 2001.
- B. Documents certifying satisfactory system(s) inspection shall be submitted to the owner upon completion of each inspection.

3.7 Warranty

- A. All ansul system components furnished and installed under this contract shall be warranted against defects in design, materials and workmanship for the full warranty period which is standard with the manufacturer, but in no case less than one (1) year from the date of system acceptance.

3.8 Approved Manufacturer of Control Panel & Equipment

- A. Kiddie
- B. Ansul

END OF SECTION

12-10-25

SECTION 22 0523 - PLUMBING SYSTEM VALVES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Work Included
 - 1. Valves for Domestic Water System
 - 2. Valves for Natural Gas System

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Valves

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves shall have the name or trademark of the manufacturer and the working pressure stamped or cast on the valve body.
- B. All valves in each system, except for special types, shall be the product of a single manufacturer.
- C. All valves requiring packing shall be designed and constructed such that they can be repacked under pressure.
- D. Valve hand wheels shall be malleable iron except where specified otherwise.
- E. All domestic water valves to be lead-free type.
- F. Approved Manufacturer's: Kitz, Nibco.

2.02 VALVES FOR DOMESTIC WATER SYSTEM

- A. Gate valves (4" in size and larger) shall have iron body, bronze trim, non-rising stem, solid wedge, and flanged ends for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 461
Hammond	IR1138
Stockham	G-612
Nibco	F-619
Grinnell	6060A
- B. Ball Valves (3" in size and smaller) shall be bronze body, full port, with PTFE Seats. Full port brass ball, orifice must be drilled, hollow ball is not acceptable. Stem shall be blowout-proof, lever handle, solder ends adjustable packing gland. Ball valve shall be rated for 150 WSP. Valves to be lead-free. Valves shall be:

Watts
Hammond
Apollo
- C. Check valves (4" in size and larger) shall be horizontal swing type with iron body, bronze trim, and flanged ends for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 373
Hammond	IR1124
Stockham	G-931

Nibco	F-918-B
Grinnell	6300A

- D. Check valves (3" in size and smaller) shall be horizontal swing type with bronze body, composition disc, and solder ends for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 1342
Hammond	IB943
Stockham	B-310-B
Nibco	S-413-W
Grinnell	3315 SJ

- E. Globe valves (2 ½" in size and larger) shall have iron body, bronze trim, rising stem, and flanged ends for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 351
Hammond	IR116
Stockham	G-512
Nibco	F-718-B

- F. Globe valves (2" in size and smaller) shall have bronze body, rising stem, composition disc, and solder ends for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 1310
Hammond	IB423
Stockham	B-14-T
Nibco	S-211-Y
Grinnell	3210 SJ

- G. Hose and drain valves shall be 3/4" in size with bronze body, non-rising stem, solid wedge, threaded inlet, and hose outlet with cap and chain for 200 pound W.O.G. Valves to be lead-free. Valves shall be:

Crane	No. 451
Jenkins	372
Nibco	T-113-H

- H. Underground Gate Valves and Valve Boxes:

- Gate valves (4" in size and larger) shall be AWWA approved with iron body, bronze trim, non-rising stem, parallel seat double disc, square operating nut, and [mechanical joint ends] [hub ends] for 200 pound W.W.P. Valves to be lead-free. Valves shall be:

	<u>Mechanical Joint</u>	<u>Hub Ends</u>
Mueller	A-2380-20	A-23 80-5
American Darling	55	53
Stockham	G-743-0	G-744-0

- Gate valves (2" & 3" in size) shall have iron body, bronze trim, non-rising stem, parallel seat double disc, square operating nut, and threaded ends for 200 pound W.W.P. Valves to be lead-free. Valves shall be:

Mueller Company	A-2380-8
Stockham	G-739-0

- Gate valves (1 ½" in size and smaller) shall have bronze, non-rising stem, solid wedge, square operating nut, and threaded ends for 200 pound W.W.P. Valves to be lead-free. Valves shall be:

Mueller Company	H-10280

- Valve boxes shall be provided over each underground gate valve. Valve boxes shall be adjustable cast iron roadway type with belled lower section and removable lid at grade.

Lid shall be labeled "Water" and boxes not in paved areas shall be set in a 24" x 24" x 6" concrete pad. Valves to be lead-free. Valve boxes shall be:

Mueller Company	H-10360
Central Foundry	B-5003
Tyler Pipe Company	6850
Russell Foundry	B-122

5. Provide one T-wrench for each size operating nut.

2.03 VALVES FOR NATURAL GAS SYSTEM

A. GAS COCKS:

1. Up to 2 Inches: Bronze body, bronze tapered plug, non-lubricated, teflon packing, threaded ends.
2. Over 2 Inches: Cast iron body and plug, non-lubricated, teflon packing, flanged ends.
3. Powell Model 961, Mueller Model H-11170, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All valves installed in horizontal lines shall be installed with the stems horizontal or above. Valve hand wheels shall be oriented, when installed, to provide maximum accessibility for operation.
- B. All valves located within ceiling space are to have two (2) complete wraps of 1" wide red reflective tape around ceiling grid hanger/support directly below valve. Tape to be concealed above ceiling.
- C. Provide color coded self adhesive "dot" of ceiling grid (T-Bar directly below valve).
- D. All valves to be located within 12" of finished ceiling. Offset piping down as required.
- E. ADDITIONAL CLOSE DOCUMENTS: Contractor to provide a set of plans shows valve schedule & valve location on plans (full size set, 24"x36 plans). Plans to have valve type, manufacturer and model #. Also provide replacement part contact information for each valve.
- F. All valves underground shall be gate valve type.
- G. All domestic water valves are to be lead-free.

END OF SECTION

12-10-25

SECTION 22 05 34 - BACKFLOW PREVENTION ENCLOSURE

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide manufactured backflow prevention assembly enclosure. Provide multiple enclosures sized to house fire water backflow preventer, domestic water backflow preventer & site irrigation backflow preventer, maintain all required access to BFP. Provide access panels on each side of BFP enclosure. Refer to Civil Engineering Drawing sheets "UTILITY LAYOUT" for backflow preventer locations. Refer to Civil Engineering specifications for backflow preventers.

1.02 QUALITY ASSURANCE

- A. Qualifications: The backflow prevention assembly enclosure manufacturer shall be a company specializing in the manufacture of backflow prevention assembly enclosures with at least 5 years of successful experience designing and selling enclosures to various customers in different climatic regions.

1.03 STORAGE AND HANDLING

- A. Store products in shipping containers and maintain in dry place until installation.

1.04 ACCEPTABLE MANUFACTURERS

- A. Safe-T-Cover™, Hot-Box Aqua Shield or prior approved equal.

1.05 REFERENCES

- A. ASTM B209.
- B. ASSE 1060-Performance Requirements for Outdoor Enclosures for Backflow Prevention Assemblies.

PART 2 PRODUCTS

2.01 MATERIALS OF FABRICATION

- A. Material of fabrication shall be 5052-H32 marine grade aluminum (.050/18 gauge), and shall meet ASTM B209.
 - 1. Finish of enclosure to be pre-finished, figure in bid custom color. Exact color to be selected by architect during submittal process.
 - 2. Provide sample of finish to architect/engineer with submittal during submittal process.
- B. Insulation shall be 1.5" (10.0 "R" value) minimum thickness polyisocyanurate foam laminated to a glass fiber reinforced facer (each side). The insulation shall have the following properties:
 - 1. Dimensional Stability-Less than 2% linear change, ASTM D-2126;
 - 2. Compressive Strength-20PSI, ASTM D-1621;
 - 3. Water Absorption-Less than 1% by volume, ASTM C-209;
 - 4. Moisture Vapor Transmission-Less than one (1) perm, ASTM E-96;
 - 5. Product Density-Nominal 2.0 lbs. per cubic foot, ASTM D-1622;
 - 6. Flame Spread=25, ASTM E-84;
 - 7. Service Temperature= -1000F to +2500F maximum.
 - 8. The insulation shall be of uniform thickness.
- C. Structural members shall be redwood.

2.02 ROOF, WALLS & PANELS

- A. The roof, walls & panels of the enclosure shall be constructed of 5052-H32 (.050/18 gauge) marine grade aluminum, mill finish, ASTM B209 outside with insulation 1 1/2" (10.0 "R" value) thick in the walls and panels and 3" (20.0 "R" value) thick in the roof.
- B. The aluminum, insulation and redwood shall be securely bonded together to form a composite panel.
- C. The aluminum panels shall be provided with a PVC or similar exterior film to prevent damage before installation. The film shall be removed before installation.

- D. The complete assembly, including valve stems, shall be protected by being inside the enclosure.
- E. The roof shall be securely attached to the walls with screws and inside roof connections.
- F. All screws shall attach to redwood members.
- G. The walls of the enclosure shall be securely attached to the concrete base with inside anchoring brackets.
- H. Access panels shall be completely removable.
- I. Access panels shall be provided with built-in pad lockable folding T-handles.
- J. Drain panel shall have a stainless steel hinge and a stainless steel light strength spring as a positive means of closure so that the drain panel will not be activated by wind.
- K. Drain panel shall be designed to remain closed except during water discharge.

2.03 HEATING EQUIPMENT (ASSE 1060 Class I-Required; ASSE 1060 Class II-Optional)

- A. Heating equipment shall be furnished and designed by the manufacturer of the enclosure to maintain an interior temperature of +400F with an outside temperature of -300F.
- B. The heater shall have two electrical resistance elements completely enclosed within a solid aluminum cast platen base.
- C. The platen heater shall be designed for installation to the concrete base with mounting hardware provided.
- D. The platen heater shall be suitable for installation underneath a reduced pressure zone device and designed to sustain water spray without damage to or impeding the performance of the heater.
- E. The platen heater shall be provided with a thermostat adjustable from +40°F to +100°F. The thermostat, all conduit and wiring fittings provided shall be suitable for "water-tight" installation.

2.04 MOUNTING HARDWARE

- A. Mounting hardware shall be furnished and shall be 300 series stainless steel.
- B. All threaded fasteners shall be furnished and shall be 400 series stainless steel and/or Hilti type Tap-Fast w/Quickcoat™ and Flo Seal washer or equal.
- C. All masonry fasteners shall be furnished and shall be stud type Hilti Kwik Bolt II™ and/or Hilti type Hit Anchors or equal.
- D. All necessary drill bits shall be furnished.

PART 3 INSTALLATION

3.01 GENERAL

- A. Enclosure shall be mounted on a 6" thick concrete reinforced (4000psi concrete; 6x6 woven wire mesh) pad (with chamfered edges), pad to extend 6" all around backflow preventer enclosure.
- B. Enclosure shall be assembled and mounted to concrete pad according to manufacturer's instructions.
- C. Enclosure shall be assembled and mounted to concrete pad in such a way that it will remain locked and secured to pad even if outside screws are removed.
- D. Provide 12x12 block out at center of concrete pad for drain, fill with large gravel. Route drain from backflow preventer to 12x12 block out.

END OF SECTION

12-10-25

SECTION 22 1000 - DOMESTIC WATER SYSTEM

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Work Included
 - 1. Domestic Water Piping
 - 2. Water Hammer Arrestors
 - 3. Hose Bibbs
 - 4. Vacuum Breakers
 - 5. Backflow Preventers
 - 6. Disinfecting
 - 7. Valve Boxes
 - 8. Refrigerator Valve Box w/ Valve
 - 9. Washing Machine Connection Box
- B. Description
 - 1. Provide systems of domestic water piping and accessories so that every fixture and piece of water using equipment in the building will be furnished with a water supply.
 - 2. Extend the domestic cold water service to point shown on the drawings.

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements in Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Domestic Water Piping
 - 2. Water Hammer Arrestors
 - 3. Hose Bibbs
 - 4. Vacuum Breakers
 - 5. Backflow Preventers
 - 6. Valve Boxes
 - 7. Refrigerator Valve Box w/ Valve
 - 8. Washing Machine Connection Box
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
 - 1. Hose Bibbs
 - 2. Vacuum Breakers
 - 3. Backflow Preventers
 - 4. Water Hammer Arrestors.
 - 5. Washing Machine Connection Box

1.04 QUALITY ASSURANCE

- A. Standards
 - 1. American National Standards Institute (ANSI):
 - a. Standard B16.18, Cast Copper Alloy Solder-Joint Pressure Fittings, 1978 Edition.
 - b. Standard B16.21, Non-Metallic Gaskets for Pipe Flanges, 1962 Edition.

- c. Standard B16.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings, 1980 Edition.
 - d. Standard B16.24, Bronze Flanges and Flanged Fittings, 150 and 300 Pound, 1979 Edition.
 - e. Standard B31.1, Power Piping and Addendum, 1977 Edition.
- 2. American Society for Testing and Materials (ASTM):
 - a. Standard A307, Carbon Steel Externally and Internally Threaded Standard Fasteners, 1980 Edition.
 - b. Standard B88, Specification for Seamless Copper Water Tube, 1983 Edition.
- 3. American Water Works Association (AWWA):
 - a. Standard C110, Grey-Iron and Ductile-Iron Fittings, 3 inc. through 48 inc., for Water and Other Liquids, 1977 Edition.
 - b. Standard C111, Rubber-Gasket Joints for Cast-Iron and Ductile-Iron Pressure Pipe Fittings, 1979 Edition.
 - c. Standard C151, Ductile-Iron Pipe, Centrifugally Cast In Metal Molds or Sand-Lined Molds, for Water or other Liquids, 1976 Edition.
- 4. Federal Specifications (Fed. Spec.):
 - a. Specification BB-C-120B, Chlorine, Technical: Liquid.
 - b. Specification WW-U-516C, Unions, Brass or Bronze, Threaded Pipe Connections, and Solder Joint Tube Connections.
- 5. Plumbing and Drainage Institute (PDI):
 - a. Standard WH-201, Water Hammer Arrestors, 1977 Edition.
- B. Qualifications of Manufacturer
 - 1. All copper piping to be a product of the United States of America. Manufacturer's of copper pipe to be Cerro, Reading, & Mueller. Contractor to provide submittals of pipe as noted within this specification.
- C. Qualifications of Installers
 - 1. All welders employed for the work shall be qualified under the requirements of ANSI B31.9.0, Section 127.5. Certification of welder's qualifications shall be submitted to the Architect before any welds are made.

PART 2 PRODUCTS

2.01 PIPING AND FITTINGS

- A. Pipe and fittings shall be as listed herein and shall be used on the services indicated.
- B. PVC Pipe: ASTM D1785, Schedule 80, or ASTM D2241. SDR for not less than 200 psig pressure rating; Fittings: ASTM D2467, PVC; and Joints: ASTM D2672, solvent weld for:
 - 1. All site domestic water piping shown on Mechanical/Plumbing drawing to 5'-0" from building slab.

Note: Refer to civil specifications for all site domestic water piping shown on civil engineering utility plan drawing.
- C. Type "k" hard down copper tubing, ASTM B88, with silver soldered joints and wrought copper, ANSI B16.22, or cast bronze, ANSI B16.18, socket fittings for:
 - 1. Under/slab water service piping 4" in size and smaller to a point 3'-0" above the finished floor.

Note: Refer to civil specifications for all site domestic water piping shown on civil engineering utility plan drawing.
- D. Type "L" hard down copper tubing, ASTM B88, with soldered joints and wrought copper, ANSI B16.22, or cast bronze, ANSI B16.18, socket fittings for:
 - 1. Above-ground cold water piping, all sizes.
 - 2. Above-ground hot water piping, all sizes.

3. All piping located in return air plenum.
4. All HVAC condensate piping.
- E. Type "L" soft drawn copper tubing, ASTM B88, with soldered joints and socket fittings for:
 1. Underground water piping to trap primers. No joints under slab allowed.

Note: All piping underslab shall be fitted with a color coded (red for "hot" and blue for "cold") polyethylene sleeve which shall be extended a minimum 6" above the slab.
- F. PEX piping NOT allowed.
- G. All potable water pipes, pipe related products, and materials that join or seal pipes conform to ANSI/NSF 61.
- H. All solvent cements and primers used to join and seal PVC materials shall comply with the requirements of ANSI/NSF 14.
- I. All underslab piping to be in polyethylene sleeve.

2.02 WATER HAMMER ARRESTORS & AIR CHAMBERS

- A. Contractor shall provide either of the following at every plumbing fixture. If Water Hammer Arrestors are used, they shall be installed in strict accordance with manufacturer's recommendations.
 1. Water Hammer Arrestors shall have a spun closed copper tube chamber permanently sealing a pressurized inert gas chamber, O-ring sealed piston and certification stamp as conforming to PDI WH-201. Water hammer arrestors shall be:

Watts	Number 15
Josam	75000-S Series
Sioux Chief	Hydra-rester
 2. Air Chambers: Air chambers shall be Type "L" copper tubing 12" in length and one pipe size larger than the pipe on which it is installed.

2.03 DIELECTRIC ADAPTERS

- A. Dielectric adapters shall be provided between copper and iron pipe connections and between ferrous and non-ferrous piping or equipment. Refer to Section 20 2116- Piping Specialties.

2.04 UNIONS

- A. Unions in copper tubing shall be cast bronze, Fed. Spec. WW-U-516C, with threaded or solder joint ends to match pipe connections.
- B. Unions between ferrous and non-ferrous piping shall be dielectric type as specified hereinbefore under Dielectric Adapters.

2.05 FLANGES

- A. Flanges in copper tubing shall be 150 pound cast bronze, ANSI B16.24, with solder neck and raised or flat face to mate with adjacent flange, valve, fitting, or piece of equipment.
- B. Flanges between ferrous and non-ferrous piping shall be dielectric type as specified hereinbefore under Dielectric Adapters.
- C. Flange gaskets shall be 1/16 inch non-metallic, ring type, ANSI B16.21.
- D. Flange gaskets shall be carbon steel, all threaded type. Nuts shall be carbon steel hexagon type. Steel for bolts and nuts shall conform to ASTM A307, Grade A.

2.06 VACUUM BREAKERS

- A. Vacuum breakers shall be the screw on vandal proof type with finish to match outlet finish - (i.e. chrome plated vacuum breakers on chrome plated hose outlets). Vacuum breakers shall be:

Watts	8A
A.W. Cash	VB101
Nidel	34HD

2.07 BACKFLOW PREVENTERS

- A. Backflow preventers shall be the same size as the pipe on which it is installed unless noted otherwise on the drawings.
- B. Backflow preventers to be lead-free.
- C. Domestic Water BFP: Refer to Civil Engineering Specifications.
- D. Fire Water BFP: Refer to Civil Engineering Specifications.
- E. Beverage Dispenser Water Supply – Dual Check Valves: Certified to ANSI/NSF Standard 18. Tested and certified under ASSE Standard 1022. Atmospheric port. 316 stainless steel body. Rated maximum pressure 150 psi and working temperature 33 to 130 degrees F. Sizes ¼” and 3/8” – Watts Regulator Company Series SD-3.
- F. BFP-1: Reduced Pressure Principle Backflow Preventer: The Reduced Pressure Principle Backflow Preventer shall be certified to NSF/ANSI 372, shall be ASSE® 1013 Listed, rated to 180° F and supplied with full port union ball valves. The main body and access covers shall be low lead bronze (ASTM B584), the seat ring and all internal polymers shall be NSF® Listed Noryl™ and the seat disc elastomers shall be silicone. The first check shall be accessible for maintenance without removing the relief valve. If installed indoors, the installation shall be supplied with integral monitor switch and air gap piped to a properly sized drain. The Reduced Pressure Principle Backflow Preventer shall be a ZURN WILKINS Model 975XL2U.
- E. BFP-2: Lead-Free Reduced Pressure Principle Backflow Preventer: The Reduced Pressure Principle Backflow Preventer shall be certified to NSF/ANSI 372 shall be ASSE® Listed 1013, rated to 180° F, and supplied with full port ball valves. The main body and access covers shall be low lead bronze (ASTM B 584), the seat ring and all internal polymers shall be NSF® Listed Noryl™ and the seat disc elastomers shall be silicone. The checks shall be oriented at a 45° angle upward and accessible for maintenance without removing the relief valve or the entire device from the line. If installed indoors, the installation shall be supplied with an air gap and “Y” type strainer. The Reduced Pressure Principle Backflow Preventer shall be a ZURN WILKINS Model 975XL2.

2.08 REFRIGERATOR VALVE BOX

- A. Refrigerator valve box shall be fully recessed flush mounted type constructed of 20 gauge steel (faceplate to be 20 gauge) with powder coat white finish. Metal box to have flame spread of 94 (UL) and 94BHB (ASTM). Valve shall comply with NSF 61 & ASME A112.18.1. Valve to be low-lead type. Valve box to have nail support brackets with screw-on faceplate frame. Valve to be 1/4 turn. Supply connection shall be 1/2" copper sweat connection. Provide with water hammer arrestor (ASSE 1010 compliant).
- B. Manufacturer: Guy Gray Model 88531, Oatey 39140

2.09 FIXED AIR GAPS

- A. Fixed air gaps shall be:

	<u>3/4" - 1"</u>	<u>1 1/4" - 4"</u>
Watts	Series AG	Series AG
J.R. Smith	Series 3950	Series 3951
Josam	Series 1801	Series 1800
Zurn	Series Z-1025	Series Z-1025
Josam	88900	

2.10 TRAP PRIMER

- A. Trap primer shall be automatic type with cast bronze body, removable valve mechanism, integral vacuum breaker, and ½ inch diameter socket tube ends.

- 1. Trap primer shall be:

J.R. Smith	2699-1
Josam	88250
Wade	W-2400-CS

Zurn	Z-1022
Precision	PR-500
Josam	Series 88250

2. Trap Primer serving more than one (1) floor drain shall be:

Precision	P-1
Mifab	MI-DU

3. Automatic trap primer shall be equipped with backflow preventer as required by Current Edition, International Plumbing Code.

- B. Drainage-Type Trap Seal Primer Valves: ASSE 1044, fixture-trap, waste-drainage-fed type, with the following characteristics:

1. Chrome-plated, cast-brass, NPS 1-1/4 DN 32 minimum, lavatory P-trap with NPS 3/8 DN 10 minimum, trap makeup connection.
2. Contractor shall utilize white PVC flexible tubing for water pipe connection from p-trap connection to wall.
3. All piping within wall & under slab to be 1/2" soft rolled copper with no joints.

2.11 ICE MAKER CONNECTION BOX

- A. Ice maker valve box shall be fully recessed flush mounted type constructed of 20 gauge steel (faceplate to be 20 gauge) with powder coat white finish. Metal box to have flame spread of 94 (UL) and 94BHB (ASTM). Valve shall comply with NSF 61 & ASME A112.18.1. Valve to be low-lead type. Valve box to have nail support brackets with screw-on faceplate frame. Valve to be 1/4 turn. Supply connection shall be 1/2" copper sweat connection. Provide with water hammer arrestor (ASSE 1010 compliant).
- B. Manufacturer: Guy Gray Model 88531, Oatey 39140

2.12 WASHING MACHINE CONNECTION BOX (FIRE RATED)

- A. All washing Machine (laundry) connection boxes shall be fully recessed flush mounted type constructed of bulk molding compound (BMC) with UL-classified intumescent pads and UL-classified fyrewrap insulating material. The connection box shall include 1/2" FIP inlet valves (hot and cold water) and 2" drain. Supply connection shall be 1/2" mpt or 5/8" sweat connection. Box to be 2 hour fire rated. Provide with water hammer arrestor (ASSE 1010 compliant).
- B. Manufacturer: Oatey Model 38478

2.13 COFFEE MAKER/MACHINE WATER VALVE

- A. Where coffee maker/machine are shown on drawings (architectural and/or plumbing drawings) the contractor shall provide & install 1/2" cold water line inside wall, stub out directly behind coffee machine with 1/2"x3/8"x3/8" quarter turn shut off valve (with chrome escutcheon plate at wall penetration). Provide 3/8" stainless steel braided hose to coffee machine water connection. Coordinate with architect/owner for exact location prior to installation.

2.14 DOMESTIC WATER BOOSTER PUMP

- A. Not used.

2.15 ALLOWANCES

- A. Plumbing Contractor shall assume a minimum of twenty (20) additional water drops (3/4" and below) with ball valves due to possible changes in equipment requirements. These drop will come off nearest available source of sufficient size.

PART 3 EXECUTION

3.01 INSTALLATION

- A. A union or flange shall be provided at all piping connection to equipment.
- B. Faucets, flush valves, and shower heads shall be cleaned of dirt and debris.
- C. Changes in pipe size shall be made with reducing fittings. No bushings will be allowed.
- D. Underground water piping shall have a minimum cover of 3' - 0" to the top of the pipe. Provide tracer warning tape, refer to General Provisions Specifications.

- E. Install water hammer arrestors within the chase or in the wall on the hot and cold water branch lines serving fixtures; on the cold water branch lines serving individual flush valve water closets and urinals; and elsewhere as indicated on the drawings.
- F. Install air chambers on the hot and cold water branch lines to all fixtures not provide with water hammer arrestors. Individual fixtures in a battery or fixtures with water hammer arrestors on the supply line will not require an air chamber.
- G. Vacuum breakers shall be provided on all hose outlets unless the drawings indicate that a backflow preventer is to be provided on the piping serving the outlet.
- H. The atmospheric relief from backflow preventers shall be piped through a fixed air gap to a floor drain.
- I. Underground piping from trap primer to floor drains shall be installed without fittings.
- J. Not used.
- K. The owner provided equipment shall be furnished and set in place under another section of these specifications and/or by separate contract. Plumbing Contractor shall provide necessary rough-in required for this equipment and shall completely connect all plumbing services for this equipment, providing cut-off valves and union for all plumbing supply service to each piece of equipment. It is the obligation of the plumbing contractor to obtain correct roughing-in dimensions and drawings for this equipment as well as the equipment furnished under this contract.
- L. Contractor to test all new backflow preventers in accordance with International Plumbing Code (current edition) & in accordance with one of the following standards: ASSE 5013, ASSE 5015, ASSE 5020, ASSE 5047, ASSE 5048, ASSE 5052, ASSE 5056, CSA B64.10.1, USC's FCCC & HR's "Manual of Cross- Connection Control", or UFL's TREEO's "Backflow Prevention – Theory and Practice". Provide initial certification (at project completion). Include certification within closeout documents (O&M manuals).
- M. Not used.

3.02 JOINTS

- A. Mechanical joints for ductile iron pipe shall be made with a follower gland, gasket, bolts, and nuts as per AWWA C111.
- B. Push-on joints for ductile iron pipe shall be made with a one piece lubricated compression rubber gasket as per AWWA C111.
- C. Threaded joints shall be made up with Teflon tape. After cutting but prior to threading, pipe shall be reamed and shall have burrs removed.
- D. Brazed joints shall be made using a BcuP-5 brazing alloy with a compatible flux.
- E. Solder joints shall be made using a 95-5 tin-antimony solder with a compatible flux.
- F. Flanged joints shall be made with ring type non-metallic gaskets, bolts and nuts.
- G. At contractor's option, tee branches in aboveground copper tubing may be made using the T-drill method. Joint between main and branch tubing shall be sealed using a BcuP-5 brazing alloy with a compatible flux.

3.03 ADJUSTING

- A. Adjust and balance all water systems to obtain operating flows at all fixtures and water using equipment. Also adjust and balance the hot water circulation from all portions of the building.

3.04 DISINFECTION

- A. All domestic water service and supply piping installed under this DIVISION shall be disinfected with chlorine before it is placed into operation in strict accordance with International Plumbing Code, Current Edition. The Contractor shall submit to the Architect written certification that the system was disinfected. Certification that the system was disinfected. Certification shall include name of project, name of owner, and name of operators, date of disinfection, times of disinfection period, maximum chlorine level, and residual chlorine level.
- B. Flush water system a minimum of three (3) times prior to owner occupancy. Provide in writing record of flush to mechanical engineer on contractor letterhead.

- C. The following is an excerpt of the International Plumbing Code (Current Edition), 610: Disinfection of Potable Water System. The plumbing official may require that a potable water system or any part thereof installed or repaired be disinfected in accordance with one of the following methods before it is placed in operation.

New potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority or water purveyor having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section. This requirement shall apply to "on-site" or "inplant" fabrication of a system or to a modular portion of a system.

1. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the Points of outlet.
2. The system or part thereof shall be filled with a water/ chlorine solution containing not less than 50 parts per million (50 mg/L) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing not less than 200 parts per million (200 mg/L) of chlorine and allowed to stand for 3 hours.
3. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.
4. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

3.05 PROTECTIVE COATING FOR UNDERGROUND PIPING

- A. Refer to specification section 200200.

3.06 WATER FLOW TEST

- A. The contractor shall provide A/E written documentation of water flow test results at new connection to existing water system. Test existing water system prior to construction.

3.07 FLUSHING OF SYSTEM

- A. Contractor shall flush new and existing system three (3) times prior to turning facility over to owner.

END OF SECTION

12-10-25

SECTION 22 11 23 - NATURAL GAS SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. Work Included
 - 1. Pipe standard compliance certificates.
 - 2. Pressure regulators.
 - 3. Gas Piping & Fittings.
 - 4. Pipe connection methods.
 - 5. Single Seal Anodeless Risers.
 - 6. Gas Connection to Equipment
- B. Description
 - 1. Provide system of natural gas piping to all equipment requiring gas. Provide new gas meter and regulator. The new gas regulator plus extension into the building will be installed by the contractor. Fees for such work shall be the responsibility of the Contractor. Contractor to coordinate with local gas company for delineation point of work (coordinate where gas company will run pipe to and where this contractor begin work). Contractor to coordinate with local gas company and include all associated fees, permits, connections, etc. (including cost of bringing gas pipe service to building). Contractor to provide a complete and working system & include all associated costs (including connection to building from city main).

1.3 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and section 200100 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Pipe standard compliance certificates.
 - 2. Pressure regulators.
 - 3. Gas Piping & Fittings.
 - 4. Pipe connection methods.
 - 5. Single Seal Anodeless Risers.
 - 6. Gas Connection to Equipment
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
 - 1. Pressure Regulators.
 - 2. Solenoid valves.

1.4 QUALITY ASSURANCE

- A. Standards
 - 1. American National Standards Institute (ANSI):
 - a. Standard B16.3, Malleable Iron Fittings, 1977 Edition.
 - b. Standard B16.5, Steel Pipe Flanges and Flanged Fittings, Joint Pressure Fittings, 1981 Edition.
 - c. Standard B16.18, Cast Copper Alloy Solder - Joint Pressure Fittings, 1978 Edition.
 - d. Standard B16.21, Non-Metallic Gaskets for Pipe Flanges, 1962 Edition.
 - e. Standard B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings, 1980 Edition.

- f. Standard B31.1, Power Piping and Addendum, 1977 Edition.
- 2. American Society for Testing and Materials (ASTM):
 - a. Standard A120, Pipe, Steel, Black and Hot-dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses, 1983 Edition.
 - b. Standard A234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures, 1982 Edition.
 - c. Standard A307, Carbon Steel Externally and Internally Threaded Standard Fasteners, 1982 Edition.
 - d. Standard B88, Specification for Seamless Copper Water Tube, 1983 Edition.
 - e. Standard D2513, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings, 1984 Edition.
- 3. Federal Specifications (Fed. Spec.):
 - a. Specification WW-U-516C, Unions, Brass and Bronze, Threaded Pipe Connections, and Solder Joint Tube Connections.
 - b. Specification WW-U-531E, Union, Pipe, Steel or Malleable Iron, Threaded Connection, 150 lbs. and 250 lbs.
- B. Qualifications of Manufacturer:
 - 1. Pipe and fittings shall be manufactured in the United States.
- C. Qualification of Installers:
 - 1. All welders employed for the work shall be qualified under the requirements of ANSI B31.2.0, Section 127.5. Certification of welders qualifications shall be submitted to the Architect/Engineer before any welds are made.

PART 2 PRODUCTS

2.1 GENERAL

- A. All gas equipment specified herein shall be designed and constructed for use with natural gas.

2.2 PIPE AND FITTINGS

- A. Pipe and fittings shall be listed herein and used on the services indicated.
- B. Schedule 40 black steel pipe, ASTM A153, with welded joints and standard weight black steel butt welding fittings, ASTM A234, for:
 - 1. Above ground gas piping 2-1/2" in size and larger downstream of regulator.
 - 2. All piping within building above concealed ceiling.
- C. Schedule 40 black steel pipe, ASTM A120, with screwed joints and 150 pound threaded malleable iron fittings, ANSI B16.3, for:
 - 1. Above ground gas piping 2" in size and smaller downstream/upstream of regulator.
- D. Polyethylene Pipe: ASTM D2513, SDR 11.5, with fittings: ASTM D2683 to ASTM D2513, socket type and joints shall be fusion welded, for:
 - 1. Gas piping installed underground.
- E. Corrugated Stainless Steel Tubing: Gas Piping as noted on drawings:
 - 1. CSST gas piping shall be routed in PVDF pipe sleeve and shall conform to the requirements of the ANSI LCI Standard for corrugated stainless steel tubing (CSST) fuel gas piping systems. Product shall carry the American Gas Association (AGA) international logo or symbol. The flexible corrugated tubing shall be made of Type 304 Series stainless steel. The tubing jacket shall be of polyethylene and shall be yellow to comply with international color code for gas. The mechanical fittings, terminations and striker plated used in the installation of CSST shall be tested and listed as a system. No joints allowed underslab. CSST shall be Gastite Flexible Gas Piping, TracPipe Gas Piping or Diamondback Gas Piping.

2. Codes: ICC Codes (IFGC, IRC, IMC, IPC), NFPA 54, UPC, CAN/CSA B149.1, NFPA58 Standards: ANSI LC1/CSA 6.26, ASTM E84 (UL723), ICC LC 1024, ANSIZ223.1
 3. Listings: CSA, ICC PMG, UL (Through Penetration Firestop System)
 4. **Pipe** - CSST tubing shall be 300 series Stainless Steel Strip conforming to ASTM A240 rated for 25 psi and have an elevated pressure rating of 125G for sizes up to 1 ¼" and 25G for 1 ½" and 2". Tubing shall not be subjected to heat treating or annealing after the corrugation forming operation.
 5. **Jacket** - CSST jacket shall be an extruded fire-retarded engineered polymer designed to enhance the energy dissipating properties of the flexible gas piping. Conductive jacket shall conform to ASTM E-84 (UL723) flame spread rating not to exceed 25 and ASTM-E84 (UL723) smoke density rating shall not exceed 50. Conductive jacket shall be resistant to UV.
 6. **Fittings** - CSST fittings shall be made of yellow brass and be tested and listed by CSA International for use in concealed locations. The fittings shall flare the tubing using a stainless steel insert to pilot the tubing ID or an integral snap ring in a one piece fitting. The fitting and tubing assembly shall provide a metal to metal seal. Brass fittings shall not contain gaskets or O-rings to facilitate the seal between the tubing and the fitting.
 7. **Quality Assurance** - CSST shall be listed by CSA International to the performance requirements of ANSI LC 1 / CSA 6.26. The conductive jacket shall meet the requirements of ANSI LC 1 / CSA 6.26, Part 5.16.
 8. **Installer Qualifications** - Each installer must meet applicable state and local requirements established by the Authority Having Jurisdiction (AHJ) and must be successfully trained through the manufacturer's installation program.
 9. **Installation** –
 - a. **Appliance Terminations:** Termination Mount fittings are to be used for the tubing at all moveable appliance locations and other stub-out points. The tubing may be run directly to the manual shut-off valve on fixed appliances
 - b. **Regulators:** Regulators shall be listed to a recognized national standard for pressure regulators. Line Pressure Regulators listed to ANSI Z21.80 and equipped with a vent limiter do not require a vent line to be run outdoors.
 - c. **Protection:** Striker plates shall be used where necessary and marked with the symbol of the Manufacturer and CSA International. Striker Plates shall be made from carbon steel, heat treated to >RB75 and <RB85. Floppy type RW galvanized steel electrical conduit shall be used for additional protection.
 - d. **Identification** - CSST shall be marked with the manufacturer's name or symbol, approving agencies, pressure rating and manufacturing date code. The piping system shall be marked by the manufacturer with the word "GAS" in black letters every two feet. Do not paint, stencil or apply unapproved labels to the piping system.
 - e. **Electrical Bonding** - Flexible gas piping shall be bonded in accordance with the National Electrical Code NFPA 70 Article 250.104 and the National Gas Code NFPA 54, and any local requirement which may exceed the national codes.
 - f. If bonding is required, a bonding clamp must be attached to the brass fitting or to a black pipe component in the same electrically continuous gas piping system. The corrugated stainless steel portion of the gas piping shall NOT be used as a bonding attachment under any circumstance.
- F. Schedule 80 black steel pipe, ASTM A153, with welded joints and standard weight black steel butt welding fittings, ASTM A234, for:
1. Gas piping serving natural gas generator.
 - a. All aspects of the natural gas supply shall be in accordance with NFPA, 37, 54 and 110. Where the gas supply is connected to the building gas supply system, it shall be connected on the supply side of the building main gas shutoff valve and marked as supplying an emergency generator. The building's main gas shutoff valve shall be

marked to indicate the existence of the separate generator shutoff valve. Gas piping shall be Schedule 80, black steel, painted ANSI "Natural Gas" Yellow and installed by a licensed plumbing contractor. The connection at the generator is to be made with a flexible piping connection provided by the generator manufacturer. Gas trains shall include an equipment isolation valve at the generator, a manual shutoff valve in a remote location, a regulator and two automatic safety shutoff valves at the generator each with manual leak test valves. The automatic safety shutoff valves shall stop the flow of fuel in the event the engine stops for any cause. All gas piping shall be tested and purged in accordance with NFPA 54:8.

2.3 UNIONS

- A. Unions in copper tubing shall be cast bronze, Fed. Spec., WW-U-516C, with threaded or solder joint ends to match pipe connections.
- B. Unions in steel piping shall be 150 pound malleable iron, Fed. Spec. WW-U-531E, with threaded ends to match pipe connections.
- C. Unions between ferrous and non-ferrous piping shall be dielectric type as specified hereinbefore under Section 202130 - PIPING SPECIALTIES.

2.4 FLANGES

- A. Flanges in steel pipe shall be 150 pound steel, ANSI B16.5, slip-on type welding flange with raised or flat face to mate with adjacent flanges, valve, fittings, or piece equipment.
- B. Flanges between ferrous and non-ferrous piping shall be dielectric type as specified hereinbefore under Section 202130- PIPING SPECIALTIES.
- C. Flange gaskets shall be 1/16 inch non-metallic, ring type, ANSI B16.21.
- D. Flange bolts shall be carbon steel, all threaded type. Nuts shall be carbon steel hexagon type. Steel for bolts and nuts shall conform to ASTM A307, Grade A.

2.5 GAS PRESSURE REGULATORS

- A. Service Pressure Regulator(s): Gas service pressure regulator(s) shall be as provided by the serving utility company (upstream gas meter).
- B. Line Pressure Regulator(s): Line pressure regulator(s) shall be provided for precise control of the gas pressure and flow rate delivered to gas-burning appliances. Line pressure regulator's shall be provided and installed by the contractor.
- C. Regulators shall be installed where line pressure exceeds the gas pressure ratings for appliances supplied thereof and as shown on Drawings.
- D. Regulators shall be required to ensure protection for gas-fired appliances against emergency gas exposure of at least 2 psig.
- E. Regulators shall comply with ANSI Z21.80 and fabricated with internal parts that are corrosion-resistant. Regulators shall be capable of maintaining outlet pressure under no flow condition or dead end lock up situation. Approved model # shall be GOVERNOR by Pietro Fiorentini or prior approved equal.
- F. Venting of Gas Regulators: If located indoors, gas pressure regulators shall have an independent vent pipe routed to the outside of the building. The vent pipe shall be arranged so as to preclude the entry of water or foreign objects. Separate vent piping is not required if the regulator is less than 1¼", is equipped with and is labeled for utilization with approved vent-limiting device installed as per the manufacturer's recommendations.
- G. Plumbing contractor to co-ordinate with General Contractor on all Owner supplied equipment which require gas. Contractor to provide additional regulators at each piece of equipment.

2.6 SINGLE SEAL ANODELESS RISERS

- A. Provide single seal anodeless riser (premanufactured epoxy coated steel to polyethylene gas pipe riser) as manufactured by Elster Perfection. Provide single fused joint under grade at riser connection to polyethylene piping (Medium Density PE2406).
 - 1. Provide where gas piping extends from below grade to above grade.
 - 2. Provide at all gas piping entry points into building.

2.7 GAS CONNECTION TO EQUIPMENT

- A. The contractor shall provide final connection of all equipment/appliances requiring natural gas. Install connection to equipment in strict accordance with equipment manufacturer's recommended installation guidelines. Where equipment manufacturer allows for the use of flexible connections the contractor shall provide.
- B. Provide connections, shutoff valves, regulators and unions at each and every appliance and piece of equipment requiring natural gas, including equipment furnished under other Divisions of these Specifications and/or by the Owner.
- C. Provide and install union type connections at all equipment to permit removal of service piping.
- D. Gas service connections shall have a diameter at least one pipe size larger than that of the inlet connection to the equipment as provided by the manufacturer and be of adequate size to provide the total input demand of the connected equipment.
- E. Food Service Equipment Connections: Provide listed and labeled appliance connectors complying with ANSI Z21.69 and listed for use with food service equipment having casters, or that is otherwise subject to movement for cleaning, and other large movable equipment. Connectors shall have listed and labeled quick-disconnect devices and shall have retaining cables attached to structures and equipment. Connectors shall not be concealed within or extended through wall, floor or partition and shall be located entirely in the same room as the connected equipment. Provide an accessible shut-off valve not less than the nominal size of the equipment connector, immediately ahead of the connector.
- F. Rigid metallic pipe and fittings shall be used at service connections to all stationary equipment.
- G. Provide 6" dirt/drip leg with threaded cap at connection to all appliances/equipment requiring natural gas.

PART 3 EXECUTION

3.1 INSTALLATION

- A. A valve and union shall be provided at each connection to a piece of equipment. Equipment provided with a flanged inlet shall have a flanged connection.
- B. Horizontal gas piping shall slope up in the direction of flow not less than 1/4 inch in 15 feet.
- C. Drip legs, 6-inches long, shall be provided in gas piping at ends of horizontal runs, at the base of risers, and at connections to equipment.
- D. Gas piping from the regulator shall be run above ground on the existing pipe rack.
- E. Branch piping shall be taken off the top or sides of horizontal lines but not from the bottom.
- F. Changes in pipe size shall be made with reducing fittings. No bushings will be allowed.
- G. Contractor shall obtain prices from the local gas company for their services. Prices shall include all necessary equipment, labor, etc. for tie-ins to mains including but not limited to all meters. Contractor's bid shall include the cost for these services. Contractor is responsible for coordinating all tie-ins to mains with the local utility companies.
- H. The owner equipment shall be furnished and set in place under another section of these specifications and/or by separate contract. Plumbing Contractor shall provide necessary rough-in required for this equipment and shall completely connect all plumbing services for this equipment, providing cut-off valves and union for all plumbing supply service to each piece of equipment. It is the obligation of the plumbing contractor to obtain correct roughing-in dimensions and drawings for this equipment as well as the equipment furnished under this contract.
- I. ALL PE pipe to be traced with copper wire when bored, when installed using open trench the pipe shall have a metallic tracer tape with words "caution gas".
- J. A steel striker barrier not less than 0.0508" thick, or equivalent, shall be installed between the gas tubing (within walls) and the finished wall and extend a minimum of 4" beyond the concealed penetrations of plates, fire stops, wall studs, and so forth.
- K. Route pipe vents from gas pressure reducing valves and pipe casing sleeves to the exterior of the building and terminated with outlet turned down and capped with corrosion resistant insect screen. Vent terminations shall be at least seven feet above grade or pedestrian traffic

and a minimum three (3) feet above or ten (10) feet horizontally from all air intakes or building openings.

- L. Provide access to the regulator and ensure that the device is properly installed by following the arrow indicating the gas flow direction. Line pressure regulator must be installed in a horizontal position if the device is equipped with a vent limiter.

3.2 JOINTS

- A. Threaded joints shall be made with a mixture of graphite and oil applied to male threads only. After cutting and prior to threading, pipe shall be reamed and shall have burrs removed.
- B. Welded joints shall be fusion welded in accordance with ANSI B31.1, Section 6.
- C. Flanged joints shall be faced true, provided with gasket, and made square and tight.
- D. Brazed joints shall be made up using a BCuP-5 brazing alloy with a compatible flux.
- E. Polyethylene Pipe: Fused joints shall be made by applying electric resistance heat to the joint in accordance with Federal Register 192.285, Title 49.

3.3 GENERATOR GAS PIPING INSTALLATION

- A. All aspects of the natural gas supply shall be in accordance with NFPA, 37, 54 and 110. Where the gas supply is connected to the building gas supply system, it shall be connected on the supply side of the building main gas shutoff valve and marked as supplying an emergency generator. The building's main gas shutoff valve shall be marked to indicate the existence of the separate generator shutoff valve. Gas piping shall be Schedule 40, black steel, painted and installed by a licensed plumbing contractor. The connection at the generator is to be made with a flexible piping connection provided by the generator manufacturer. Gas trains shall include an equipment isolation valve at the generator, a manual shutoff valve in a remote location, a regulator and two automatic safety shutoff valves at the generator each with manual leak test valves. The automatic safety shutoff valves shall stop the flow of fuel in the event the engine stops for any cause. All gas piping shall be tested and purged in accordance with NFPA 54:8.
 - 1. Automatic Emergency Shut-off Valves shall be U.L. Listed F.M. Approved for natural gas service, 2-way electrically tripped solenoid type; fail safe closed; manual reset; Type 3; 24 volt; solenoid enclosure; Aluminum body; POM core guide; PTFE Rider Ring, stainless steel core and plugnut; NBR seals and disc; stainless steel core tube and springs; copper shading coil; manufactured by ASCO Red Hat Series 8214 or prior approved equal (Emerson approved manufacturer). UL listed to standard 429. FM approved to class 7400. CSA certified to standard C22.2, Automatic Gas Valves Z21.21, & Automatic Gas Safety Shutoff Valves File 112872.

3.4 TRACER WIRE & WARNING TAPE

- A. Refer to General Provisions specification.

3.5 WELD TESTING:

- A. All welds are subject to inspection, visual and/or x-ray, for compliance with Specifications. The Owner will at the Owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or x-ray testing. Initial visual and x-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1 and B31.3 due to the discovery of poor, unacceptable or rejected welds.
- B. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

END OF SECTION

12-10-25

SECTION 22 1300 - SANITARY WASTE & VENT AND STORM DRAINAGE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Work Included
 - 1. Piping
 - 2. Floor Drain(s)
 - 3. Drainage Accessories
 - 4. Cleanouts
 - 5. Traps
 - 6. Flashing

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Piping
 - 2. Floor Drain(s)
 - 3. Drainage Accessories
 - 4. Cleanouts
 - 5. Traps
 - 6. Flashing

1.04 QUALITY ASSURANCE

- A. Standards
 - 1. American National Standards Institute (ANSI):
 - a. Standard B16.3, Malleable Iron Threaded Fittings, 1977 Edition.
 - b. Standard B16.5, Steel Pipe Flanges and Flanged Fittings, 1981 Edition.
 - c. Standard B16.12, Cast-Iron Threaded Drainage Fittings, 1977 Edition.
 - d. Standard B16.18, Cast Copper and Bronze Solder-Joint Pressure Fittings, 1978 Edition.
 - e. Standard B16.21, Non-metallic Gaskets for Pipe Flanges, 1962 Edition.
 - f. Standard B16.22, Wrought Copper and Bronze Solder-Joint Pressure Fittings, 1980 Edition.
 - 2. American Society for Testing and Materials (ASTM):
 - a. Standard A74, Cast Iron Soil Pipe and Fittings, 1982 Edition.
 - b. Standard A120, Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses, 1983 Edition.
 - c. Standard A234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures, 1982 Edition.
 - d. Standard A307, Carbon Steel Externally and Internally Threaded Standard Fasteners, 1980 Edition.
 - e. Standard B43, Specification for Seamless Red Brass Pipe, Standard Sizes, 1984 Edition.
 - f. Standard B88, Specification for Seamless Copper Water Tube, 1983 Edition.

- g. Standard B306, Specification for Copper Drainage Tube, 1983 Edition.
 - h. Standard C444, Specification for Perforated Concrete Pipe, 1980 Edition.
 - i. Standard C564, Specification for Rubber Gaskets for cast Iron Soil Pipe and Fittings, 1970 Edition.
 - j. Standard D2148, Specification for Polyethylene Plastics Molding and Extrusion Materials, 1981 Edition.
 - k. Standard D2146, Specification for Propylene Plastic Molding and Extrusion Materials, 1982 Edition.
- B. Qualifications for Manufacturer
- 1. Pipe and fittings shall be of domestic manufacturer. Manufacturers of cast iron to be Charlotte Pipe or Tyler Pipe of Texas. PVC pipe manufacturers to be Charlotte Pipe or JM Eagle.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

- A. Pipe and fittings shall be as listed herein and shall be used for the services indicated.
- B. PVC pipe: Solid Wall Schedule 40 ASTM D 2665 (cellular "Foam Core" NOT allowed) with PVC fittings and joints ASTM D 2665 shall be solvent welded, for:
 - 1. All below ground (under building slab) sanitary sewer waste, sewer vent piping, & roof drain piping.
 - 2. All site sanitary sewer & roof drainage piping shown on mechanical/plumbing site plan.

NOTES: 1. Refer to civil specifications for all site sanitary sewer & storm drainage piping shown on civil documents.
- C. Wrought copper and wrought copper alloy solder-joint drainage fittings for plumbing drainage waste & vents, ASTM B306; Wrought Copper Fittings ASME B16.29, or Cast Copper ASME B16.23:
 - 1. All waste piping 1" in size and smaller
- D. Cast Iron Pipe: ASTM A74, service weight; Fittings: Cast iron; Joints: Hub-and-spigot, CISPI 301 HSN, NSF listed compression type with ASTM C564 neoprene gaskets or lead and oakum for:
 - 1. All above ground sanitary sewer waste, sewer vent piping, & roof drain piping: pipe above slab to be service weight with no-hub couplings as mentioned in section 2.02 below.
- E. GREASE WASTE: Cast Iron Pipe: ASTM A74, service weight; Fittings: Cast iron; Joints: Hub-and-spigot, CISPI 301 HSN, NSF listed compression type with ASTM C564 neoprene gaskets or lead and oakum for:
 - 1. All above grade sanitary sewer & vent piping upstream of grease trap.
 - 2. All below grade sanitary sewer & vent piping upstream of grease trap.

Note: All cast iron pipe and fittings below grade shall be fully coated with 2-part coal tar epoxy coating, Carbolite 300M or approved equal. Contractor has option to provide cast iron pipe & fittings with epoxy coating factory applied.
- F. Type "L" hard down copper tubing, ASTM B88, with soldered joints and wrought copper, ASME B16.22, or cast copper ASME B16.18, socket fittings for:
 - 1. Discharge from elevator sump pump.
 - A. All copper pipe, fittings and joints underground shall be field coated using a flexible polyethylene tape. Damaged polyethylene tape shall be repaired prior to backfill. Tape shall have overlapping joints, multiple layers shall be applied until a minimum thickness of 25mils is achieved.
- G. Polypropylene Pipe: ASTM-4101, NSF Standard 14, ASTM-F1412; flame-retardant polypropylene pipe and fittings.
 - 1. Not used.

2.02 NO-HUB COUPLINGS

- A. Furnish & install hub-less soil pipe couplings designated Heavy Weight (HW) as manufactured by Mission Rubber Company & Anaco, made of extra wide, heavy duty, corrugated series 304 stainless steel with axially slotted, heavy duty worm drive clamps tightened to 80 in. Lbs. of torque. Flanged gasket to be made of neoprene rubber, meeting the requirements of ASTM C-564, with sealing rubber rings under each stainless steel clamp. Coupling to be ASTM 1540 & FM 1680 compliant, CISPI 310 rated, NSF listed.

2.03 FLANGES

- A. Flanges in steel pipe shall be 150 pound steel, ANSI B16.5, slip-on type welding flange with raised or flat face to mate with adjacent flanges, valve, fitting, or piece of equipment.
- B. Flange gaskets shall be 1/16 inch non-metallic, ring type, ANSI B16.21.
- C. Flange bolts shall be carbon steel, all threaded type, Nuts shall be carbon steel hexagon type. Steel for bolts and nuts shall conform to ASTM A307, Grade A.

2.04 FLOOR DRAINS

- A. FD (Restrooms and General Use): Floor drains shall have a cast iron body with adjustable 6"x6" square nickel bronze strainer and flashing flange. Drains shall be:

<u>Manufacturer</u>	<u>Hub & Spigot / No hub</u>
Wade	1100-G

Approved Equal: J.R. Smith, Watts, Zurn, Mifab, Josam

- B. FD2 (Mechanical Rooms - Air Handling Rooms): Floor drains shall have a cast iron body with adjustable 8" round polished bronze strainer, recessed lip, and flashing flange. Drains shall be:

<u>Manufacturer</u>	<u>Hub & Spigot / No hub</u>
J.R. Smith	2005-F37
Josam	30000-E1
Wade	W-1100ER
Zurn	ZN-415-71
Watts	FD-100-ER7
Mifab	F1100-C-ER7-1

- C. FD3 (Ligature Resistant Areas): FD3 shall be similar to floor drain type FD1. Whitehall Manufacturing model WHDG-SQ, square type. Ligature resistant floor drain grate for use in JR Smith floor drains. 304 stainless steel grate, vandal resistant screws, ligature resistant baffle.

- D. FD4 (Main Mechanical/Equipment Room, Ground Floor.): Floor drains shall have a cast iron body with 12x12 cast iron grate, slotted sediment bucket, and flashing flange. Drains shall be:

<u>Manufacturer</u>	<u>Hub & Spigot</u>
J.R. Smith	2630
Josam	35450
Wade	W-2370
Zurn	Z-566
Mifab	F1480-4

- E. FD5 (Flushing Rim Type): FD5 shall be concealed flush valve with hydraulic activation for flushing rim floor drain, valve to be Zurn model ZH6150AV, flushing rim floor drain to be Zurn model Z300. Flush valve to be located within wall. Provide access panel with push button on wall, Zurn model Z6199. button to be metal with wall plate. provide label on wall above push button labeled "floor drain". Label to be stainless steel with black lettering.

- F. FD6 (Floor Drains within Security Areas): FD6 shall be similar to Floor Drain type FD1. Floor drain strainer shall be fastened with security screws. Security screws shall be Torx type with security pin.

- G. All floor drains shall be equipped with trap primer connections.

- H. All floor drains to have barrier type trap primers in addition to the automatic/electronic trap primers. Barrier type trap primers to be SureSeal Waterless Inline Drain Trap Seal as manufactured by Rectorseal or prior approved equal. Typical entire project.

2.05 CLEANOUTS

- A. Cleanouts shall be provided where shown on the drawings and shall be the same size as the pipe on which installed except cleanouts on underground piping shall be a maximum of 4". Contractor to provide cleanouts whether indicated on drawings or not (with cast iron boxes and covers marked "CO") every eighty (80) feet (max.) or change in direction as required by International Plumbing Code, current Edition.
- B. Cleanouts in waterproofed floors shall have flashing clamp.
- C. Exterior Cleanouts: Exterior cleanouts shall be as detailed on drawings.
- D. For Exposed Horizontal Piping: Cleanout shall be a cast iron ferrule with countersunk taper thread bronze plug for insertion in end of pipe. Cleanout shall be:

	<u>Hub & Spigot</u>	<u>No-Hub</u>
J.R. Smith	4420	Blind Plug
Josam	58540	Blind Plug
Wade	W-8550-D	Blind Plug
Zurn	Z-1470-7	Blind Plug
Mifab	C1450	

- E. For Exposed Vertical Piping: Cleanout shall be countersunk bronze plug with taper threads for insertion into tapped cast iron cleanout tee. Cleanouts shall be:

	<u>Hub & Spigot</u>	<u>No-Hub</u>
J.R. Smith	4472-U	4470
Josam	58540-15	58540
Wade	W-8590-D	W-8590-D
Zurn	Z-1470-8-VP	Z-1470
Mifab	C1430	C1430

- F. For masonry and steel stud walls: Cleanout shall be countersunk bronze plug tapped for machine screw, tapered threads, shallow stainless steel face-of-wall access cover, and vandal proof securing screw. Cleanout shall be inserted into tapped cast iron cleanout tee. Cleanout shall be:

	<u>No-Hub</u>
J.R. Smith	4472
Josam	58890
Wade	W-8470-R-75
Zurn	Z-1460-8
Mifab	C1430-RD-3

- G. For piping concealed in pipe chase or shaft: Cleanout shall be a countersunk bronze plug with taper threads for insertion into a tapped cast iron cleanout tee. Locate a 10" x 10" chrome plated flush-with-wall access cover, with vandal proof securing screw adjacent to cleanout plug. Cleanout and cover shall be:

<u>Cleanout</u>	<u>No-Hub</u>
J.R. Smith	4472
Josam	58890
Wade	W-8590-D
Zurn	Z-1470
Jonespec	63000NH

Mifab	C1430
<u>Cover</u>	
J.R. Smith	4735
Josam	58640
Wade	W-8480-S
Zurn	ZANB-1460
Mifab	C1400-S9

- H. For concrete floors: Cleanout shall have cast iron body, adjustable square scoriated nickel bronze cover and rim, securing screw, and countersunk bronze plug with taper threads. Cleanout shall be manufactured by JR Smith, Josam, Wade, Zurn, Mifab or prior approved equal.
- I. For quarry tile or ceramic tile floors: Cleanouts shall have cast iron body, adjustable square scoriated nickel bronze cover and rim, securing screw, and countersunk bronze plug with taper threads. Cleanouts shall be manufactured by JR Smith, Josam, Wade, Zurn, Mifab or prior approved equal.
- J. For resilient tile floors: Cleanout shall have cast iron body, adjustable square nickel bronze cover recessed for tile, securing screws, and countersunk bronze plug. Cleanouts shall be manufactured by JR Smith, Josam, Wade, Zurn, Jonespec, Mifab or prior approved equal.
- K. For carpeted floors: Cleanout shall have cast iron body, adjustable square nickel bronze cover and rim, carpet marker, and countersunk bronze plug with taper threads. Cleanouts shall be manufactured by JR Smith, Josam, Wade, Zurn, Mifab or prior approved equal.
- L. For cleanouts to grade: Cleanout shall have cast iron ferrule and countersunk bronze plug with taper threads. Where not in paved areas, cleanouts shall be set in a 12" x 12" x 6" deep poured concrete pad set flush with grade. Cleanout shall be:

J.R. Smith	4400
Josam	58500
Wade	WL-8550-S
Zurn	Z-1440
Mifab	C1450

2.06 TRAPS

- A. Traps other than those furnished as a part of the plumbing fixture, shall be of the same materials and size as the pipe into which they discharge, unless specified otherwise hereinafter. Where not underground, traps shall be provided with cleanout plugs on the bottom.

2.07 DRAINAGE ACCESSORIES

- A. Backwater valves shall be cast iron with bronze backwater flap, adjustable cast iron body and collar, hub inlet spigot outlet. Backwater valves shall be:

J.R. Smith	7022
Zurn	Z-1095
Jonespec	76000
Mifab	BV-1200-R

- B. Fixed air gaps shall be cast iron with spigot outlet. Fixed air gaps shall be:

J.R. Smith	3955
Josam	1800
Zurn	Z-1025
Wade	W-2490
Mifab	MI-CAG

2.08 DECONTAMINATION TANK

- A. Not used.

2.09 FLOOR SINK MARKED "FS"

- A. Floor sink shall be 12" square, cast iron, 6" deep with acid resisting porcelain enameled interior double drainage flange with weepholes, bottom outlet, inside caulk connection, aluminum interval dome strainer, and cast-iron, 3/4 acid resisting grate, sediment bucket, 1/2" trap primer connection. Floor sink shall be Josam 49320A series, Wade or approved equal.

2.10 SMOKE TEST

- A. Contractor shall perform smoke test on entire sanitary sewer system at completion of project and shall include all associated costs in bid, re: Section 200213.

2.11 ROOF DRAINS:

- A. Roof Drains (RD & ORD): Cast iron with clamping device for making watertight connection. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, provide a soft copper membrane 12 inches in diameter greater than outside diameter of drain collar. Provide four pound lead flashing 12 inches in diameter greater than outside diameter of drain collar. Provide an integral gravel stop for drains installed on roofs having built-up roofing covered with gravel or slag. Provide integral no-hub, soil pipe gasket or threaded outlet connection. All beehive or dome strainers to be cast iron.
 - 1. Flat Roofs: Beehive or dome shaped strainer with integral flange not less than 12 inches in diameter. For insulated roofs, provide a roof drain with an adjustable drainage collar, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. Bottom section shall serve as roof drain during construction before insulation is installed.
 - 2. Canopy Roofs: Beehive or dome shaped strainer with the integral flange not larger than 200 mm (eight inches) in diameter. For insulated roof provide a roof drain with an adjustable drainage collar, which can be raised or lowered to meet the required insulation heights, sump receiver and deck clamp. Bottom section shall serve as roof drain during construction before insulation is installed.
 - 3. Promenade Deck Drains (DD, Smoking Balconies): Same as for canopy roofs, except decks shall have flat, round, loose, non-slip, and bronze grate set in square, non-slip, bronze frame. Overflow balcony drain to be same except mounted at high elevation.
 - 4. Portico Roofs and Gutters: Horizontal angle type drain with flat bottom and horizontal outlet at the same elevation as the pipe to which it is connected. Strainer shall be removable angle grate type.
 - 5. Protective Roof Membrane Insulation Assembly: Perforated stainless steel extension filter, non-puncturing clamp ring, large sump with extra wide roof flange and deck clamp.
 - a. Non-pedestrian Roofs: Large polypropylene or aluminum locking dome.
 - b. Pedestrian Roof: Bronze promenade 14 inches square, set in square secured frame support collar.
- B. Expansion Joints: Heavy cast iron with cast brass or copper expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.
- C. Interior Downspouts: Provide an expansion joint, specified above, at top of run on straight, vertical runs of downspout piping 40 feet long or more.
- D. Downspout Nozzle: The nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout. Coordinate height of nozzle with architect for approval of location prior to installation.
- E. Roof Drain & Overflow Drain to be JR Smith model 1015BS with cast iron dome strainer, drain receiver, & under deck clamp. Roof drain to be adjustable type.

2.12 SANITARY SEWER MANHOLES

- A. Refer to Civil Engineering Documents.

2.13 GREASE TRAP

- A. Contractor to provide pre-cast concrete grease trap with manhole covers labeled "GREASE". Refer to detail # sheet P for grease trap detail.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Horizontal soil and waste piping 2 ½ inches in size and smaller shall be sloped at a minimum of 1/4 inch per foot. Horizontal soil and waste piping 3", 4", 6" shall be sloped at a minimum of 1/8 inch per foot. Horizontal soil and waste piping 8 inches in size and larger shall be sloped at a minimum of 1/16 inch per foot.
 - 1. Not used.
- B. Horizontal vent branches shall be kept above the highest fixture served by the vent branch in order to preclude the possibility of vents being used as waste pipes. Horizontal vent branches shall be sloped to prevent the accumulation of waste or scale therein.
- C. Horizontal storm drainage piping 2 ½ inches in size and smaller shall be sloped at a minimum of 1/4 inch per foot. Horizontal storm drainage piping 3" in size and larger shall be sloped at a minimum of 1/8 inch per foot.
- D. On soil, waste and vent piping changes in pipe size shall be made with reducing fittings and changes in pipe direction shall be made with fittings. No bushings allowed.
- E. On storm drainage piping changes in pipe size shall be made with reducing fittings and changes in direction shall be made with fittings. No bushings will be allowed.
- F. Caulked hubs on all drainage and vent piping shall have the open hub end facing against the direction of flow.
- G. During construction all pipe openings, not being worked on, shall be plugged or capped to prevent foreign objects from entering system.
- H. Except for special types, floor drains shall be set flush with the floor at the low points designated on the architectural drawings.
- I. Open hub drains shall be installed as shown on the drawings and have the hub set in the floor with top 1" above the finished floor. Indirect waste piping shall terminate 2" above the top of the hub.
- J. Cleanouts on underground drainage shall have piping extended to the floor and finished with cleanout plug and removable floor plate.
- K. Cleanouts in vertical piping shall be roughed with centerline not more than 1'-6" above the finished floor, but high enough to clear the baseboard.
- L. Not used.
- M. All vertical storm drainage leader to be equipped with cleanout at base of all risers, provide access door suitable in size for servicing of the cleanout.
- N. At project completion the contractor shall remove all debris (concrete, dirt, etc.) from all exterior cleanouts & manhole covers, then apply two-part epoxy coating (black) for all exterior cleanouts, manhole covers, and valve covers.
- O. Install all manufacturer's components in accordance with respective manufacturer's recommended installation guidelines.

3.02 JOINTS

- A. Gasketed joints for cast iron pipe shall be made with lubricated neoprene compression gaskets.
- B. Clamped joints for hubless cast iron pipe shall be made with bolted stainless steel clamps and neoprene gasket. Clamps shall be tightened by alternately tightening screws to 60 in. lb. torque.
- C. Threaded joints for steel pipe shall be made with a mixture of graphite and oil applied to male threads only. After cutting, but prior to threading, pipe shall be reamed and have burrs removed.
- D. Soldered joints for type 'L' copper tubing and cast DMV bronze pipe shall be made with 95-5 tin-lead solder and a compatible flux.
- E. Brazed joints for red brass pipe shall be made with BcuP-5 brazing alloy and a compatible flux.

- F. Clamped joints for storm drainage & waste drainage hubless cast iron pipe 6" and larger shall contain tie rods on the vertical to horizontal and horizontal to vertical.
- G. Not used.
- H. Not used.

3.03 FLASHING

- A. Vent pipe (in membrane roofs) shall be flashed and made water tight at roof with flashing recommended or provided by roofing manufacturer.
- B. Roof drains (in membrane roofs) shall be flashed and made watertight at the roof with flashing recommended or provided by roofing manufacturer. The flashing shall be secured to the roof drain with the flashing clamp furnished with the drain.

END OF SECTION

12-10-25

SECTION 22 15 13 - COMPRESSED AIR PIPING AND EQUIPMENT

PART 1– GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and pipe fittings.
 - 2. Air receiver and accessories.
 - 3. Pressure reducing station.
- B. Related Sections
 - 1. Section 20 01 00 - General Provisions

1.2 REFERENCES

- A. Compressed Gas Association:
 - 1. CGA G7 - Compressed Air for Human Respiration.
 - 2. CGA P2.1 - Recommendations for Medical-Surgical Vacuum System.
 - 3. CGA V5 - Diameter Index Safety System.
- B. Factory Mutual System:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

1.3 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate piping system schematic with electrical and connection requirements general assembly of components, mounting and installation details, and general layout of control and alarm panels. Indicate detailed medical wall assembly drawings.
- C. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. System Components: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes. When applicable, include electrical characteristics and connection requirements.
 - 5. Compressors: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

- A. Product Data: Submit manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

PART 3– PRODUCTS

3.1 COMPRESSED AIR PIPE AND PIPE FITTINGS

- A. Galvanized steel pipe: ASTM A53; ANSI/ASTM A135; ASME B36.10 Schedule 40 galvanized pipe.
- B. Fittings: Malleable galvanized threaded iron fittings: ANSI/ASME B16.3, screwed type, ANSI/ASTM A47.
- C. Malleable-Iron Unions: ASME B16.39, Class 150, Threaded.

3.2 COMPRESSED AIR VALVES

- A. Ball Valves: MSS SP 110, Class 150, 400 psi, bronze, two piece body, chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded ends with union.
- B. Swing Check Valves: MSS SP 80, Class 150, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends.
- C. Air Outlets: Quick Connector: brass, snap on connector with self closing valve.

3.3 AIR COMPRESSOR

- A. Provided by owner, contractor installed.

3.4 AIR PRESSURE REDUCING VALVE (REGULATOR)

Champion heavy duty airline regulator **Model CR16-04-000** heavy duty air line regulator.

A) **Standard Equipment Features:**

- a. **Adjustable knob allows for easy adjustment**
- b. **Automatic self-relieving diaphragm**

B) **Technical Specification:**

- ❖ Max temperature: 150°F
- ❖ Max operating pressure: 300PSI
- ❖ Pipe Size 1/2" NPT
- ❖ Width: 3"
- ❖ Height: 6"
- ❖ Weight: 2 lbs.
- ❖ Flow Capacity: 88SCFM
- ❖ Flow Capacity based on 100 psig inlet /90 psig outlet

3.5 REFRIGERATED AIR DRYER

- A. Provided by owner, contractor installed.

3.6 SPECIALTIES

- B. Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
 - 1. Manufacturer's.
 - a. Aeroquip, Bowes, Foster, Milton, Parker Hannifin, Rectus, Schrader-Bridgeport, Snap-tite, TOMCO, Tithill.
 - 2. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
 - a. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
 - b. Plug End: Straight-through type with serrated outlet for attaching hose.
- C. Hose Assemblies: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.
 - 1. Hose: double-wire-braid, CR-covered hose for compressed-air service.
 - 2. Hose Clamps: Stainless-steel clamps or bands.
 - 3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with serrated ends for connecting two sections of hose.
- D. Hose Reel:
 - 1. Air hose reel, provide with 100' 1/2" air hose. Model: Grainger 4NA97.
- E. Coalescing & Particulate filters: Refer to compressed air system detail.

PART 4 – EXECUTION

4.1 PREPARATION

- A. Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe, fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed 1 pound to 3 gallon of water. After washing, rinse with water, dry and cap until installation.
- B. Ream pipe and tube ends. Remove burrs.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment with flanges or unions.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

4.2 INSTALLATION – INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide 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 and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

4.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.9, ASTM F708 and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Provide copper plated hangers and supports for copper piping

4.4 INSTALLATION - ABOVE GROUND PIPING - COMPRESSED AIR SYSTEMS

- A. Install air and drain piping with 1% slope downward in direction of airflow.
- B. Install drip connections with valves at low points of piping system.
- C. Install take-off to outlets from top of main, with shut off valve after take off. Slope take-off piping to outlets.
- D. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated on equipment drawings and or plumbing drawings.
- E. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
- F. Cut pipe and tubing accurately and install without springing or forcing.
- G. Slope piping in direction of flow.
- H. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions.
- I. Install pipe identification as per Section 200553.

- J. Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.
- K. Install strainers on inlet side of pressure reducing valves. Install pressure reducing valves with bypasses and isolation valves to allow maintenance without interruption of service.

4.5 INSTALLATION – EQUIPMENT

- A. Install air compressor on concrete housekeeping pad, minimum 6” inches high and 6 inches larger than compressor base on each side.
- B. Install air compressor unit on vibration isolators. Level and bolt in place.
- C. Install air valve and drain connection on horizontal casing.
- D. Install line size shut-off valve and check valve on compressor discharge.
- E. Install flexible pipe connector on each connection to air compressors.
- F. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver.
- G. Not used.
- H. Install condensate drain piping to nearest floor drain.
- I. Install bypass with valves around air dryer. Use factory insulated inlet and outlet connections.
- J. Provide bypass with valves, around filters.

4.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to specialties and equipment to allow service and maintenance.
- C. Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.

4.7 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.
 - 2. Piping Leak Tests: Test piping. Refer to specification 200100.
 - 3. Repair leaks and retest until no leaks exist.
 - 4. Report results in writing.

END OF SECTION

12-10-25

SECTION 22 3300 - WATER HEATER ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Work Included
 - 1. Circulating Pump
 - 2. Tempering Valve
 - 3. Thermostatic mixing valve
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 22 33 01 - "Electric Water Heater".
 - 2. Section 22 33 02 - "Gas Fired Tank Water Heaters".
 - 3. Section 22 33 03 - "Gas Fired Instantaneous Water Heaters".

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: Data shall be submitted on the following items:
 - 1. Circulating Pump
 - 2. Tempering Valve
 - 3. Thermostatic mixing valve
- C. Operation and Maintenance Instructions: Data shall be provided for the following items:
 - 1. Circulating Pump
 - 2. Tempering Valve
 - 3. Thermostatic mixing valve

1.04 QUALITY ASSURANCE

- A. Standards
 - 1. American Society of Heating, Refrigeration, Air Conditioning Engineers (ASHRAE):
 - a. Standard 90 A, Energy Conservation in New Building Design, 1980 Edition.
 - 2. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section IV Low-Pressure, Heating Boilers, 1980 Edition.
 - b. Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels, 1980 Edition.

PART 2 PRODUCTS

2.01 GENERAL

- A. Refer to the drawings for capacities and electrical characteristics of water heaters.
- B. Water heaters shall be provided with all openings for specified and detailed accessories.
- C. Where heater storage volume is 120 gallons or greater, tank shall be constructed in accordance with ASME Code Section IV for 125 psig working pressure.

2.02 TEMPERATURE AND PRESSURE RELIEF VALVES

- A. Temperature, pressure, and combination relief valves, if not factory installed, shall be automatic type with bronze body, threaded ends and manual test level. The temperature relief setting shall be 210 degrees F and the pressure relief setting shall be equal to the water heater tank working pressure. Relief valves shall be:

Watts
A.W. Cash

2.03 NOT USED

2.04 WATER TEMPERING VALVES

- A. General: High-Low type, manually adjustable, thermostatically controlled water tempering valve; bronze body; and adjustable temperature setting.
- B. System Water Tempering Valves: Piston or discs controlling both hot- and cold-water flow, capable of limited antiscald protection. Include threaded inlets and outlet.
- C. Finish: rough bronze.
- D. Integral combination checkstops with strainers and wall support.
- E. Available Manufacturers: Leonard model XL-32-LF, lawler, or prior approved equal.
- F. Water Tempering Valves to be lead-free.
- G. Water tempering valve to be ASSE 1017 compliant.

2.05 DOMESTIC WATER THERMAL EXPANSION TANK

- A. Furnish and install, as shown on the plans, ASME Precharged steel Thermal Expansion Tank with a fixed bladder. The tank shall have a top NPT stainless system connection and a .301" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code, stamped for 150 psi working pressure. Unit shall be designed and constructed per ASME Section VII. Manufacturer: Wessels TTA Series.
- B. Thermal expansion tank to limit the pressure of the water being heated to no more than 80 pounds per square inch as required per section 613.2 of the International Plumbing Code (current edition)

2.06 NOT USED

2.07 DOMESTIC HOT WATER CIRCULATION PUMPS

- A. Domestic hot water circulation pump shall be the in-line centrifugal type designed for 125 psi working pressure with bronze body and impeller, mechanical seals and stainless steel impeller shaft. The pump motor shall be the open drip-proof design with sleeve bearings, built-in thermal over-load protectors, and shall operate at 1750 RPM. Pump shall have the capacities as shown on the drawings. Pump shall be:

Bell & Gossett	Booster Series
Taco	Circulation Series
Thrush	Circulator Series

2.08 THERMOSTATIC MIXING VALVE

- A. Thermostatic mixing valve shall be high-low manifold system capable of flows from 2 GPM to 41 GPM with a maximum 10 psi pressure drop, refer to schedule on drawings for exact size and type. Assembly shall contain an intermediate and small thermostatic mixing valve each with thermostat directly linked to valve porting adjustable limit stop, scale: cold to ht, wall support, inlet union angle strainer check stops, outlet ball valve, pressure gauges, dial thermometer ad 1 1/2" inlets and outlets. Assembly shall be rough bronze finish factory assembled and installed in wall mount stainless steel cabinet (w/ door, piano hinged and lockable) and tested. Each box to be labeled for intended services. Thermostatic mixing valve assembly shall be: Bradley, Leonard, Powers or Lawler. Provide one (1) TMV per hot water heater, refer to typical detail for installation. Thermostatic mixing valves to be lead-free.

2.09 NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

- A. Hot water heaters to be installed over auxiliary drain pan per International Plumbing Code (Current Ed.) Install water heaters to be installed in strict accordance with manufacturer's recommendations.

- B. Floor mounted hot water heaters to be installed on 6" thick reinforced housekeeping pad with chamfered edges. Install water heaters to be installed in strict accordance with manufacturer's recommendations.
- C. Temperature control valves shall be installed in accordance with manufacturer's requirements.
- D. Temperature, pressure, and combination relief valves shall have discharge piped full size to exterior wall & turn down (terminate no less than 6" and no more than 12" above finished grade). If water heater is not installed by exterior wall, pipe to nearest floor sink (indirect waste receptor).

3.02 OPERATING MANUAL (DOMESTIC HW HEATERS)

- A. Instructions for installation, operation and maintenance of the water heater shall be contained in a manual provided with each boiler unit. Provide four (4) manuals with the submittal process for use by the installing contractor during the installation process.
- B. A wiring diagram corresponding to the water heater shall be affixed to the water heater near the electrical panel.

3.03 MARKING

- A. All water heaters shall bear the following, or equal wording on a visible decal or label by the manufacturer:
- B. "There shall be installed at time of heater installation a combination temperature and pressure relief valve, selected and located in conformance with the requirements of ANSI Z21.22."

END OF SECTION

12-10-25

SECTION 22 33 01 - ELECTRIC WATER HEATERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes electric storage water heaters for potable water.

1.3 REFERENCES

- A. UL 1453 “Electric Booster and Commercial Storage Tank Water Heaters”
- B. ASME Boiler and Pressure vessel code, Section IV, Part HLW
- C. ASHRAE/IES 90.1-2010
- D. ISO 9001 “Quality Management System”
- E. NFPA 70- National Electric Code NSF/ANSI Standard 61- Drinking Water System Components
- F. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

1.4 SUBMITTALS

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties and accessories for each model indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, components, and size of each field connection
- C. Wiring Diagrams: Detail for wiring power signal, differentiate between manufacture-installed and field-installed wiring
- D. Maintenance Data: Include in the maintenance manuals specified in Division 1. Include maintenance guide and wiring diagrams

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable code for internal wiring of factory wired equipment
- B. Units: ETL, UL or CSA Listed as a Complete Electric Water Heater Assembly.
- C. Conform to ASME Section IV. Part HLW for Water Heater construction.

1.6 QUALITY ASSURANCE

- A. Listing: The water heater will be listed ETL listed to UL 1453 “Electric Booster and Commercial Storage Tank Water Heaters”
- B. ASME Compliance: Water heater shall bear the ASME HLW stamp and be National Board listed
- C. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum twenty years’ experience.
- D. Water heater manufacturer certified to ISO 9001 Quality Management System.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases

1.8 WARRANTY

- A. Storage Tank: 25-year (15 years full, 10 years prorated) coverage for manufacturing or material defects, leaks, production of rusty water and/or chloride stress corrosion cracking. Tank warranty does not require inspection and maintenance of anode rods.
- B. The heater shall have a first year service policy, which shall cover labor and freight costs under certain conditions for warranty covered services.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years’

- experience. The water heaters shall be manufactured by a company that has achieved certification to the ISO 9001 Quality Management System.
- B. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses.
 - C. Manufacturers: PVI is the basis of design. Acceptable manufacturers shall be subject to compliance with the requirements.

2.2 CONSTRUCTION

- A. The storage section of the water heater shall be ASME HLW stamped and National Board Registered for a maximum allowable working pressure of 150 psi and pressure tested at 1-1/2 times working pressure.
- B. All tank connections/ fittings shall be nonferrous. Tank shall be equipped with a ball-type drain valve. Tank design will include a manway sized access to the tank interior.
- C. The storage tank shall be an unlined pressure vessel constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2 and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."
- D. Waterside surfaces shall be welded internally utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
- E. All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
- F. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
- G. Water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
- H. Lined or plated storage tanks will not be acceptable.
- I. Water heaters that require anodes will not be acceptable.
- J. Heating elements will be rated at 9 kW and 40 watts per square inch heat density
- K. Heating elements will be sheathed in Incoloy. Each element will individually mount to the tank by means of a four-bolt bronze flange over stainless steel studs with an o-ring seal. A fused magnetic contactor will be supplied for each power circuit. Maximum current per circuit will be 50 amps on three-phase units.

2.3 PERFORMANCE

- A. Water heater will meet the requirements of ASHRAE 90.1– 2010.

2.4 WATER HEATER TRIM

- A. As a minimum, the heater will be equipped with the following:
 - a. electronic low water cutoff
 - b. an *immersion* operating thermostat
 - c. *immersion* temperature limiting device
 - d. an ASME rated temperature and pressure relief valve

- e. Each water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system for integration into the Building Automatic Temperature Controls System.
- B. Operating and safety controls shall meet the requirements of UL

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install water heaters level and plumb in accordance with manufacturers' written instructions and referenced standards.
- B. All piping from pop-off to be type "L" copper with soldered joints.
- C. Provide ASME certification rating.
- D. Refer to plans for size and capacity.
- E. Hot water heaters to be installed on 4" thick reinforced housekeeping pad with chamfered edges. Install water heaters to be installed in strict accordance with manufacturer's recommendations.
- F. Temperature, pressure, and combination relief valves shall have discharge piped full size to exterior wall & turn down (terminate no less than 6" and no more than 12" above finished grade). If water heater is not installed by exterior wall, pipe to nearest floor sink (indirect waste receptor).

3.2 FINISHING

- A. The heater will be completely packaged, requiring only hookup for electrical and plumbing. The heater will be insulated with multiple layers of heavy-density fiberglass, jacketed with powder-coated steel panels, and mounted on heavy-duty channel skills.
- B. The heater will fit properly in the space provided and installation will conform to all local, state, and national codes.

3.3 OPERATING MANUAL (DOMESTIC HW HEATERS)

- A. Instructions for installation, operation and maintenance of the water heater shall be contained in a manual provided with each boiler unit. Provide four (4) manuals with the submittal process for use by the installing contractor during the installation process.
- B. A wiring diagram corresponding to the water heater shall be affixed to the water heater near the electrical panel.

3.4 MARKING

- A. All water heaters shall bear the following, or equal wording on a visible decal or label by the manufacturer: "There shall be installed at time of heater installation a combination temperature and pressure relief valve, selected and located in conformance with the requirements of ANSI Z21.22."

3.5 STARTUP

- A. Start up on the unit will be performed by factory trained and authorized personnel. A copy of the startup report will be provided to the owner.

END OF SECTION

12-10-25

SECTION 22 33 02 - GAS FIRED TANK WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, high efficiency condensing domestic water heaters, trim and accessories for generating hot potable water.
 - 1. Water heaters to be suitable for outdoor installation.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 22 33 00 - "Water Heater Accessories".

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
- C. Shop Drawings: For water heaters, water heater trim and accessories, include:
 - 1. Elevations, sections, details
 - 2. Wiring Diagrams for power
- D. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
- E. Warranty: Standard warranty specified in this Section.
- F. Made in America Certification
- G. Other Informational Submittals.
 - 1. ASME Stamp Certification and Report

1.4 QUALITY ASSURANCE

- A. ASME Compliance: Condensing water heaters must be constructed in accordance with ASME Water heater and Pressure Vessel Code, Section IV (HLW) Potable Water Heaters.
- B. ETL Compliance. Condensing water heaters must be tested for compliance with ETL, "Commercial-Industrial Gas Heating Equipment." Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- C. CO Emission Standards. When installed and operated in accordance with manufacturer's instructions.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 GAS FIRED TANK WATER HEATER PRODUCT DATA

- A. Furnish and install PVI Conquest condensing type natural gas fired water heater(s) with storage capacity, BTUH input, and recovery as indicated on the plan schedule. The water heater will be a vertical fire tube, design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure

tested at 1-1/2 times working pressure. Water heater will be a single-pass, down-fired, spiraled fire tube contained within an integral storage tank.

- B. The water heater shall be ETL listed as complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters. Water heater will meet the thermal efficiency and standby heat loss requirement of ASHRAE 90.1-2010. When tested to the ANSI Z21.10.3 standard, the water heater shall operate at 96% thermal efficiency at full firing rate. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.
- C. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified. Water heater shall be a category IV condensing appliance suitable for power direct venting Category IV doublewall AL294C inner with 430 stainless steel outer jacket. The combustion air intake shall be doublewall stainless steel vent pipe (316/304 SS).
- D. The tank, combustion chamber and fire tubes shall be unlined and fabricated of LDX2101 duplex stainless steel that combines the grain structures and physical properties of both 300 and 400 stainless materials. Lined or plated water heaters or storage tanks requiring anode rods will not be acceptable. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems.
- E. The heater will be equipped with the following: electronic flame monitoring, electronic low water cutoff, and immersion operating control, an immersion UL listed temperature limiting device, an ASME rated temperature and pressure relief valve.
- F. Operating and safety controls shall meet the requirement of UL 795 and FM and comply with CSD-1. Electrical service 120/1/60, 11 amps. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol.
- G. The storage and heating sections shall be completely factory packaged on a single skid, requiring only job site hookup to utilities, venting, and plumbing. The heater shall be insulated to meet ASHRAE 90.1-2010 standby loss requirements and jacketed with a polyethylene liner consisting of 100% recycled material. Pressure vessel shall include a ball type drain valve. The heater shall fit properly in the space provided and installation shall conform to all local, state, and national codes.
- H. Storage tank, heating surfaces, and combustion chamber will have a 15 year warranty (8 years non-rated and 7 years prorated) covering manufacturing or material defects, leaks, and/or the production of rusty water. Stress corrosion cracking warranty: 15 year coverage for failure of tank or heat exchanger due to chloride-induced stress corrosion cracking with no limit to the level of dissolved chlorides in the potable water supply and no exclusion for scale build up. Burner and all heater parts shall have a 1 year warranty. Start up on the unit shall be performed by factory trained and authorized personnel. A copy of the start up report shall be provided to the owner/architect/engineer.
- I. All piping from pop-off to be type "L" copper with soldered joints.
- J. Provide ASME certification rating.
- K. Flue for water heater shall be Category IV double wall type AL294C inner wall with 430 stainless steel outer wall. Install in accordance with applicable national, state and/or

local codes. The combustion air intake shall be doublewall stainless steel vent pipe (316/304 SS).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Floor mounted hot water heaters to be installed on 4" thick reinforced housekeeping pad with chamfered edges. Install water heaters to be installed in strict accordance with manufacturer's recommendations.
- B. Temperature control valves shall be installed in accordance with manufacturers requirements.
- C. Temperature, pressure, and combination relief valves shall have discharge piped full size to exterior wall & turn down (terminate no less than 6" and no more than 12" above finished grade). If water heater is not installed by exterior wall, pipe to nearest floor sink (indirect waste receptor).

3.02 OPERATING MANUAL (DOMESTIC HW HEATERS)

- A. Instructions for installation, operation and maintenance of the water heater shall be contained in a manual provided with each boiler unit. Provide four (4) manuals with the submittal process for use by the installing contractor during the installation process.
- B. A wiring diagram corresponding to the water heater shall be affixed to the water heater near the electrical panel.

PART 2 - EXECUTION

3.1 EXAMINATION

- A. Before water heater installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.
 - 1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where water heaters will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER HEATER INSTALLATION

- A. Install gas-fired water heaters plumb and level to the wall securely.
- B. Install gas-fired water heaters in accordance with
 - 1. Local, states, provincial and national codes, laws, regulations, and ordinances.
 - 2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.
 - 3. National Electrical Code, ANSI/NFPA 70 - latest edition.
 - 4. Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.
 - 5. Manufacturer's installation instructions, including required service clearances and venting guidelines.
- C. Assemble and install water heater trim.
- D. Install electrical devices furnished with water heater but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to water heater to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to water heater gas valve with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return water heater tapings with shutoff valve and union or flange at each connection.
- F. Multiple heaters shall be piped such that all cold water entering the system will go through the heater first. A series of approved piping installation examples are shown in the installation and maintenance manuals provided with the unit. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Water heater Venting
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect venting full size to water heater connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
 - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.
 - 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Occupancy Adjustments: Within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests

The water heater manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU

input levels. If these curves are not available, it is the responsibility of the water heater manufacturer to complete the following performance tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Water heaters shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of water heaters.
 - a. Test for full capacity.
 - b. Test for water heater efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect/Engineer.

END OF SECTION

12-10-25

SECTION 22 33 03 - HIGH EFFICIENCY GAS DOMESTIC WATER HEATERS

PART 1 - GENERAL

1. RELATED DOCUMENTS

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

2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, high efficiency condensing domestic water heaters, trim and accessories for generating hot potable water.

3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
- C. Shop Drawings: For water heaters, water heater trim and accessories, include:
 - 1. Elevations, sections, details
 - 2. Wiring Diagrams for power
- D. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
- E. Warranty: Standard warranty specified in this Section.
- F. Made in America Certification
- G. Other Informational Submittals.
 - 1. ASME Stamp Certification and Report

4 QUALITY ASSURANCE

- A. ASME Compliance: Condensing water heaters must be constructed in accordance with ASME Water heater and Pressure Vessel Code, Section IV (HLW) Potable Water Heaters.
- B. ETL Compliance. Condensing water heaters must be tested for compliance with ETL, "Commercial-Industrial Gas Heating Equipment." Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

- C. CO Emission Standards. When installed and operated in accordance with manufacturer's instructions.

5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

6 WARRANTY

- A. Standard Warranty: Water heaters shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Condensing Water heaters:

- a. The heat exchanger coil shall carry a 10 year from shipment, non-prorated, limited warranty against any failure due to waterside corrosion, mechanical defects, or workmanship. The heat exchanger coil shall carry a 10 year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.
- b. Manufacturer labeled control panels are conditionally warranted against failure for two (2) years from shipment.
- c. All other components, including the electronic igniter and electrode, are conditionally guaranteed against any failure for 24 months from shipment.

PART 2 - PRODUCTS

1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Intellihot Model IQ251; or a comparable product by one of the following:
 - 1. AERCO
 - 2. Lochinvar
 - 3. PVI

2 CONSTRUCTION

- A. General: The water heating plant shall have a recovery of refer to schedules. Each water heater shall be ETL Listed; ASME Section IV (HLW) coded and stamped and shall incorporate a negative Pressure gas valve on each exchanger capable of full fire operation at of 2.5" WC of Gas pressure. Each unit shall achieve a minimum turn down 8.3 per 251,000 BTU of input . The total water content in the system shall be less than 2 Gallons per 251,000 BTU/hr of input.
- iQ251 each with an input of 251 MBH, output of 241 MBH, 279 GPH, (4.60 GPM) at 40-140 °F when fired with natural gas, turndown ratio 8.33:1, CO emissions of less than 400 PPM.) 1 - 251,000 Btu Heat Exchanger
- B. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/HR input. Water heaters that have an input greater than 30,000 BTU/Hr at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining set point. Water heater shall have an operational set point capability of 100 °F to 185 °F and shall maintain the outlet temperature within an accuracy of +/- 4 °F during load changes of up to 30% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing water heater with heat exchanger sealed pressure-tight, built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum with a built in serviceable air filter
- C. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tube, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass unitary design (no separate primary and secondary heat exchanger). The water tubes shall be 0.75" ID, with no less than 0.0472" wall thickness. The heat exchanger shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 psig.
- D. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of an - 8.33 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be stainless fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- E. The exhaust manifold shall be of polypropylene with a 3" diameter.
- F. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and dual electronic flame supervision.

3 CONTROLS

- A. Refer to Division 23, Section "Instrumentation and Control of HVAC."
- B. The water heater control system shall be a Masterless Cascading design with no-master - slave designation. The entire system shall have built-in usage optimization routine.
- C. The control panel shall consist of one individual circuit. The circuit boards shall include:
1. A LED display to indicate temperature

2. A CPU board housing all control functions

Each board shall be individually field replaceable.

- D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
- E. The unit shall have a selectable exhaust temperature limit suitable for venting with Polypropylene
- F. The controls shall annunciate water heater and sensor status and include extensive self-diagnostic capabilities.
 1. Set point High Limit: Set point high limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a closed loop function that automatically limits firing rate to maintain outlet temperature.
- G. The water heater control system shall incorporate the following additional features for enhanced external system interface:
 1. Temperature set point
 2. High Exhaust temp monitor and control. Turn down the Gas valve until the exhaust temp is kept below selected material.
 3. Cascading via RS232
 4. Error Code Display -
 - a. Fan Speed Fault
 - b. Blocked Flue Fault
 - c. Ignition Failure
 - d. Temp Sensor Short
 - e. Temp Sensor Wiring Fault
 - f. Flue Temp Fault
 - g. Heat Exchanger Temp Fault
- H. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow Masterless Cascading (Not Lead/Lag) functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
 - a. Efficiently sequence 2 up to 16 (4,000,000 Btu) heat exchangers on the same system to meet the load requirement.
 - b. Individual heat exchanger logic to enable accurate temperature control.
 - c. Operate one motorized valve per heat exchanger as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (depending upon Mode selection) must always stay open for recirculation.
 - d. Automatically rotate Start/Stop amongst the heat exchangers in the chain based upon an internal calculation of run hours, water through put, burner starts and stops

and length of time each burner has been firing. Sequencing is not based upon next in line (Lead/Lag), it is based upon the most logical (least used) heat exchanger in an effort to equalize unit run hours.

- e. Automatic bump-less transfer of sequencing in case of heat exchanger failure. All systems must be able to fail all but one heat exchanger in any order or for any reason and the last will continue to operate.
- f. Each heat exchanger will default to individual control upon failure of the sequencing chain.
- g. Automatic isolation of heat exchanger module from water circuit in case of failure and prevention of cold water from exiting the system
- h. Masterless control, change any parameter in any one of the units and all the rest in the series will automatically adjust to the most recent parameter change.

4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the water heater.
- C. Electrical Characteristics:
 - 1. Voltage: 120 V
 - 2. Phase: Single
 - 3. Frequency: 60 Hz
 - 4. Full-Load Current 5 Amps or less per 250,000 BTU of heat input

5 CONDENSATE

- A. Condensate traps, manufactured from only non-corrosive materials.

6 VENTING

- A. The exhaust vent must be PolyPropylene compatible with positive pressure, condensing flue gas service.
- B. The minimum exhaust vent duct size for each water heater is three-inch diameter.
- C. Combustion-Air Intake: Water heaters shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the water heater and the outdoors.
- D. The minimum sealed combustion air duct size for each water heater is 3" diameter.
- E. Common Vent and Common Combustion Air up to 10 units. Depending upon the application and number of elbows there can be as much as 200 ft of intake and exhaust ducting. Consult manufacturer for common vent and combustion air sizing.

7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency.
- B. Live-fire Test and inspect factory-assembled water heaters, before shipping.
- C. Allow Owner access to source quality-control testing of water heaters.

PART 3 - EXECUTION

1 EXAMINATION

- A. Before water heater installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.
 - 1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where water heaters will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

2 WATER HEATER INSTALLATION

- A. Install gas-fired water heaters plumb and level to the wall securely.
- B. Install gas-fired water heaters in accordance with
 - 1. Local, states, provincial and national codes, laws, regulations, and ordinances.
 - 2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.
 - 3. National Electrical Code, ANSI/NFPA 70 - latest edition.
 - 4. Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.
 - 5. Manufacturer's installation instructions, including required service clearances and venting guidelines.
- C. Assemble and install water heater trim.
- D. Install electrical devices furnished with water heater but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to water heater to permit service and maintenance.

- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to water heater gas valve with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return water heater tapings with shutoff valve and union or flange at each connection.
- F. Multiple heaters shall be piped such that all cold water entering the system will go through the heat exchanger first. A series of approved piping installation examples are shown in the installation and maintenance manuals provided with the unit. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Water heater Venting
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect venting full size to water heater connections. Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks for Condensing Appliances."
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
 - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.
 - 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests

The water heater manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the water heater manufacturer to complete the following performance tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Water heaters shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of water heaters.
 - a. Test for full capacity.
 - b. Test for water heater efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION

12-10-25

SECTION 22 4000 - PLUMBING FIXTURES AND TRIM

PART 1 GENERAL

1.01 GENERAL

- A. Plumbing Fixtures and Trim.

1.02 RELATED WORK

- A. Section 20 01 00: General Provisions
- B. Section 22 05 23: Plumbing System Valves
- C. Section 22 10 00: Domestic Water System
- D. Section 22 33 00: Water Heaters and Accessories
- E. Section 22 13 00: Sanitary Waste and Vent Drainage System

1.03 SUBMITTALS

- A. Submit manufacturer's product data and installation instruction complete with rough-in sheets.
- B. Submit a copy of the linear shower trench drains specified within the architectural contract documents to the mechanical engineer for coordination with the installing contractor and the contractor.

1.04 GENERAL REQUIREMENTS

- A. Plumbing Contractor shall furnish and install plumbing fixtures as shown on the accompanying drawings and in accordance with the approved rough in drawings. This will include service sinks, lavatories, water closets, urinals, etc., with all brass in connections with supply with tubing, traps, escutcheons, stop and basin cocks, etc. All fixtures shall be new and must be delivered to the building properly crated and in perfect condition.
- B. All brass must be best quality. All brass pipe to be seamless brass tubing and all fixture traps shall be heavy with C.O. plugs. Nipples shall be extra heavy. Lightweight goods will not be accepted.
- C. All exposed metal on fixtures shall be C.P. or Chromard. All "P" traps shall be complete with cleanout plug.
- D. Plumbing contractor shall submit in his fixture brochure for approval, a rough in sheet of each fixture and indicate any variation required for the fixtures. Fixtures are to be roughed in accordance with these approved rough-in sheets and anchored so that piping cannot be moved.
- E. All plumbing fixtures, materials, and units shall conform to applicable standards (ANSI/NSK, ASME, ASSE, ASTM, FS, UL, etc.) as required International Plumbing Code, Current Edition.

1.05 JOB CONDITIONS

- A. Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.06 GENERAL REQUIREMENTS AND JOB CONDITIONS

- A. Plumbing Contractor shall furnish and install plumbing fixtures as shown on the accompanying drawings and in accordance with the approved rough in drawings. This will include service sinks, lavatories, water closets, urinals, etc., with all brass in connections with supply with tubing, traps, escutcheons, stop and basin cocks, etc. All fixtures shall be new and must be delivered to the building properly crated and in perfect condition.
- B. All brass must be best quality. All brass pipe to be seamless brass tubing and all fixture traps shall be heavy with C.O. plugs. Nipples shall be extra heavy. Lightweight goods will not be accepted.
- C. All exposed metal on fixtures shall be C.P. or Chromard. All "P" traps shall be complete with cleanout plug.
- D. Plumbing contractor shall submit in his fixture brochure for approval, a rough in sheet of each fixture and indicate any variation required for the fixtures. Fixtures are to be roughed in accordance with these approved rough-in sheets and anchored so that piping cannot be moved.

- E. Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
- F. Rough-in locations shall be carefully spotted to result in a symmetrical pattern with sufficient spacing to accommodate full escutcheons.
- G. All fixtures shall have supplies with stops. Stops shall be chrome plated brass. Trim shall be polished, chrome plated brass, same manufacturer as fixture unless otherwise indicated. All pipe, fittings, etc. in connection with supply or drain trim shall be chrome plated. In cases where fixtures may have hot and cold water trim without hot water service, connect cold water to both trim inlets.
- H. Trap separately each fixture and piece of equipment requiring connection to drainage, unless otherwise shown on drawings. Place traps as near to the fixture as possible. No fixture shall be double trapped. Unless indicated otherwise, drain "P" traps shall be polished, chrome plated cast brass with cleanout plug and 17 gauge tubular outlet to wall. For floor drains, hub drains or other similar devices with under floor traps, drain "P" traps shall be same material as the branch piping system.
- I. All plumbing fixtures, materials, and units shall conform to all applicable standards (ANSI/NSF, ASME, ASSE, ASTM, etc.) as required by the International Plumbing Code, Current Edition.
- J. All low water consumption fixtures and flush valve to be provided by the same manufacturer.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES

- A. FIXTURES: Refer to schedule on drawings.
- B. All plumbing fixtures are to be lead-free.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each fixture in accordance with rough-in drawings as per manufacturer's recommendations. At completion thoroughly clean plumbing fixtures and equipment. Anchor fixtures rigidly; anchor piping in walls so that piping cannot be moved.
- B. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers and escutcheons.
- C. Solidly attach floor water closets to floor with lag screws and finishing caps.
- D. Existing fixtures on project in remodeled areas, not shown refused and/or relocated, shall be removed and turned over to the Owner, capping off all existing services behind finished surfaces.
- E. Install each fixture with trap, easily removable for servicing and cleaning.
- F. Mount fixtures to the following heights above finished floor (unless otherwise noted on architect's elevation drawings, ARCHITECTURAL DRAWINGS TO GOVERN FIXTURE HEIGHTS):
 - 1. Water Closets:
 - a. Standard 15" to top of bowl rim
 - b. Handicapped 18" to top of seat
 - 2. Urinal:
 - a. Standard 22" to top of bowl rim
 - b. Handicapped 17" to top of bowl rim
 - 3. Lavatories:
 - a. Handicapped 32" to top of basin rim
 - 4. Water Closet Flush Valves:
 - a. Standard 11" min. above bowl rim
- G. Provide stop valves on all hot and cold water supplies to all fixtures.
- H. Furnish fixture carriers to suit wall construction (and drainage fittings where necessary) on wall hung water closets, wall hung urinals and lavatories. Carriers to be anchored securely to floor.

- I. Install all fixtures according to manufacturer's recommendation.
- J. Mount wall hung water closets with rim at height required by applicable codes.
- K. All exposed screws and fasteners on all plumbing penel fixture including floor drains, cleanout covers, access panels on equipment, etc. shall be vandal proof and tamper resistant.
- L. Provide insulation on hot water, cold water and sanitary piping below handicapped lavatories.
- M. At each toilet on plan provided with a floor drain (or drains), provide a trap primer assembly as specified herein at the handicapped water closet installation or sink/lavatory and extend a trap primer supply line to floor drain or trap connection in accordance with the manufacturer's recommendations.
- N. All flush valves installed on handicapped water closet (ADA) shall be installed with handle to wide side of toilet. Handles on all tanks (applicable to tank water closets) shall be installed with handle to wide side of toilet.
- O. Contractor shall provide copper plated bracket between wall stubs to anchor water piping for flush valves for both water closets and urinals. Contractor shall spot solder water pipe to bracket.
- P. Contractor to provide offset in vertical flush valve piping as not to conflict with installation if grab bars.
- Q. All hardware utilized to secure plumbing fixtures is to be stainless steel. Submit product cut sheet to A/E for review prior to installation.

3.2 FIXTURE ROUGH-IN SCHEDULE

- A. Rough-in fixture piping and size connections shall be in accordance with the following table of minimum sizes for particular fixtures unless noted different on the drawings:

=====

WATER PIPE SIZING TABLE

=====

UNLESS SHOWN OTHERWISE, DOMESTIC WATER LINES SHALL RUN CONCEALED OVERHEAD AS DESIGNATED IN PLUMBING FIXTURE SCHEDULE AND BE SIZED ACCORDING TO TABLE BELOW. PLANS AND RISER DIAGRAMS DO NOT NECESSARILY SHOW ALL PIPING RUNS. INSTALL A FACTORY SHOCK ABSORBER AT TOP OF EACH FIXTURE GROUP AND ALSO AT WATER HEATERS.

=====

<u>NUMBER OF FIXTURES</u>	<u>PIPE SIZE (IPS)</u>
2 or Less	1/2"
3 to 5	3/4"
6 to 10	1"
11 to 15	1-1/4"
16 to 28	1-1/2"

**FLUSH VALVE WATER CLOSET IS EQUIVALENT TO SIX (6) FIXTURES*

- B. SIZES INDICATED ABOVE ARE MINIMUM SIZES TO BE USED UNLESS OTHERWISE SPECIFIED DIFFERENT.

END OF SECTION

12-10-25

SECTION 22 4600 - SECURITY PLUMBING FIXTURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes security plumbing fixtures for detention facilities.

1.3 DEFINITIONS

- A. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.
- B. Back-Mounting-Type Fixture: Designed to mount on wall sleeve built into wall so installation and removal of fixture and piping and other components are only accessible from service space behind wall.
- C. Front-Mounting-Type Fixture: Designed to mount on fixture support with installation and removal from fixture side of wall, and piping and other components are accessible from access panels in fixture or wall.

1.4 SUBMITTAL

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For security plumbing fixtures to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain stainless-steel security plumbing fixtures through one source from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements of ICC A117.1, "Accessible and Usable Buildings and Facilities" and Public Law 101-336, "Americans with Disabilities Act"; about security plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements of U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about security plumbing fixtures for people with disabilities.
- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents (round up to next whole number for fixture amounts).
 - 1. Flushometer Valves: Equal to 5 percent of amount installed for each type indicated.
 - 2. Mechanical and Air-Operated Valves: Equal to 5 percent of amount installed for each type indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. For fixture descriptions and manufacturers refer to the "Plumbing Fixture Schedule" on the drawings.

2.2 FIXTURE SUPPORTS

- A. Off-Floor, Plumbing Fixture Supports: ASME A112.6.1M carriers with dimensions and trim matching fixture.
 - 1. Stainless-Steel, Front-Mounting Fixtures: With modifications.
 - 2. Drinking Fountains: Not used.
 - 3. Lavatories: Type III lavatory carrier.
 - 4. Water Closets: Combination support and waste fitting assembly.

2.3 VANDAL PROOF SCREWS:

- A. All screws to any exposed cover, floor drain, clean out, valve box, etc. to be vandal proof and tamper resistant (rejection pin torx style).

2.4 ANTI FLOOD DEVICES

- A. All security fixtures to come with anti-flood devices to prevent inmates from repeatedly operating fixture to flood the facility.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water, soil, and waste piping systems to verify actual locations of piping connections before security plumbing fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SECURITY PLUMBING FIXTURE INSTALLATION

- A. Install back-mounting-type, stainless-steel security plumbing fixtures as follows:
 - 1. Install wall sleeve in wall.
 - 2. Install fixture on wall sleeve; mount components on or attached to wall sleeve with access from accessible service space.
 - 3. Extend supply piping from service space to fixture.
 - 4. Install soil and waste piping from fixture and extend into service space.
 - 5. Install fixture trap in service space instead of below fixture drain.
- B. Install front-mounting-type, stainless-steel security plumbing fixtures as follows:
 - 1. Install fixture support or mounting bracket.
 - 2. Install fixture on support; mount components inside of or attached to fixture.
 - 3. Extend supply piping from pipe space to fixture.
 - 4. Install trap below fixture and extend soil and waste piping into pipe space.
- C. Install security plumbing fixture outlets with gasket seals.
- D. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.
- E. Install fixtures level and plumb.
- F. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves in locations where they can be easily reached for operation.
- G. Install dielectric fittings in water-supply piping to fixtures if piping and fixture connections are made of different metals. See Division 20 Section "Basic Mechanical Materials and Methods" for dielectric fittings.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20,21 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect hot- and cold or tempered as indicated -water-supply piping to security plumbing fixtures.
- C. Connect security plumbing fixture soil and waste drain outlets to sanitary drainage and vent piping.
- D. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Testing: After installing security plumbing fixtures and after electrical circuitry has been energized, test for compliance with requirements.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

3.5 ADJUSTING

- A. Operate and adjust water-supply flushometers and flow-control valves on security plumbing fixtures.

3.6 CLEANING

- A. Remove sediment and debris from supply and drain piping, faucets, and strainers.
- B. Clean security plumbing fixtures with manufacturers' recommended materials and methods.

END OF SECTION
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SECTION 23 01 35 - WELDING EXHAUST FAN

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Belt Driven Single Width Centrifugal Fan Welding Exhaust Fan

1.2 RELATED SECTIONS

- A. All sections, drawing plans, specifications and contract documents.

1.3 REFERENCES

- A. ANSI/AMCA Standard 99-10, "Standards Handbook"
- B. ANSI/AMCA Standard 204-05, "Balance Quality and Vibration Levels for Fans"
- C. ANSI/AMCA Standard 210-07, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
- D. AMCA Publication 211-05, "Certified Ratings Program – Product Rating Manual for Fan Air Performance"
- E. ANSI/AMCA Standard 300-08, "Reverberant Room Method for Sound Testing of Fans"
- F. AMCA Publication 311-05, "Certified Ratings Program – Product Rating Manual for Fan Sound Performance"
- G. AMBA - Method of Evaluating Load Ratings of Bearings ANSI-11 (r1999).
- H. AMCA Standard 500-D-12, "Laboratory Methods of Testing Dampers for Rating"
- I. OSHA guideline 1910.212 – General requirements for Machine Guarding.
- J. OSHA guideline 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus.
- K. OSHA guideline 1926.300 – General requirements for safe operation and maintenance of hand and power tools.
- L. UL/cUL 705, Power Ventilators
- M. UL/cUL 762, Power Ventilators for Restaurant Exhaust Appliances
- N. UL/cUL Power Ventilator for Smoke Control Systems

1.4 QUALITY ASSURANCE

- A. Performance ratings: Conform to ANSI/AMCA Standards 210 and 300. Fans must be tested in accordance with AMCA Publications 211 and 311 in an AMCA accredited laboratory and certified for air and sound performance. Fans shall be licensed to bear the AMCA ratings seal for air performance (AMCA 210).
- B. Classification for Spark Resistant Construction shall conform to ANSI/AMCA Standard 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)
- D. Comply with the National Electrical Manufacturers Association (NEMA) standards for motor and electrical accessories.
- E. Each fan shall undergo a factory run test where fan RPM and amp draw are recorded. This information is available to the customer free of charge upon request.

1.5 SUBMITTALS

- A. Provide dimensional drawings and product data on each centrifugal fan.
- B. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- C. Provide outlet velocity of centrifugal fans and fan's inlet and outlet sound power readings for the eight octave bands.
- D. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.4 of this specification.
- E. Provide manufacturer's certification that exhaust fan is licensed to bear the Air Movement and Control Association (AMCA) Certified Rating Seal for air performance and sound performance where applicable.
- F. Provide manufacturer's Installation, Operation and Maintenance manual (IOM), including instructions on safety information, receiving, handling, and storage, installation, electrical wiring diagrams, operation, maintenance, troubleshooting guide, and warranty.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage, follow manufacturer's Installation, Operation and Maintenance manual.
- C. Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.7 WARRANTY

- A. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
 - a. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from date of acceptance with project.
 - b. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished prove defective during this period, they should be returned to the nearest authorized motor service station.

PART 2 – PRODUCTS

2.1 GENERAL

- A. Base fan performance at standard conditions (density 0.075 Lb/ft³).
- B. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
- C. Each fan shall be belt drive in AMCA arrangement 10 according to drawings.
- D. Normal operating temperature up to 180 Degrees Fahrenheit.
- E. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model and individual serial number.
- F. Fans are to be equipped with lifting lugs.

- G. Constructed of heavy gauge steel
- H. After fabrication, untreated steel components go through a multi-stage cleaning and pre-treatment process before being finished with a high-performance powder coating having a minimum thickness of 2-4 mils, electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method. No uncoated metal fan parts will be allowed.

2.2 FAN HOUSING AND OUTLET

- A. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
- B. Fan shall be of airtight continuously welded heavy gauge scroll construction. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating.
- C. Housing and bearing support shall be constructed of bolted framework.
- D. An OSHA compliant belt guard shall be included to completely cover the motor pulley and belt(s).

2.3 FAN WHEEL

- A. The fan wheel shall be of the single width backward inclined centrifugal type.
- B. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
- C. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

2.4 FAN MOTORS AND DRIVE

- A. Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 1170, 1770 or 3500 RPM in 60 Hz, (1425 or 2900 in 50 Hz) Open Drip Proof (ODP), Totally Enclosed Fan Cooled (TEFC) or Explosion Proof (EXP).
- B. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
- C. Movable motor plate with adjustment screws to make belt tensioning operations.
- D. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
- E. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
- F. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
- G. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class {Average Life or (L-50) of 400,000 hours}.
- H. Bearings shall have Zerk fittings to allow for lubrication.

2.5 ACCESSORIES

- A. Parallel blade gravity damper shall be factory mounted. Galvanized
- B. Provide coated steel weatherhood to protect motor and drives
- C. Fan shall be Spark C resistance construction. This includes aluminum inlet cone and aluminum wheel rub ring.
- D. Provide equipment supports with direct mount 1 inch spring isolators.

- E. Provide NEMA 3R disconnect switch.
- F. Provide hinged access door in housing.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install fans systems as indicated on the contract drawings.
- B. Install fans in accordance with manufacturer's Installation, Operation and Maintenance manual.

PART 4 - ACCEPTABLE MANUFACTURERS

- A. Greenheck Fan Corporation Model USF or prior approved equal.

END OF SECTION

12-10-25

SECTION 23 04 14 - MOTOR STARTERS

PART 1 MANUFACTURER

1.01 Manufacturer

- A. Approved Manufacturer: Franklin Controls, General Electric, or prior approved equal.

1.02 Submittals

Manufacturer shall provide copies of the following documents:

- A. Product data sheets on specified products.
- B. Shop drawings for specified product.
- C. Wiring Schematics for specified products.

PART 2 PRODUCTS

2.01 Section Includes:

- A. Enclosed FVNR combination single phase motor starter with electronic overload relay
- B. Enclosed FVNR non-combination motor starters with electronic overload relay
- C. Enclosed FVNR combination motor starters with electronic overload relay

2.02 References

The starters referenced in this section are designed and manufactured to the following standards unless otherwise noted:

- A. ANSI/NFPA -70, National Electric Code
- B. UL 508, and UL508A Industrial Control Equipment
- C. NEMA ICS-2, 2000
- D. IEC 60947-5, 60947-4, 60947-3

2.03 System Description

- A. Single Phase Starter: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation. Refer to Section 2.03.1 for single phase starter requirements.
- B. Magnetic Starters: Starters for 3-phase motors shall be magnetic starters. Refer to Section 2.03.2 for magnetic starter requirements.
- C. Combination Starters: Provide combination magnetic starters for all motors requiring branch circuit protection or a line-of-sight disconnect. Refer to Section 2.03.3 for combination magnetic starter requirements.
- D. Enclosures: NEMA/UL Type 1 for indoor applications, NEMA or UL Type 3R for outdoor applications

2.03.1 Enclosed Full Voltage Non-Reversing (FVNR) Single Phase Starter

- A. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.
- B. Approved manufacturer: Franklin Controls, model BAS-1P or approved equal.

2.03.2 Enclosed Full Voltage Non-Reversing (FVNR) Non-Combination Starter

- A. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
- B. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 2NO and 2NC auxiliary contacts and solid state electronic overload relay.
- C. Overload relay shall protect all three phases with a wide range 1-40 amp current setting and trip class to allow field adjustment for specific motor FLA. Interchangeable heater elements are not acceptable.
- D. Overload relay shall incorporate SmartStart Technology, or the following protective functions:
 - a. Out of calibration protection (if the FLA on the overload is set outside acceptable range, overload will trip to indicate fault event)
 - b. Stall protection
 - c. Max time to start
 - d. Locked Rotor
 - e. Phase Unbalance
 - f. Phase loss
 - g. Cycle Fault
- E. Starter shall be field selectable for manual or auto reset to restore normal operation after a trip or fault condition. Manual pushbutton shall be accessible without removing or opening cover on starter.
- F. In the event of a power failure, starter shall restart in last mode by default. Starter shall also be capable of restart with 10 second delay, or restart in "off" mode.
- G. All starters must be provided with a universal power supply capable of a 208 to 600 volt input range. The power supply must accept the available line voltage and the control voltage shall not exceed 24V.
- H. Installed accessories shall include Hand-Off-Auto operation pushbutton keypad. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions.
- I. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals from 12-250V to allow direct connection of the transistorized automation signal to the starter.
- J. Starter must contain an integral current sensor with NO contact which closes to indicate motor run status as well as a NO contact which closes when an overload trip condition occurs.
- K. In applications where the motor is interlocked with a 24VDC damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
- L. The starter shall include a dedicated voltage input for Fireman's Override operation. When activated, the starter run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
- M. If the starter is controlled by a fire alarm or life safety system, the starter shall include an Emergency Shutdown input which will disable the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
- N. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served

2.03.3 Enclosed Full Voltage Non-Reversing (FVNR) Combination Starter

- A. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. All disconnects shall include a lock-out mechanism when in the off position.
- B. Motor circuit protectors (MCP) shall be provided as the acceptable form of disconnecting means. The MCP shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The MCP shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.

2.04 PROVIDE OPTIONAL FEATURES, AS REQUIRED, TO MEET DESIGN PERFORMANCE ACCORDING TO THE FOLLOWING REQUIREMENTS.

- A. Must provide over/under voltage and phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after a trip.
- B. Starter must measure and display output current on the front cover. If necessary, install digital or analog ammeter.
- C. The starter shall provide the capability to monitor and calculate power consumption (kWh) of the motor load. Each starter shall display the calculated kW and kWh. Additionally, provide either a pulse output (kWh) or 4-20mA analog signal (kW) to the automation system to monitor the power consumption.
- D. Starter must be capable of communicating over BACnet MS/TP. At a minimum, reported points shall include starter mode, terminal input status, run/fault status, voltage, current, power factor, kW and kWh.

2.05 Quality Assurance

- A. Manufacturer shall provide a five year warranty on the complete starter assembly.
- B. The starter assembly shall be UL listed under UL 508A.

END OF SECTION

12-10-25

SECTION 23 05 14 - VARIABLE FREQUENCY DRIVE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This specification is to cover a complete Adjustable Frequency motor Drive (AFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.
- B. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of twenty years.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - 2. Underwriters laboratories
 - a) UL508C
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a) ICS 7.0, AC Adjustable Speed Drives
 - 4. IEC 16800 Parts 1 and 2
- B. Qualifications:
 - 1. AFDs and options shall be UL listed as a complete assembly. AFD's that require the customer to supply external fuses for the AFD to be UL listed are not acceptable. The base AFD shall be UL listed for 100 KAIC without the need for input fuses.
 - 2. CE Mark – The AFD shall conform to the European Union ElectroMagnetic Compatibility directive, a requirement for CE marking. The AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
 - 3. Acceptable Manufactures
 - a) ABB ACH Series, Honeywell or prior approved equal.
 - b) Engineer approved within 2 weeks of bid. Approval does not relieve supplier of specification requirements.
 - c) AFDs that are manufactured by a third party and "brand labeled" shall not be acceptable.
 - 4. The AFD manufacturer shall have available a comprehensive, HVAC Drive Computer Based Training (CBT) product. The CBT product shall include detailed, interactive sections covering AFD unpacking, proper mechanical and electrical installation, and programming. The CBT product shall allow the user to provide just-in-time training to new personnel or refresher training for maintenance and repair personnel on the user's site. The CBT product shall be repeatable, precise and shall include record keeping capability. The CBT product shall record answers to simulations and tests by student ID. The CBT product must be professionally produced and have interactive sections, student tests, and include video clips of proper wiring and installation.

1.03 SUBMITTALS

- A. Submittals shall include the following information:
 - 1. Outline dimensions, conduit entry locations and weight.
 - 2. Customer connection and power wiring diagrams.

3. Complete technical product description include a complete list of options provided
4. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - a. The AFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFD's shall include a minimum of 5% impedance reactors, no exceptions.

PART 2 – PRODUCTS

2.01 ADJUSTABLE FREQUENCY DRIVES

- A. The AFD package as specified herein shall be enclosed in a UL Listed Type 3R (for interior & exterior installations) enclosure, completely assembled and tested by the manufacturer in an ISO9001 facility. The AFD tolerated voltage window shall allow the AFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
 1. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - a. The AFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519. All AFD's shall include a minimum of 5% impedance reactors, no exceptions.
 2. Environmental operating conditions: 0 to 40°C continuous. AFD's that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.
 3. Enclosure shall be rated UL type 12 and shall be UL listed as a plenum rated AFD. AFD's without these ratings are not acceptable.
- B. All AFDs shall have the following standard features:
 1. All AFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple AFDs.
 2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Hand” and “Auto” modes. There shall be fault reset and “Help” buttons on the keypad. The Help button shall include “on-line” assistance for programming and troubleshooting.
 3. There shall be a built-in time clock in the AFD keypad. The clock shall have a battery back up with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the AFD shall automatically revert to hours of operation since initial power up. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The AFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

4. The AFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The AFD shall have two user macros to allow the end-user to create and save custom settings.
5. The AFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the AFD from the wall or removal of circuit boards. The AFD cooling fans shall operate only when required. To extend the fan and bearing operating life, operating temperature will be monitored and used to cycle the fans on and off as required.
6. The AFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The AFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
9. The AFD shall have an integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. AFD's with only one DC reactor shall add AC line reactors.
10. The input current rating of the AFD shall be no more than 3% greater than the output current rating. AFD's with higher input current ratings require the upstream wiring, protection devices and source transformers to be oversized per NEC 430-2.
11. The AFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The AFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false underload condition.
13. If the input reference (4-20mA or 2-10V) is lost, the AFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the AFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
14. The AFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All AFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the AFD from operating the load continuously at an unstable speed.
2. Two (2) PID Setpoint controllers shall be standard in the drive, allowing

pressure or flow signals to be connected to the AFD, using the microprocessor in the AFD for the closed loop control. The AFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID setpoint shall be adjustable from the AFD keypad, analog inputs, or over the communications bus. There shall be two parameter sets for the first PID that allow the sets to be switched via a digital input, serial communications or from the keypad for night setback, summer/winter setpoints, etc. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain setpoint of an independent process (ie. valves, dampers, etc.). All setpoints, process variables, etc. to be accessible from the serial communication network. The setpoints shall be set in Engineering units and not require a percentage of the transducer input.

3. Two (2) programmable analog inputs shall accept current or voltage signals.
4. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
5. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices, typically programmed as follows:

There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications) the AFD shall provide a dry contact closure that will signal the damper to open (AFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to an AFD digital input and allows AFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety status shall also be transmitted over the serial communications bus. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC.
6. Three (3) programmable digital Form-C relay outputs. The relays shall include programmable on and off delay times and adjustable hysteresis. Default settings shall be for run, not faulted (fail safe), and run permissive. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.
7. Seven (7) programmable preset speeds.
8. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.
9. The AFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.
10. The AFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual AFD temperature that allows the highest carrier frequency without derating the AFD or operating at high carrier frequency only at low speeds.
11. The AFD shall include password protection against parameter changes.

- D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall utilize the following assistants:
1. Start-up assistants.
 2. Parameter assistants
 3. Maintenance assistant
 4. Troubleshooting assistant
- E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
- Output Frequency
 - Motor Speed (RPM, %, or Engineering units)
 - Motor Current
 - Calculated Motor Torque
 - Calculated Motor Power (kW)
 - DC Bus Voltage
 - Output Voltage
- F. The AFD shall include a fireman's override input. Upon receipt of a contact closure from the fireman's control station, the AFD shall operate at an adjustable preset speed. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands) and force the motor to run at the adjustable, preset speed. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the AFD shall resume normal operation.
- G. Serial Communications
1. The AFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base AFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.
 2. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - a. Data Sharing – Read Property – B.
 - b. Data Sharing – Write Property – B.
 - c. Device Management – Dynamic Device Binding (Who-Is; I-AM).
 - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - e. Device Management – Communication Control – B.
 - f. If additional hardware is required to obtain the BACnet interface, the AFD manufacturer shall supply one BACnet gateway per drive. Multiple AFDs sharing one gateway shall not be acceptable.
 3. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the

DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the AFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote AFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad “Hand” or “Auto” selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The DDC system shall also be able to monitor if the motor is running in the AFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The AFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any AFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.
 5. The AFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the AFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The AFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.
- H. EMI / RFI filters. All AFD's shall include EMI/RFI filters. The onboard filters shall allow the AFD assemble to be CE Marked and the AFD shall meet product standard EN 61800-3 for the First Environment restricted level.
- I. All AFD's through 50HP shall be protected from input and output power mis-wiring. The AFD shall sense this condition and display an alarm on the keypad.
- J. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
1. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection and shall be provided in both drive and bypass modes.
 2. Door interlocked, padlockable circuit breaker that will disconnect all input power from the drive and all internally mounted options.
 3. Fused AFD only disconnect (service switch). Fast acting fuses exclusive to the AFD – fast acting fuses allow the AFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the AFD and the bypass will not be accepted. Three contactor bypass schemes are not acceptable.
 4. The drive / bypass shall provide single-phase motor protection in both the AFD and bypass modes.
 5. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector

- c. Bypass mode selector
 - d. Bypass fault reset
6. The following indicating lights (LED type) shall be provided. A test mode or push to test feature shall be provided.
 - a. Power-on (Ready)
 - b. Run enable (safeties) open
 - c. Drive mode select damper opening
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Bypass H-O-A mode
 - j. Automatic transfer to bypass selected
 - k. Safety open
 - l. Damper opening
 - m. Damper end-switch made
 7. The following relay (form C) outputs from the bypass shall be provided:
 - a. System started
 - b. System running
 - c. Bypass override enabled
 - d. Drive fault
 - e. Bypass fault (motor overload or underload (broken belt))
 - f. Bypass H-O-A position
 8. The digital inputs for the system shall accept 24V or 115VAC (selectable). The bypass shall incorporate internally sourced power supply and not require an external control power source.
 9. Customer Interlock Terminal Strip – provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in Fireman's Override 2). The remote start/stop contact shall operate in AFD and bypass modes.
 10. Dedicated digital input that will transfer motor from AFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required.
 - a. One mode forces the motor to bypass operation and overrides both the AFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
 - b. The second fireman's override mode remains as above, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).
 11. The AFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in AFD or bypass mode). The AFD system (AFD or bypass) shall not operate the motor until it receives a dry contact

closure from a damper or valve end-switch. When the AFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.
13. There shall be an internal switch to select manual or automatic bypass.
14. There shall be an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

PART 3 – EXECUTION

3.01 INSTALLATION: In accordance with the general conditions, contractor is responsible for dividing the work among the subcontractors and suppliers and for delineating the work to be performed by specific trades. The following are suggestions as to how the work may be divided. This is not a complete list of all the work:

- A. Installation shall be the responsibility of the electrical contractor. The contractor shall install the drive in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.
- B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the AFD manufacturer as outlined in the installation manual.

3.02 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.03 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with the AFD products offered shall be locally available at both the specifying and installation locations. A 24/365 technical support line shall be available on a toll-free line.
- B. A computer based training CD or 8-hour professionally generated video (DVD format) shall be provided to the owner at the time of project closeout. The training shall include installation, programming and operation of the AFD, bypass and serial communication. Provide copy in O&M manuals.

3.04 WARRANTY

- A. Warranty shall be 24 months from the date of substantial completion. The warranty shall include all parts, labor, travel time and expenses. There shall be 365/24 support available via a toll free phone number.

3.05 SCHEDULE

- A. Provide VFD's for all air handling units, and as noted on plans & schedules.
- B. Provide shaft grounding rings for all motors that are to be controlled by variable frequency drives.

END OF SECTION

12-10-25

SECTION 23 0590 - CONTRACTOR COORDINATION WITH TESTING, ADJUSTING & BALANCING

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.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. Perform all Work required to prepare the building HVAC systems for testing, adjusting, and balancing (TAB) Work indicated by the Contract Documents, including the following:
 - 1. Preparation of air systems for testing, adjusting and balancing.
 - 2. Not used.
 - 3. Providing materials and labor to assist TAB Firm in meeting testing, adjusting and balancing requirements.
- B. Testing, adjusting and balancing of the air conditioning systems and related ancillary equipment will be performed by a technically qualified TAB Firm. The preparation for and corrections necessary for the testing, adjusting and balancing of these systems, as described herein, are the responsibility of this Contractor.
- C. Make any changes or replacements to the sheaves, belts, dampers and valves required for correct balance as advised by the TAB Firm, at no additional cost to the Owner.

1.3 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. AABC: National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems.
 - 2. AABC: Testing and Balancing Procedures.
 - 3. ASHRAE HVAC Applications Chapter 37: Testing, Adjusting and Balancing.
 - 4. ANSI/ASHRAE Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.4 QUALITY ASSURANCE

- A. Provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including during the testing, adjusting and balancing period.
- B. In order that systems may be properly tested, adjusted, and balanced, the Contractor shall operate systems at Contractor's expense for the length of time necessary to properly verify the systems' completion and readiness for TAB.
- C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. Allow adequate time for the testing and balancing activities during the construction period and prior to Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. None used.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Contractor shall be responsible to prepare the building heating, ventilating, and air conditioning systems ready for TAB when scheduled.
- B. Operational readiness requires that construction status of the building will permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.
- C. Notification of System Readiness:
 - 1. Upon completion of the system installation Work, the Contractor shall notify the Owner and TAB Firm in writing, certifying that the Work has been accomplished and that the air conditioning systems are in operational readiness for testing, adjusting, and balancing.
 - 2. TAB Firm shall notify the Contractor of TAB Firm's readiness for balancing.
 - 3. Should the TAB Firm be notified as described above, and the TAB Work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by a duly appointed representative of the Owner, Architect, TAB Firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted Work accomplished by the TAB Firm shall be the responsibility of the Contractor.

3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Allow sufficient time for the TAB Firm to perform TAB Firm's Work within the Project schedule. Complete installation Work by system or floor, whichever is the most efficient for scheduling. Develop the Project schedule in close coordination with the TAB Firm.
- D. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions. Install these devices in a manner that will leave the devices accessible and readily able to be adjusted. Immediately correct any malfunction encountered that the TAB Firm reports so that the balancing Work can proceed with minimal delay.
- E. Contractor shall promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB Work.

3.3 SYSTEMS VERIFICATION

- A. Air Distribution Systems:
 - 1. Verify installation for conformity to the Contract Documents. All supply, return, and exhaust ducts shall be terminated and pressure tested for leakage as required by the Contract Documents.
 - 2. All volume, smoke and fire/smoke dampers are properly located and functional. Dampers serving requirements of minimum and maximum outside, return, and relief air shall provide tight closure and full opening, smooth and free operation.
 - 3. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices are installed and airflow at each device shall be verified.
 - 4. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., shall be sealed or blanked-off to eliminate excessive uncontrolled bypass or leakage of air.
 - 5. All fans (supply, return and exhaust) operating and verified for freedom from vibration, with proper fan rotation and belt tension. Heater elements in motor starters are of proper size and rating. Record motor amperage and voltage on each phase at Start-up and running, and verify they do not exceed nameplate ratings.

6. All single and/or double duct variable and constant volume terminal units ("mixing boxes") shall be installed and functional (i.e. controls functioning).
 7. Duct systems and air handling units and coils are clean and free of debris.
 8. Air systems are pressure independent and can be tested by floor, riser, system, etc. but once the all systems are installed, the total flows and system tracking will require final testing, adjusting and balancing.
- B. Water Circulating Systems:
1. Not used.
- C. Building Automation System (BAS):
1. Verify that all control components are installed in accordance with the Contract Documents and that all control components are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.
 2. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB Firm and BAS Provider.
 3. BAS Provider shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB Firm that the building automation system is operational. The BAS Provider shall provide technical support, including technicians and necessary computers, to the TAB Firm for a complete check of these systems.
 4. BAS Provider shall assist the Contractor with functional performance testing and point-to-point testing back to the main graphics.
 5. BAS Provider, if requested by Owner, shall set-up controls on sample fan powered terminal units at TAB Firm's office.

END OF SECTION

12-10-25

SECTION 23 0593 - TESTING AND BALANCING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. All division 23 specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to in this section.

1.2 SCOPE OF WORK

- A. The **CONTRACTOR** shall obtain the services of an independent Test and Balance (TAB) Company which specializes in the testing and balancing of heating, ventilating and air conditioning (HVAC) systems to test, adjust and balance all HVAC systems in the building(s). *The project shall not be accepted until approved Testing and Balancing Report has been submitted and approved.*
- B. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results. The testing, adjusting and balancing agency shall act as a reporting agency; that is, list and report each piece of equipment as to identification number, manufacturer, model number, serial number, proper location, specified performance, and report actual performance of all equipment as found during testing. The report is intended to be used during the life of the building as a ready reference indicating original conditions, equipment components, etc.
- C. Representatives of the Test and Balance Company shall visit the job site at 60% and 90% completion of installation of the HVAC equipment, piping and ductwork to review the installation. After each site visit, the Test and Balance Company shall report to the Architect any items that are not installed properly, are missing from the installation or items that are required to enable him to perform the testing and balancing of the HVAC systems as per normal standard practice. After review, the Architect shall instruct the Contractor to implement the recommendations at no additional cost to the Owner if these items were specified in the original scope of the project.
- D. Upon completion of the HVAC system installation, the Test and Balance Company shall perform all required testing and balancing with the full cooperation of the Contractor and his Sub-contractors. The Contractor shall make changes and/or adjustments to the HVAC system components that are required by the Test and Balance Company to accomplish proper balancing. The TAB agency shall not supply or install any materials or balancing devices such as pulleys, drives, belts, etc. All of this work is by the Contractor and shall be performed at no additional cost to the Owner.
- E. The test and balance report shall be submitted to the Architect for review by his Mechanical Engineer. If the Mechanical Engineer agrees with the report, he shall sign it and return it to the Architect. If he does not concur with the report, he shall meet with the Test and Balance Company to determine what needs to be done to obtain a properly balanced system.
- F. After the Mechanical Engineer signs the testing and balancing report, the Test and Balance Company shall supply four (4) copies of the final and complete report to the Architect for inclusion in the Operation and Maintenance Manuals.
 - 1. Report to in format of sample report located at the end of this specification section. For all items that are not applicable the contractor shall note as "NOT

APPLICABLE”.

- G. The items requiring testing, adjusting, and balancing include (but are not restricted to) the following:

AIRSYSTEMS:

Supply Fan

AHU

Exhaust Fans

Zone branch and main ducts

Diffusers, Registers, Grilles and Dampers

Coils (Air Temperatures)

Valves

Vibration Isolators

Fan Coil Units

Outside Air Units

Kitchen Exhaust/Supply Fans

- H. The Contractor will provide the services of a qualified test and balance contractor. The qualifications of the TAB contracting firm shall be submitted, along with the specific qualifications of the lead site technician who will remain on site during all TAB work, within 30 days of notice to proceed. Recent projects shall be listed and described for both the company and the lead technician. Names and telephone numbers of the project contractors and facility managers will be provided.
- I. The owner must approve in writing the qualifications of both the company and the lead technician.
- J. At the time of final inspection, the TAB agency shall be required to recheck, in the presence of the owner's representative & mechanical engineer, specific and random elections of data, temperatures, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative & mechanical engineer at time of recheck. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, shall not exceed 10% of the total number tabulated in the report.

1.3 DEFINITIONS, REFERENCES, STANDARDS

- A. All work shall be in accordance with the latest edition of the Associated Air Balance Council (AABC) National Standards. If these contract document set forth more stringent requirements than the AABC National Standards, these contract documents shall prevail.

1.4 QUALIFICATIONS

- A. Agency Qualifications: The TAB Agency shall be a current member of the AABC, NEBB certification alone not acceptable.

1.5 SUBMITTALS

- A. Qualifications: The TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy

of the agency's test and balance engineer (TBE) certificate.

- B. Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.
- C. Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

1.6 TAB PREPARATION AND COORDINATION

- A. Shop drawings, submittal data, up-to-date revisions, change orders, fan curves, pump curves and other data required for planning, preparation, and execution of the TAB work shall be provided when available and no later than 30 days prior to the start of TAB work.
- B. System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin, except that duct leak testing shall be done during construction.
- C. The building control system (BCS) contractor shall provide and install the control system, including all temperature, pressure and humidity sensors. These shall be calibrated for accurate control. If applicable, the BCS contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.
- D. All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
- E. Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.
- F. If, upon commencing the work, the TAB contractor finds that the systems are not ready, or if a dispute occurs as to the readiness of the systems, the TAB contractor may request an inspection to be made by the Designer's Mechanical Engineer. This inspection shall establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for testing and balancing. Items that are determined to be not ready for testing and balancing shall be completed by the Mechanical Contractor and placed in operational readiness before TAB services are again requested.

1.7 REPORTS

- A. Final TAB Report - The TAB agency shall submit the final TAB report for review by the Architect. On plans provided, all outlets, devices, HVAC equipment, etc., shall be identified (including manufacturer, model number, serial number, motor manufacturer, HP, drive type, fan and motor sheaves and belt number), along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.
- B. Submit 4 copies of the Final TAB Report to the Architect for inclusion in the Operation and Maintenance Manuals.

PART 2 - INSTRUMENTATION

- A. All instruments used for measurements shall be accurate and calibrated.
- B. Calibration and maintenance of all instruments shall be in accordance with the

requirements of AABC National Standards.

PART 3 - EXECUTION

3.1 GENERAL

- A. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be + or - 10% unless otherwise stated.
- B. Equipment settings, including manual damper quadrant positions, valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.
- C. All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions of work required, as listed in this section, are a guide to the minimum information needed.
- D. TAB contractor shall cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. Upon completion, patch insulation, ductwork and housings using materials identical to those removed. Seal insulation to reestablish integrity of the vapor barrier.
- E. TAB work shall include additional inspection and adjustment of components during the season following the initial balance to include re-balance of any items influenced by seasonal changes or as directed by the Owner.

3.2 AIR SYSTEMS

- A. The TAB agency shall verify that all ductwork, splitters, extractors, dampers, grilles, registers, and diffusers have been installed per design, are functional and set full open. Any leakage in the ductwork shall be repaired prior to the test. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:

For supply fans:

- 1. Fan speeds - Test and adjust fan RPM to achieve design CFM requirements.

*Prior to replacing pulley's & sheaves at supply fan, TAB contractor to measure total air flow of supply fan with respective variable speed drive (VFD) set @ 30Hz. TAB contractor to dial up on VFD until total specified total air flow is achieved. Provide frequency of VFD at maximum air flow on TAB report.
- 2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
- 3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
- 4. Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. If a traverse is not practical use the mixed- air temperature method if the inside and outside temperature difference is at least 20 degrees

Fahrenheit or use the difference between Pitot-tube traverses of the supply and return air ducts.

5. Static Pressure - Test and record system static pressure, including the static pressure profile of each supply fan.

For kitchen exhaust / supply fans:

1. Fan speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main transfer ducts to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Static Pressure - Test and record system static pressure, including the static pressure profile of each smoke exhaust fan.

For exhaust fans:

1. Fan speeds - test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Static Pressure - Test and record system static pressure, including the static pressure profile of each exhaust fan.

For zone, branch and main ducts:

1. Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi- diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

For diffusers, registers and grilles:

1. Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts. Include required CFM, initial test CFM and final CFM.
2. Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

For coils:

1. Air Temperature - Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the

entering and leaving side of each heating coil.

3.3 HYDRONIC SYSTEMS

1. Not used.

3.4 SOUND TESTING

- A. The TAB agency shall conduct sound testing in the following areas per AABC National Standards and to the criteria listed, using sound meter with octave band analyzer:

<u>TEST AREA</u>	<u>NUMBER OF LOCATIONS</u>	<u>ACCEPTABLE LEVEL</u>
General Offices	6	30-35
Executive Offices	1	25-30
Computer/Equipment Rooms	2	40-45
Schools/Classrooms	3	25-30

- B. All measurements are to be in accordance with AABC. Contractor shall utilize a sound meter with octave band analyzer.
- C. Provide cut sheet of all sound measurement devices to mechanical engineer for approval.

3.5 ADDITIONAL TAB SERVICES

- A. Verification of HVAC Controls:

The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.

- B. Temperature Testing:

To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit from the thermostat or control set point during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

- C. Kitchen Hood Testing:

The TAB agency shall test and adjust kitchen hood total air flow by duct Pitot-tube traverse if applicable under local code. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. All sealing of test holes in the exhaust duct to be by others per local code requirements. The TAB agency shall test and record face velocities in accordance with design requirements. It shall test and adjust makeup air flow (if included) to meet design face velocities and pressurization and to minimize turbulence.

- D. TAB Report Verification:

At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific and random selections of data, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

E. Job Site Inspections:

During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are performed when 60% of the total system is installed and again when 90% of the total system is installed, prior to insulation of the duct and piping). The TAB agency shall submit a written report of each inspection to the Architect.

F. Seasonal Rebalancing:

This TAB contractor shall figure in bid rebalancing HVAC system during peak seasonal conditions (summer & winter) in order to provide design team with HVAC information from peak design conditions. This work shall be completed within the one (1) year warranty period.

G. Duct Leakage Testing:

The installing contractor shall isolate and seal sections of ductwork for testing. The pressurization fan and test apparatus shall be connected to the test section and the test performed. The test pressures required and the amount of duct to be tested shall be described by the engineer in the appropriate duct classification section. All testing shall be based on one test per section.

I. Fume Hood Testing:

The TAB agency shall test and adjust fume hood total air flow by duct Pitot-tube traverse. If the Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. Test and record face velocities under design operating conditions using a maximum of one square foot grid pattern across the entire open face. The TAB agency shall set height on hoods to obtain face velocities within 20% of 100 feet per minute unless specified otherwise. It shall test and adjust VAV controllers to obtain design exhaust air flows and make-up air flows to maintain design hood pressures and face velocities, and design room pressurization. The TAB agency shall test for turbulence and proper air flow patterns at the face and inside the hoods using a hand-held smoke puffer or other approved smoke-emitting device.

H. Building/Zone Pressurization:

The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

J. Air Leakage Rate Testing:

The entire facility (All Buildings) shall be tested for air leakage rate by fan pressurization (Blower Door Test). The air leakage test shall be in accordance with ASTM E779 (Current Edition).

3.4 INDOOR AIR QUALITY VERIFICATION

- A. The TAB agency shall take measurements at minimum outside air. It shall measure temperature and humidity uniformity throughout the space, check filter installation for proper fit, seal, and operation, and verify condensate drain operation. The TAB agency shall note any water damage or obvious contamination sources from inside or outside.
- B. The TAB agency shall conduct the following air sampling tests using TWA limits shown in ASHRAE Standard 62.1-2013, Table B-1 (the test shall be performed on the exterior of the building as well as throughout the interior of the building as to establish comparative data between the indoor & outdoor IAQ):
 - 1. Carbon dioxide
 - 2. Carbon monoxide
 - 3. Formaldehyde
 - 4. Lead
 - 5. Nitrogen dioxide
 - 6. Ozone
 - 7. Radon
 - 8. Sulfur Dioxide
 - 9. Particles
- C. The TAB agency shall prepare a short report showing the results and location of each test, a summary of the HVAC operating conditions, and a listing of any discrepancies.

3.5 VIBRATION TESTING

- A. The TAB agency shall conduct vibration testing on the following equipment per AABC National Standards. Test deflection in mils and velocity in inches per second shall be measured and the results compared to requirements in equipment specification sections.

EQUIPMENT:

Air Handling Units

Fans

VRF Units

END OF SECTION

12-10-25

TEST AND BALANCE ANALYSIS REPORT

FOR

JOB

CONTRACTOR

ARCHITECT

ENGINEER

C_x AGENT

PJ#

CERTIFICATION:

AIR DISTRIBUTION SYSTEM HAS BEEN COMPLETELY BALANCED AS PER
REQUIREMENTS OF SPECIFICATIONS AND RESULTS FOR TESTS HEREIN LISTED.

CERTIFICATION NO.

BY

DATE

APPROVED

AIR UNIT TEST SHEET

JOB NAME: _____ DATE _____

SYSTEM _____

SPECIFICATIONS:

FAN: CFM _____ TSP _____ ESP _____ RPM _____ BHP _____ O.A. CFM _____

COOLING	MBH _____	GPM _____	WATER ON _____	OFF _____
	AIR ON DB/WB _____		OFF DB/WB _____	Δ TH _____
HEATING	MBH _____	GPM _____	WATER ON _____	OFF _____
	AIR ON DB _____		OFF DB _____	
	MBH _____	GPM _____	WATER ON _____	OFF _____
	AIR ON DB/WB _____		OFF DB/WB _____	

TEST DATA:

UNIT _____ SIZE _____ SERIAL _____

MOTOR _____ HP _____ RPM _____ VOLTAGE _____ FLA _____

TEST VOLTAGE _____ CORRECTED FLA _____ MISC. _____

STARTER / HEATER SIZE _____ RATING _____ RUNNING AMPS _____

FAN: CFM _____ TSP _____ ESP _____ RPM _____ O.A. CFM _____

COIL:	AIR ON	AIR OFF	Δ		WATER ON	OFF	Δ T	MBH
COOLING				Δ TH				
HEATING				Δ T				
				Δ T				

FLOW METER:	MODEL/SIZE	DESIGN READING	TEST READING	GPM
COOLING	_____			
HEATING	_____			

MTR. PULLEY = _____ FAN SUCTION = _____

FAN PULLEY = _____ FAN DISCHARGE = _____

BELTS = _____ TOTAL STATIC = _____

AIR MOVING EQUIPMENT TEST SHEET

JOB NAME: _____

DATE: _____

	UNIT #		UNIT #		UNIT #		UNIT #
LOCATION							
MANUFACTURER							
MODEL NO.							
SA SIZE/FPM							
OPERATING COND.	SPECIFIED	ACTUAL	SPECIFIED	ACTUAL	SPECIFIED	ACTUAL	SPECIFIED
TOTAL C.F.M.							
RETURN AIR C.F.M.							
O.S.A. C.F.M.							
EXT. STATIC PRESS.							
SUCTION PRESSURE							
DISCHARGE PRESS.							
FAN SHEAVE							
MOTOR SHEAVE							
BELTS							
MOTOR MANUF.							
SIZE HP							
VOLTAGE							
PHASE							
RPM MOTOR							
AMPERAGE	RATED	RUNNING	RATED	RUNNING	RATED	RUNNING	RATED
RPM FAN							
COOL MBH							
HEAT MBH							

DUCT TRAVERSE SHEET

ZONE TOTALS

JOB NAME: _____ DATE: _____

[illegible]

VAV BOX TEST SHEET

JOB NAME _____

DATE _____

SYSTEM _____

[illegible]

VAV BOX AT MAX. CFM TEST SHEET

JOB NAME: _____ DATE: _____

[illegible]

AIR QUANTITY EACH INLET/OUTLET

JOB NAME: _____ DATE: _____

SYSTEM _____

[illegible]

FAN TEST SHEET

JOB NAME: _____

DATE: _____

SPECIFIED

Total CFM

Fan RPM

Total S.P.

Motor H.P.

FAN #	FAN #	FAN #	FAN #

TEST

Manufacturer

Model #

Serial #

Size

Motor Mfg.

Motor HP

Motor RPM

Motor Volts

Motor F.L.A.

Run Amps.

Heaters Size/Rtg.

Line Voltage

Total CFM

Fan RPM

Total S.P.

Notes

ERV TEST SHEET

JOB NAME: _____

DATE: _____

SPECIFIED

Total CFM

Fan RPM

Total S.P.

Motor H.P.

OSA FAN	WHEEL	EXH. FAN	WHEEL

TEST

Manufacturer

Model #

Serial #

Size

Motor Mfg.

Motor HP

Motor RPM

Motor Volts

Motor F.L.A.

	DES. TEMPS.		DES. TEMPS.
	EDB =		EDB =
	EWB =		EWB =
	LDB =		LDB =
	LWB =		LWB =

Run Amps.

Heaters Size/Rtg

Line Voltage

Total CFM

Fan RPM

Total S.P.

	ACT. TEMPS.		ACT. TEMPS.
	EDB =		EDB =
	EWB =		EWB =
	LDB =		LDB =
	LWB =		LWB =

Notes

ELECTRIC RE-HEAT COIL TEST SHEET

JOB NAME: _____ DATE: _____

[illegible]

HOT WATER RE-HEAT COIL TEST SHEET

JOB NAME: _____ DATE: _____

[illegible]

PUMP TABULATION TEST SHEET

JOB NAME: _____ DATE: _____

SPECIFIED

GPM

HEAD

HP

TEST

MANUFACTURER

MODEL

SIZE

SERIAL

MOTOR MFG.

HP

RPM

VOLTS

LINE VOLTS

F.L. AMPS

TEST AMPS

HEATER

IMPELLER SIZE

DISCHARGE LBS.

SUCTION LBS.

DIFFERENTIAL

HEAD IN FEET

GPM

PUMP #		PUMP #		PUMP #		PUMP #	

AIR COOLED CHILLER DATA

JOB NAME: _____

DATE: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
EVAPORATOR	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

REMARKS: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
EVAPORATOR	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

REMARKS: _____

WATER COOLED CHILLER DATA

JOB NAME: _____

DATE: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
EVAPORATOR	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CONDENSER	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

REMARKS: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
EVAPORATOR	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CONDENSER	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

REMARKS: _____

COOLING TOWER DATA

JOB NAME: _____

DATE: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
PERFORMANCE	DESIGN	ACTUAL
AMBIENT AIR DB		
AIR EWB		
AIR LWB		
GPM		
EWT		
LWT		
MOTOR	DESIGN	ACTUAL
MANUFACTURER		
HORSEPOWER		
RPM		
VOLTAGE		
PHASES		
AMPERAGE		
HEATER AMPS		
HEATER VOLTS		
HEATER KW		

REMARKS: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
PERFORMANCE	DESIGN	ACTUAL
AMBIENT AIR DB		
AIR EWB		
AIR LWB		
GPM		
EWT		
LWT		
MOTOR	DESIGN	ACTUAL
MANUFACTURER		
HORSEPOWER		
RPM		
VOLTAGE		
PHASES		
AMPERAGE		
HEATER AMPS		
HEATER VOLTS		
HEATER KW		

REMARKS: _____

AIR COOLED CONDENSING UNIT DATA

JOB NAME: _____

DATE: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
CONDENSER	DESIGN	ACTUAL
EAT		
LAT		
ELECTRICAL	DESIGN	ACTUAL
VOLTAGE		
AMPERAGE		

REMARKS: _____

HOT WATER BOILER DATA

JOB NAME: _____

DATE: _____

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
SECONDARY HW	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CNTL. SET. PT.		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
SECONDARY HW	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CNTL. SET. PT.		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
SECONDARY HW	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CNTL. SET. PT.		

UNIT NUMBER		
MANUFACTURER		
CAPACITY		
MODEL NUMBER		
SERIAL NUMBER		
SECONDARY HW	DESIGN	ACTUAL
EWT		
LWT		
P.D. FT.		
GPM		
CNTL. SET. PT.		

REMARKS: _____

LETTERHEAD

FUME HOOD TEST SHEET

JOB NAME: _____

DATE: _____

ROOM NO. _____ HOOD NO. _____ HOOD SIZE _____ AVERAGE FACE VELOCITY _____

FULL OPEN HEIGHT

ROOM NO. _____ HOOD NO. _____ HOOD SIZE _____ AVERAGE FACE VELOCITY _____

OPERATIONAL HEIGHT

**AIR CHANGE PER HOUR
TEST SHEET**

JOB NAME: _____ DATE TESTED: _____
EXPIRATION DATE: _____

LOCATION

AREA CU. FT.

REQUIRED MIN. SUPPLY ACH

REQUIRED MIN. OUTSIDE AIR ACH

REQUIRED MIN. RA/EXH. ACH

REQUIRED MIN. SUPPLY CFM

REQUIRED MIN. OUTSIDE AIR CFM

REQUIRED MIN. RA/EXH. CFM

ACTUAL SUPPLY QUANTITY CFM

ACTUAL OUTSIDE AIR QUANTITY CFM

ACTUAL RA/EXH. QUANTITY CFM

ACTUAL SUPPLY ACH

ACTUAL OUTSIDE AIR ACH

ACTUAL RA/EXH. AIR ACH

ROOM PRESSURE

NOTE: _____

**DUCT PRESSURE TEST
CERTIFICATION**

JOB NAME _____

DATE TESTED _____

DUCT SYSTEM ID _____

DESIGN CFM _____

OPERATING PRESSURE _____

TEST REQUIREMENTS _____

TEST RESULTS _____

CFM LEAKAGE _____

COMMENTS _____

APPROVED BY _____

ELECTRIC RE-HEAT COIL
TEST SHEET

JOB NAME: _____ DATE: _____

BOX NO.	DESIGN CFM	DESIGN BTUH	DESIGN KW	ACTUAL CFM	ACTUAL EAT/LAT	ACTUAL BTUH	ACTUAL KW
NOTE: 1.0 KW = 3413 BTUH							

Testing & Balancing Agency: _____

[illegible]

SPACE TEMPERATURE/HUMIDITY TEST SHEET

JOB NAME: _____ DATE: _____

[illegible]

CHILL WATER COIL
AIR DATA TEST SHEET

JOB NAME: _____DATE: _____

UNIT NO.	CFM	EDB/EWB	LDB/LWB	Δ TH	MBH	NOTES	
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL

CHILL WATER COIL WATER DATA TEST SHEET

JOB NAME: _____ DATE: _____

UNIT NO.	MBH	EWT	LWT	Δ TW	WPD	GPM	
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL

HOT WATER COIL
AIR DATA TEST SHEET

JOB NAME: _____ DATE: _____

UNIT NO.	CFM	EAT	LAT	ΔTA	MBH	NOTES	
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL

**HOT WATER COIL
WATER DATA TEST SHEET**

JOB NAME: _____ DATE: _____

UNIT NO.	MBH	EWT	LWT	Δ TW	WPD	GPM	
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL
							DESIGN
							ACTUAL

JOB NAME: _____

[illegible]

111

[illegible]

FAN COIL UNIT
TEST SHEET
COOLING

JOB NAME: _____ DATE: _____

Testing & Balancing Agency: _____

[illegible]

FAN COIL UNIT TEST SHEET HEATING

JOB NAME: _____ DATE: _____

Testing & Balancing Agency: _____

[illegible]

BLOWER DOOR TEST

DATE: _____

JOB NAME:	
CITY/STATE:	

BLOWER DOOR MODEL	FAN MODEL	NUMBER OF FANS	RING

LOCATION			
REFERENCE			
TEST NUMBER			
RELATIONSHIP			
DESIGN Δp	INCHES H ₂ O	PASCALS	1 Pa (N/m ²) = 0.0040186 Inch of
FINAL CFM			
FINAL Δp INCHES H₂O / PASCALS	INCHES H ₂ O	PASCALS	1 Pa (N/m ²) = 0.0040186 Inch of

TESTED BY:

NOTES:

SECTION 23 0700 - DUCTWORK INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ductwork insulation.
- B. Duct Liner.
- C. Insulation jackets.

1.02 RELATED SECTIONS

- A. Section 23 31 00 - Metal Ductwork.

1.03 REFERENCES

- A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- E. ASTM E84 - Surface Burning Characteristics of Building Materials.
- F. ASTM E96 - Water Vapor Transmission of Materials
- G. NFPA 255 - Surface Burning Characteristics of Building Materials.
- H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- I. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
- C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 25.

1.06 QUALIFICATIONS

- A. Applicator: Company specializing in performing the work of this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 01600.
- B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.
- C. Store insulation in original wrapping and protect from weather and construction traffic.
- D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' ("ksi") value: ASTM C518, 0.29 at 75 degrees F.
 - 2. Maximum service temperature: 250 degrees F.

3. Maximum moisture absorption: 0.20 percent by volume.
4. Density: 0.75 lb/cu ft.
- B. Vapor Barrier Jacket
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture vapor transmission: ASTM E96; 0.04 perm.
 3. Secure with pressure sensitive tape.
- C. Vapor Barrier Tape
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- D. Tie Wire: Annealed steel, 16 gage.

2.02 GLASS FIBER, RIGID

- A. Insulation: ASTM C612; rigid, noncombustible blanket.
 1. 'K' value: ASTM C518, 0.29 at 75 degrees F.
 2. Maximum service temperature: 250 degrees F.
 3. Maximum moisture absorption: 0.20 percent by volume.
 4. Density: 1.5 lb/cu ft.
- B. Vapor Barrier Jacket
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture vapor transmission: ASTM E96; 0.04 perm.
 3. Secure with pressure sensitive tape.
- C. Vapor Barrier Tape
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.03 GLASS FIBER DUCT LINER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 1. 'K' value: ASTM C518, 0.28 at 75 degrees F.
 2. Maximum service temperature: 250 degrees F.
 3. Density: 1.5 lb/cu ft.
 4. Maximum Velocity on Coated Air Side: 4,000 ft/min.
- B. Adhesive
 1. Waterproof fire-retardant type.
- C. Liner Fastener
 1. Galvanized steel, impact applied with integral head.

2.04 GLASS FIBER DUCT LINER, RIGID

- A. Insulation: ASTM C518, 0.23 at 75 degree F.
 1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
 2. Maximum service temperature: 250 degrees F.
 3. Density: 3.0 lb/cu ft.
 4. Maximum Velocity on Coated Air Side: 4,000 ft/min.
- B. Adhesive
 1. Waterproof fire-retardant type.
- C. Linear Fasteners
 1. Galvanized steel, self-adhesive pad with press on head.

2.05 FIRED RATED GLASS FIBER DUCT, FLEXIBLE

- A. Insulation: ASTM C518, 0.23 at 75 degree F.
 - 1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
 - 2. Flammability (ASTM E 84 / UL 723)
 - Foil: Flame spread 5, Smoke developed 5
 - Blanket: Flame Spread 0, Smoke developed 0
 - 3. Insulation, strict accordance with manufacturer's recommendations.
- B. Manufacturer: "Fyrewrap", 3M Fire master "Fast Wrap".

2.06 DUCTWORK JACKET (Exterior or in ventilated spaces)

- A. Contractor to provide specialty rubberized bitumen membrane designed specifically to be installed over insulation on ductwork subject to ambient conditions. The membrane is 'peel and stick', self-healing if punctured, UV stable, and will expand and contract with the mechanical system. The membrane has excellent emissivity and sound attenuation properties.
 - 1. Total product thickness of 0.60"
 - 2. Water Vapor Transmission (grains/hr-ft²) of 0.0022
 - 3. Upper Temperature Limit of 160 degrees (F).
 - 4. Sound Transmission Coefficient of 0.18
 - 5. Permeance of 0.0053
- B. Manufacturer: "Alumaguard" as manufactured by Polyguard. Provide "Alumaguard lite" on bottom of ductwork as to eliminate the need to pin through the Alumaguard on the bottom of the ductwork.

2.07 AIR HANDLING UNIT ROOMS

- A. Finish and install over entire areas of walls/doors at occupied spaces of air handling rooms/elevator equipment rooms 2" thick acoustical type fiberglass hullboard insulation 3# density, applied over Stick-Klips 12" on center. Stick-Klips shall be applied to wall with Construction Adhesive. Acoustical material shall be applied over Stick-Klips with duct linear adhesive spotted between pins. Joints to be sealed with fiberglass lagging tape.
- B. Manufacturer:
 - 1. Nautica IMO PFG Acoustic Board as manufactured by RB, LLC.

2.08 APPROVED MANUFACTURERS

- A. John Manville, Knauf, Owens Corning

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that ductwork has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign materials removed, and dry.

3.02 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jackets.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connection, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature.
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. External Duct Insulation Application

1. Secure insulation with vapor barrier tape and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Secure insulation without vapor barrier with adhesive tape.
 3. Install without sag or underside of ductwork. Use adhesive & mechanical fasteners to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 6. Not used.
 7. All external insulation to be installed utilizing adhesive & mechanically pinned fasteners.
- E. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
 3. Seal and smooth joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions are metal to metal dimension.
- F. Walk-in Plenum Application:
1. Adhere insulation on interior surface of plenum with adhesive for 100 percent coverage. Secure insulation with mechanical fasteners. Seal and smooth joints. Do not use nail-type fasteners.
 2. Continue insulation with vapor barrier throughout penetrations. Vinyl backing to go against wall, raw insulation to be exposed.

3.03 TOLERANCE

- A. Substituted insulation materials shall provide thermal resistance with 10 percent at normal conditions, as materials indicated.

3.04 FLEXIBLE GLASS FIBER DUCTWORK INSULATION SCHEDULE

<u>LOCATION</u>	<u>THICKNESS (inch)</u>	<u>FINISH</u>
1. Round/oval Supply, Return, Fresh air, & exhaust ductwork	3"	Foil Faced
2. Tops of Diffuser	3"	Foil Faced
3. Rectangular fresh air & Exhaust Air Ductwork	3"	Foil Faced
4. Rectangular Supply & Return Air Ductwork	3"	Foil Faced

- Note:*
1. All exposed supply/return ductwork to be double wall pre-insulated duct (with perforated inner wall).
 2. All exposed exhaust ductwork to be double wall pre-insulated duct (with solid inner wall).

3.05 GLASS FIBER DUCT LINER

<u>LOCATION</u>	<u>THICKNESS (Inch)</u>
1. Rectangular Return air Duct & rectangular supply duct	1"
2. Return air transfer assembly ducts And sleeves	1"

Note: 1. All other ductwork to be externally insulated.

2. Kitchen hood supply ductwork to be externally insulated, do not internally insulate kitchen hood supply ductwork.

3.06 DUCTWORK JACKET SCHEDULE

<u>LOCATION</u>	<u>THICKNESS (mil)</u>	<u>FINISH</u>
1. Rectangular & Round Outside air, Exhaust, Supply & Return Ductwork	60	Aluminized

- Note:*
- 1. Install as per manufacturers recommendations.*
 - 2. Provide on all ductwork that are exposed to ambient conditions.*
 - 3. Not used.*

3.07 RIGID GLASS FIBER DUCTWORK INSULATION SCHEDULE

<u>LOCATION</u>	<u>THICKNESS (inch)</u>	<u>FINISH</u>
1. Air Handling Room/closet Walls	2"	Perforated

3.08 FIRE RATED GLASS FIBER, FLEXIBLE

<u>LOCATION</u>	<u>THICKNESS (inch)</u>	<u>FINISH</u>
1. Kitchen Hood Exhaust Duct	3"	Foil Faced

3.09 MINERAL WOOL, FLEXIBLE

1. Top of Kitchen Hood (and back side between hood and wall if wall type hood provided), contractor shall also extend insulation 18" around Perimeter of hood. Insulation to lay on 22 ga. Metal with minimal 1" air space clearance. 1" thickness.

END OF SECTION

12-10-25

SECTION 23 0800 - OPERATING AND MAINTENANCE INSTRUCTIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Refer to individual Division 20, 21, 22 and 23 sections for additional equipment specific Operations and Maintenance Manual requirements.

1.02 SUMMARY

- A. This Section includes preparing and furnishing an operating and maintenance manual for mechanical equipment.

1.03 DESCRIPTION

- A. Compile an Operating and Maintenance Manual:
 - 1. For all building mechanical systems and major equipment items.
 - 2. Including, but not necessarily limited to:
 - a. Installing company's name, address, telephone number and name of job supervisor.
 - b. Maintenance and operating booklets (as supplied by the equipment Manufacturer) for each item or representative type item installed.
 - c. Valve tag schedule. Contractor to provide a set of plans shows valve schedule & valve location on plans (full size set, 24"x36 plans). Plans to have valve type, manufacturer and model #. Also provide replacement part contact information for each valve.
 - d. A complete set of Shop Drawings.
 - e. Temperature control drawings.
 - f. Equipment information forms for each equipment piece.
 - 3. Each equipment information form includes all applicable items of the following:
 - a. Type of unit.
 - b. Manufacturer's name.
 - c. Equipment service area.
 - d. Filter Information:
 - 1) Filter change period.
 - 2) Type of filter.
 - 3) Size of filter and number.
 - e. Motor and Drive Information:
 - 1) Belt type and quantity.
 - 2) Belt size.
 - 3) HP.
 - 4) Voltage.
 - 5) Phase.
 - f. Lubrication Information:
 - 1) Recommended service interval.
 - 2) Lubricant application points.
 - 3) Recommended lubricant type.
 - g. Recommended cleaning procedures and intervals.
- B. Prepare Information Packets:

1. Attach to each major piece of equipment in a string tie envelope labeled with the equipment's designation in large print.
2. Information Required:
 - a. A copy of the equipment information form as defined above.
 - b. A temperature control written operation sequence.
 - c. A maintenance checklist form with equipment identification information and listing all relevant maintenance procedures in a column format to accommodate date entries.

1.04 SUBMITTALS

- A. Three copies of Operating and Maintenance Manual.

PART 2 PRODUCTS

- A. Not used.

PART 3 EXECUTION

- A. Not used.

END OF SECTION

12-10-25

SECTION 23 09 00 - BUILDING AND AUTOMATIC TEMPERATURE CONTROLS

PART 1 - General Conditions

1.1 GENERAL

- A. This section describes the Integrated Building Management System (IBMS) technical and/or products specification to be undertaken by the IBMS Contractor.
- B. Portions of work described in this section but which may not be further detailed in other sections of the IBMS specifications shall not relieve IBMS Contractor his obligation to carry out the mentioned works. Conversely, the description of work in other sections of the IBMS but which has not been described in this section is also deemed to be included in the scope of works.

1.2 SCOPE OF WORK

- A. Furnish and install Niagara (Tridium) Framework IBMS software, workstations, and JACE controllers compliant with the specifications herein consisting of:
 - 1. JACE controllers as necessary to integrate with existing LonWorks, BACnet, Modbus, or Legacy Field Level Devices that shall remain in place and be reused as shown on the drawings.
 - 2. JACE Controllers as necessary to integrate to the new works as shown on the drawings along with new BACnet only, BTL Listed controllers as stated in Section 1.2.B.
 - 3. JACE Controllers as necessary to integrate to existing or new MODBUS power meters and other gateway protocol devices allowed in Section 1.2.C.
 - 4. ALL JACE controllers provided under this specification shall conform to the Niagara "Vykon open JACE" profile to enable any certified Niagara contractor the ability to make full changes to the system. "Proprietary JACE" controllers as offered by select "Niagara" vendors that restrict access to the programming, configuration, or other utilization of the JACE are STRICTLY NOT ALLOWED.
 - 5. The IBMS shall utilize multiple Daikin ITM's and BacNET controllers networked with a Niagara Framework Web Supervisor.
 - 6. The work shall include the IBMS for the Swanson Correctional Center
 - 7. Any and all wiring changes necessary in accordance with Part 3 (Execution) and Part 4 (Sequences of Operation) of these Specifications.
- B. Furnish and install new BACnet BTL Listed Controls for the control of equipment subject to the "Minimum controller requirements" of paragraph 1.4.
- C. INTEGRATION OF BACNET OR OTHER PROTOCOL PRODUCTS PROVIDED BY OTHERS
 - 1. Furnish and install controllers as necessary to integrate any "Non-BACnet" protocol gateways provided by others for the integration to the Niagara framework Supervisor Workstation. In all cases, furnish and install BACnet IP or BACnet MS/TP wiring trunk to the following BACnet or "Non-BACnet" gateways/interfaces provided by other contractors:
 - a. Generator System
 - b. Lighting

- c. Variable Refrigerant Volume Systems Gateway (Provided by the VRV Supplier and/or Mechanical Contractor.) The gateway shall be provided and installed by the VRV or Mechanical System Contractor. He shall further provide to the IBMS contractor all necessary setup, programming, and configuration software to allow the IBMS contractor to access necessary VRF system BACnet objects that are in accordance with the BACnet standard.
 - d. Variable Frequency Drives with BACnet interface (Provided by AHU, Pump, or Mechanical Contractor). The gateway shall be provided and installed by the VFD supplier. He shall further provide to the BMS contractor all necessary setup, programming, and configuration software to allow the IBMS contractor to access necessary VFD BACnet objects that are in accordance with the BACnet standard.
 - 2. Integrate BACnet objects provided by the gateway(s) of Section 1.2.C.1 into B-AWS graphical user interface displays, alarm routing, and control sequences as required and specified in the sequences of operation.
- D. CONTROL WIRING
- 1. The IBMS Contractor shall furnish all electrical control and interlock wiring connected to the controls and instrumentation systems.
 - 2. All conduits in connection with the controls and instrumentation system shall be furnished and installed by this Contractor.
- E. The Control Contractor shall complete all sensing and control installations including electrical and electronic components, not the Mechanical Contractor, unless otherwise required.
- F. Provide a comprehensive operator and technician-training program as described herein.
- G. Provide as-built documentation, software, and all DDC control logic and all associated support documentation on approved media, which accurately represents the final installed system.

1.3 COORDINATION WITH OTHER TRADES AND DIVISIONS

- A. 110 VAC or greater voltage power wiring to main control panels (i.e. AHU's) as shown on the mechanical plans and/or specifications, shall be provided by the Electrical Contractor, and coordinated by this Contractor. Failure of the IBMS Contractor to coordinate requirements with other Divisions shall result in the IBMS Contractor to be responsible for any non-coordinated items.
- B. VAV terminal box manufacturer shall provide a line voltage to 24VAC transformer of minimum 40VA rating to supply control power to VAV terminal controls. The IBMS manufacturer shall be responsible for all low voltage control wiring of the VAV terminal unit controllers and coordinate such wiring with the terminal unit manufacturer as necessary. Contractor.
- C. Control Valves for cooling or heating coil shall be furnished by the IBMS contractor to the Mechanical Contractor for installation by the Mechanical Contractor.
- D. Thermowells for sensing of fluid temperatures by IBMS sensors shall be furnished by the IBMS contractor to the Mechanical Contractor for installation by the Mechanical Contractor.

1.4 MINIMUM SYSTEM REQUIREMENTS

- A. Subject to the provisions of the applicable individual types of equipment contained herein, furnish and install BACnet BTL Listed equipment, software, and devices compliant with the BACnet standard profiles indicated in the following minimum quantities specified as follows:

1. Niagara "Supervisor" Engineering Toolkit – Provide all Engineering Workstation and application development software from the IBMS manufacturer necessary to allow the Owner complete access for the programming of additional points, sequences of operation, web graphical pages, and other tools needed to expand or modify the system as needed. Provide software copies or server workstation installation as needed to allow properly authorized users access to the software on designated "Engineering Workstations".
2. BACnet Routers (B-RTR profile) – Install a minimum of (1) BACnet router per floor level and not more than 1 router per 62 MS/TP devices. If more than 31 MS/TP devices are connected to one router, than provide an MS/TP repeater device after every 31 MS/TP devices on the sub-network OR at every "T" in the MS/TP trunk wiring, whichever quantity is GREATER.
3. BACnet Building Controllers (B-BC profile) – Furnish and install a minimum of (1) B-BC for control of
 - a. For each AHU exceeding a total quantity of (80) physical connected points
4. BACnet Advanced Application Controllers (B-AAC profile) – Furnish and install a minimum of (1) BACnet Advanced Application Controllers (B-AAC) for the control of:
 - a. Each central Chilled Water OR Hot Water plant $\leq$ 80 physical points of capacity.
 - b. Central Station AHUs, $> 68\text{KW}$ (20 Ton) Capacity - 1 controller per AHU
 - c. VAV terminal units – 1 Controller per CAV/VAV terminal or fume hood system used in room pressurization applications along with associated independent or dependent control supply/exhaust terminal controller.
 - d. FCU terminal units – 1 controller per FCU requiring customized sequence of operations as identified in Sequences of Operation
 - e. General Ventilation, Smoke Pressurization, and other Exhaust Fans - 1 controller per 16 fans maximum
 - f. Lighting Systems 1 controller per lighting distribution board
 - g. Other Electrical Systems – 1 controller per Main, Sub-Main, ATS, or other Electrical distribution board as required to meet point requirements.
 - h. Other controlled and monitored systems – 1 controller per each system interface location
5. BACnet Application Specific (B-ASC profile) – Furnish and install a minimum of (1) BACnet Application Specific Controllers for the control of EACH:
 - a. Central Station AHUs, $\leq 68\text{KW}$ (20 Ton) Capacity meeting the sequences of operation specified
 - b. Packaged Unitary or Split system AHUs, typically $\leq 68\text{KW}$ (20 Ton) Capacity meeting the sequences of operation specified
 - c. Single duct CAV/VAV terminal units with or without reheat
 - d. Fan Coil Units (FCUs) meeting the sequences of operation specified
 - e. Air and Water Source Heat Pump units meeting the sequences of operation specified.
6. Digital Room Sensors (DRS) with display – Furnish and install Manufacturer's compatible Digital Room Sensors with LCD display at each location shown on the drawings or as specified in the points list. At a minimum, provide 1 DRS sensor Per VAV terminal, FCU, or packaged unitary equipment unit (if controller does not have built in equivalent display).

1.5 QUALIFICATION OF IBMS SUPPLIERS/BRAND NAME REFERENCES

- A. Any reference in this Specification to brand names or to a specific manufactured product without the use of "or approved equal" is to be interpreted to mean that the specific article or product is the only one to be supplied or used.
- B. All approved bidders must be Systems Integrators and specialty control contractors in the business of installing Niagara Framework based IBMS systems and direct digital temperature controls.
 - 1. The Niagara Framework IBMS/DDC control contractor shall provide evidence of certification of his engineers/technicians that will be assigned to the project. At a minimum, the Project Engineer shall be registered as a currently certified Niagara Framework Engineer.
 - 2. The Niagara Framework IBMS/DDC control contractor shall provide evidence of a successful track record of implementation of Niagara framework projects by submitting the project name and reference contact information for a minimum of 3 projects so the Consultant/Owner may qualify their bid capabilities.
 - 3. Subject to the provisions of these specifications, provide a Niagara Framework IBMS/DDC/control system from one of the following manufacturers:
 - a. KMC Controls
- C. Components used for this project including control damper actuators, control valves (including PIC-V valves if used), sensors, switching devices, and other accessories shall be provided from one of the manufacturers named above or the following listed manufacturers:
 - 1. Control Actuators & Control Valves – Belimo, KMC, Bray, Griswold
 - 2. Room, duct, pipe, outside ambient temperature, pressure, humidity, and other gas concentrations – KMC, Greystone Energy, Mamac, Carlo Gavazzi, Automation Components
- D. Only vendors named in this specification or pre-approved by addendum shall be acceptable.

1.6 MANDATORY SYSTEM & QUALITY REQUIREMENTS

- A. All Niagara Framework devices shall be new and at the Niagara 4 level or latest available, released version. This shall include the Niagara Supervisor software and accessories and JACE 8000 controllers. Niagara Framework controllers shall ONLY be utilized at the I/P level, to integrate existing "legacy systems" that will be maintained, and to integrate new BACnet IBMS controllers installed under this contract in the "new" portion of the works.
- B. All "New" IBMS controllers shall strictly adhere to the following characteristics:
 - 1. The controller shall consist of native BACnet, direct digital control, microprocessor-based, real-time clock, peer-to-peer, networked, energy management, distributed devices utilizing the ASHRAE/ANSI standard 135 BACnet, communication protocol in an open, interoperable system. All controllers shall be BACnet Testing Laboratories (BTL) Listed at standard revision 2008 or later and PICs statements available on the BTL website.
 - 2. The BACnet operating stack must be embedded directly in every device at the board level and in all operator interface software packages.
 - 3. With the exception of those gateways identified in Section 1.2.C.1 no Gateways, Communication Bridges, Protocol Translator or any other device that translates any

- proprietary or other communication protocol to the BACnet communication protocol shall be permitted as a part of the installation pursuant with this specification section.
4. Controllers and software used on this project shall be newly manufactured 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.
 5. Each of controller hardware shall be suitable for anticipated ambient conditions and rated for a minimum of 32 – 122F (0 – 50C).
 6. The IBMS contractor must provide a PICS document showing the proposed & installed systems compliance level to the ANSI/ASHRAE Standard 135-2008 or later revision for all BACnet devices.
- B. Control Components & Accessories – All control components and accessories used for this project shall be newly manufactured and supplied by the IBMS contractor from one of the named manufacturers of paragraph 1.5.C or as approved by Addendum in paragraph 1.5.E
- C. Quality Standards – As control devices and components shall meet the following quality and standards for use in commercial buildings as appropriate:
1. Digital controllers and systems NOT used in “smoke control applications” - UL Standard 916, Category PAZX (Energy Management standard)
 2. Digital controllers and systems used in “smoke control applications” - UL Standard 864, Category UUKL (smoke control systems)
 3. Control components using voltages > 24VAC Nominal voltage – UL Standard 873 (Temperature Indicating and Regulating)
 4. Control components using voltages < = 24VAC Nominal voltage – UL 873 or UL Component recognized (ULR)
 5. FCC Part 15, Sub-Part A
 6. EMC Directive 89/336/EEC (European CE Mark)
 7. Uniform Building Code (UBC), including local amendments
 8. National Electrical Code (NEC)

1.7 SUBMITTALS

- A. Submit under provisions of this Section
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.

C. Drawings:

1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
2. Drawings shall be submitted in the following standard sizes: 11 x 17 inch (ANSI B).
3. An electronic complete set of submittal drawings shall be provided.

D. System Documentation: Include the following in submittal package:

1. System configuration diagrams in simplified block format.
2. All input/output object listings and an alarm point summary listing.
3. Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
4. Complete bill of materials, valve schedule and damper schedule.
5. Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
6. Overall system operation and maintenance instructions-including preventive maintenance and troubleshooting instructions.
7. For all system elements-operator's workstations, building controllers, application controllers, routers, and repeaters-provide BACnet Protocol Implementation Conformance Statements (PICS) as per ANSI/ASHRAE Standard 135.
8. A list of all functions available and a sample of function block programming that shall be part of delivered system.
9. Product Warranty – Submit Manufacturer's standard product warranty statement. Products NOT meeting the requirements of Paragraph 1.9 below shall be rejected OR the IBMS contractor shall stipulate in his proposal that he fully complies with the cost provisions of paragraph 1.9 and he has included any additional replacement costs in his price.

E. Project Management: The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases.

1.8 Project Warranty

- A. Material Warranty – The selected manufacturer of IBMS controllers and components shall be provided with a 1 year manufacturer's replacement warranty from the date of manufacture.

- B. Labor Warranty – The selected IBMS contractor shall provide a full project warranty in accordance with the Warranty provisions of the General Conditions and Defects Liability Period of the project.

PART 2 - PRODUCTS & MATERIALS

2.1 SYSTEM ARCHITECTURE (ANSI BACnet Standard 135/2008 or later compliant, with Niagara/Tridium Legacy system Integrations)

- A. The System Architecture of the IBMS system to be furnished by the IBMS contractor shall be completely based on the use of controllers and devices that comply with ANSI/ASHRAE standard 135 (BACnet), revision 2008 or later for all “newly built” areas of construction. For existing “built” areas that may contain “legacy” proprietary controllers of one or more manufacturers, the intended Architecture will “integrate” these “legacy” systems using a Tridium/Niagara platform as the basis of design. NO ADDITIONAL “LEGACY” CONTROLLERS SHALL BE INSTALLED AS PART OF THESE WORKS. As a result, at the “Operator Workstation” level defined in the following paragraphs, the User Interface will be provided by a Niagara “Supervisor” type software interface that allows the interoperability desired between newly installed BACnet systems and “legacy” systems that remain. This desired architecture allows the balance/migration necessary to balance budget constraints of construction against the cost of “rip out and replace” aging prior generation BMS systems.
- B. This Architecture consists of a “client/server” Architecture with four levels of products, systems, and services.
1. Definition of “Edge Controller” - BACnet controllers that are physically connected to controlled mechanical, electrical, water, and other systems of the building are defined as “Edge Controllers” in that they sense and control physical characteristics of the building “at the edge” of the physical environment. By strict definition, this may include some of the controllers used at the “I/P” or “MS/TP” Network Levels defined in the following paragraphs. Freedom is given to the IBMS system contractor to select either Network Level or Edge Level controllers at their discretion as long as the Minimum Controller Requirements of Section 1.4 are maintained.
 2. Operator Workstation Level – The Level consists of desktop or server computers and user workstations that are provided by the IBMS contractor. These computers are loaded with the Tridium/Niagara “Supervisor” level software and Workbench engineering tools. This level of equipment communicates with sub-ordinate levels of devices strictly using common “I/P” level infrastructure, structured wiring, and other facilities that are provided either by the IBMS contractor directly OR, more commonly, the project’s ELV (structured cabling) sub-contractor. When using the I/P infrastructure, the IBMS system communicates to all Niagara JACE sub-systems using their Proprietary protocol and to all other BACnet I/P level controllers by STRICTLY using the BACnet I/P or BACnet Ethernet (8802.3) Communication protocols defined in ANSI/ASHRAE 135.
 3. I/P Network Level Controllers and Gateways
 - a. BACnet I/P & BACnet Ethernet Level – The level consists of BACnet “I/P” level controllers and BACnet routers. A requirement of any device at this level is that

it must and shall comply with BACnet I/P or BACnet Ethernet to seamlessly link with B-AWS systems or other BACnet I/P level systems. Typically, the BACnet level controllers residing at this level conform to the:

1. BACnet B-BC (Building Controller)
 2. B-RTR (Router)
 3. B-GW (Gateway) - "B-GW" Gateway devices are special gateways provided by select manufacturers to convert "older generation" device information to BACnet object information. Pursuant to Master Specification Section 1.2.C, the use of these gateways are specific and limited in scope. Unless specifically allowed as stated in Section 1.2.c, gateways ARE NOT ALLOWED to "future proof" the system as much as possible to allow changes as needed in the future.
 4. B-AAC (Advanced Application Controller) device profiles.
 5. It is also common and allowed that select pieces of equipment from 3rd party sub-systems may be provided with BACnet I/P level interfaces to allow communication and interoperability at this level.
- b. Niagara I/P Level – The level consists of Niagara JACE controllers with locally applied hardware interfaces as required. Requirements of any JACE controller at this level is that it will communicate using the following protocols to Edge level devices:
1. BACnet I/P, BACnet Ethernet, or BACnet MS/TP using suitable structured cabling or RS-485 type daisy chain wiring as appropriate.
 2. Niagara proprietary "protocol drivers" to any existing "legacy" systems from the existing building BMS system appropriate for the vendor and technology. Wiring to be I/P or RS-485 type as appropriate.
4. MS/TP Level Controllers – The level consists of BACnet "MS/TP" communicating controllers. A requirement of any device at this level is that it must and shall comply with BACnet MS/TP communications standards. The devices shall support communication data rates up to and including 76.8 or 115.2Kbps at a minimum. Typically, the BACnet level controllers residing at this level conform to the:
- a. B-AAC (Advanced Application Controller) device profiles
 - b. B-ASC (Application Specific Controller) device profiles
 - c. B-SS (Smart Sensor) device profiles
5. Field Device Level – The level consists physical components and select "proprietary" communicating sensors of the IBMS Manufacturer's design.
- a. These devices are typically physically wired to the "Edge Level" controllers for the direct sensing of physical conditions of the building such as temperature, humidity, pressure, air quality, fluid level, light level, etc.
 - b. Other physical devices such as relays, actuators, and other actuating devices are physically connected to system control points to regulate the desired conditions of the controlled environment.
 - c. Some "proprietary" communicating sensors of the IBMS manufacturer may be used at this level at the IBMS manufacturer's discretion as long as the device is directly connected to an Edge controller and provides no other functions other than the abilities to:
 1. Sense one or more physical parameters from one location (ie temperature, occupancy, humidity, CO2 levels)

2. Allow a local user to make simple operational changes (ie change a setpoint or mode of operation.)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the Intelligent Building Management System manufacturer or its factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience and shall provide documentation in submittal package verifying longevity of the installing company.
- B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- C. Drawings of Intelligent Building Management Systems are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.
- D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the IBMS sub-contractor in accordance with these specifications.
- E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the IBMS sub-contractor.
- F. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.2 WIRING

- A. All electrical control wiring and power wiring to the control panels shall be the responsibility of the IBMS contractor.
- B. The Electrical Contractor (Div. 16) shall furnish all power wiring to electrical starters and motors.
- C. All wiring shall be in accordance with the Project Electrical Specifications (Division 16), the National Electrical Code and any applicable local codes. Where IBMS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance. Manufacturer shall provide a warranty for all provided IBMS equipment of 1 year to the original owner of the IBMS system through the Manufacturer's authorized installing contractor.
- B. Within this period, upon notice by the Owner, any defects in the IBMS due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the IBMS sub-contractor at no expense to the Owner

3.4 WARRANTY ACCESS

- A. The Owner shall grant to the IBMS sub-contractor, reasonable access to the IBMS during the warranty period. The owner shall allow the contractor to access the IBMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 ACCEPTANCE TESTING

- A. Upon completion of the installation, the IBMS sub-contractor shall load all system software and start-up the system. The IBMS sub-contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. The IBMS sub-contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results.
- C. System Acceptance: Satisfactory completion is when the IBMS sub-contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative.

3.6 OPERATOR INSTRUCTION, TRAINING

- A. During system commissioning and at such time acceptable performance of the IBMS hardware and software has been established, the IBMS sub-contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
- B. The IBMS sub-contractor shall provide 12 hours of instruction to the owner's designated personnel on the operation of the IBMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the IBMS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
- C. The training shall be in up to three sessions as follows:
 - 1. Initial Training: One-half day session (4 hours) after system is started up and at least one week before first acceptance test.
 - 2. First Follow-Up Training: One day (8 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

PART 4 - SEQUENCE OF OPERATION (All temperature to be adjustable) & EMS POINT LIST

4.00 DX SPLIT SYSTEM HVAC UNITS

- A. These AHU's are equipped with a DX cooling coil, a condensing coil, an electric heater, supply fan and a motorized outside air damper.
- B. The AHU shall be enabled when: The Master AHU Control virtual point is "ON"
- C. If the Master AHU control virtual point is "ON":
The AHU supply fan shall be enabled by the BAS to run based off of a time schedule in the BAS server. The AHU supply fan shall show run status thru a CT relay in the fan starter and shall issue an alarm condition to the BAS in the event of a fan failure. The outside air damper shall be indexed open anytime the AHU supply fan runs based off of the fan run status (motorized damper

position based on CO2 sensor in return air ductwork). The smoke detector and freeze stat shall stop the AHU supply fan thru a hardwired connection in the fan starter in case of an alarm condition.

D. Space Temperature Control:

The AHU DX cooling coil and electric heater shall be staged by the BAS to maintain space temperature from a pre-determined setpoint (adj.). The space temperature shall be transmitted to the BAS by the space temperature sensor. If the space temperature exceeds the space temperature alarm setpoint (adj.), an alarm shall be sent to the BAS. If the space temperature rises above the space temperature setpoint (adj.), the first stage of DX shall be indexed to run. Upon a return to space temperature setpoint, the first stage of DX shall be indexed to stop. If the space temperature drops below the space temperature setpoint, the electric heater shall be indexed to run. Upon a rise back above the space temperature setpoint, the electric heater shall be indexed to stop. Upon a fan failure alarm at the BAS, the DX cooling shall be indexed to stop and the electric heater shall be indexed to stop.

1. The AHU/CU shall have the ability to be controlled based on any one specific temperature sensor (located within the space) or an average of any/all the temperature sensors.

E. Humidity Monitoring:

The AHU shall have a humidity sensor in the return air that transmits the return air humidity to the BAS. Upon a rise in humidity above the return air humidity setpoint (65% adj.), an alarm will be sent to the BAS.

- F.** A temperature sensor in the discharge air of the AHU shall transmit the discharge air temperature back to the BAS for monitoring purposes only. A temperature sensor in the return air of the AHU shall transmit the return air temperature back to the BAS for monitoring purposes only. A temperature sensor in the mixed air of the AHU shall transmit the mixed air temperature back to the BAS for monitoring purposes only.

G. Air Purification:

- a. The DDC system shall monitor the air purification system at each air handling unit and send alarm to operator. Refer to specification 233500 for Air Purification Devices.

4.02 EXHAUST FANS

- A.** Exhaust fans shall be interconnected per the mechanical schedules. The control system shall also monitor and control all exhaust fans based on a time of day schedule. Exhaust fans shall be disabled when the control system is in the unoccupied mode.

4.03 SERVER ROOM HVAC UNITS

- A.** The Data/Elec/Server Rooms shall be monitored by the control system by means of space temperature and humidity sensors and a BACNet interface card at CRAHU-1. In the event that the space temperature in the area that the unit serves rises above 80 and/or humidity drops below 40%, an alarm shall be generated by the control system at the operator workstation. This will notify the Owner that a high temperature or low humidity condition has occurred.
- B.** Wall temperature sensors shall monitor the room temperature 24 hours a day. Upon failure of the A/C unit, a temperature alarm shall be activated and reported to the control system operation workstation.
- C.** Not used.

4.04 VARIABLE REFRIGERANT VOLUME SYSTEM

- A. The Variable Refrigerant Volume manufacturer shall furnish and program a Bacnet interface board that will allow for direct connection of the control panel into the control system. Room controls for the unit shall be factory furnished for these units operating per manufacturers recommendations.

4.05 MISCELLANEOUS

- A. The control system shall monitor the Outside Air Temperature and provide this data for safety functions, sequencing functions, alarming and trending.
- B. Not used.
- C. The control system shall monitor the building's incoming power and provide instantaneous demand and usage data (kwh) for the current day, month to date and year to date. A building power monitor shall be furnished by the Controls Contractor but the wiring of the meter to the incoming power wiring shall be accomplished by the Electrical Contractor. Coordinate installation with Division 26 contractor.
- D. EMS system to monitor emergency generator transfer switch & generator for determination of when system is in emergency mode.
- E. Provide UPS battery backup for all controllers as to remain online during loss of power prior to emergency generator startup.
- F. Not used.
- G. Not used.
- H. Electrical Coordination with Building and Automatic Temperature Controls Prior to Bid: Given the nature of the evolving technology in the field of Building & Automatic Temperature Controls (and the differences between various manufacturers), various Temperature Control Devices have been specified at various voltages (120-1-60, 24V, etc., Refer to Specification 230900). It is the responsibility of the General Contractor, Electrical Contractor, Mechanical Contractor, & Temperature Controls contractor to coordinate prior to bid as to ensure all electrical provisions for all Temperature Control Devices are accounted for (material, equipment, conduit, breakers, wiring, devices, installation, labor, etc.) as to provide a complete and working Temperature Controls System. Should the Contractor (and subcontractors) fail to coordinate all electrical provisions prior to bid, then the cost to provide such electrical provisions shall be solely borne by the Contractor (and subcontractors). No additional cost to be provided by the owner to the Contractor for failure to coordinate prior to bid.

4.09 FMS POINT LIST

A. DX Split A/C Units:			
1.	Return air temperature		AI
2.	Discharge air temperature		AI
3.	Fan Start/Stop		BO
4.	Fan status		BI

	5.	Outside air damper control	AO
	6.	Outside air damper position	AI
	7.	Electric Heat stages	BO
	8.	Cooling stages	BO
	9.	Supply air static pressure transmitter (if applicable)	AI
	10.	AHU Fan speed control (if applicable)	AO
	11.	Space temperatures	AI
	12.	Space temperature setpoints (adj)	AI
	13.	Space temperature minimum/maximum setpoints (adj)	AI
	14.	Space temperature unoccupied setpoints (adj)	AI
	15.	Air Purification Device	
B. EXHAUST FANS:			
	1.	Exhaust Fan start/stop	BO
	2.	Exhaust Fan status	BI
C. MISC:			
	1.	Electrical Closet temperature (Wall Mounted)	AI
	2.	Electrical Closet humidity (Wall Mounted)	AI
	3.	Outside air temperature/humidity	AI
	4.	Not used.	
	5.	Emergency Generator Status (Transfer switch & generator)	BI
	6.	Data/Server Room temperature (Wall Mounted)	AI
	7.	Data/Server Room humidity (Wall Mounted)	AI
	8.	Building KW/KWH	AI
	9.	Lighting control circuits common areas enable/disable	BO
	10.	Lighting control circuits common areas status	BI

11.	Lighting control circuits exterior enable/disable	BO
12.	Lighting control circuits exterior status	BI
13.	Schedule of all equipment	
14.	Auxiliary Drain Pan Moisture Sensors	
15.	Variable Frequency Drives The interface for Variable Frequency Drives shall be connected directly to the main FMS network trunk (via or BACNET communications) to monitor, display, trend and report all available parameters of the VFD, including (but not limited to): 1. Motor Speed RPM 2. Motor Frequency Hertz 3. Motor Current Amps 4. Motor Runtime 5. VFD Status 6. In Fault Condition 7. In Bypass 8. Safeties	
16.	Variable Refrigerant Volume System (BACNet)	

END OF SECTION

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SECTION 23 2300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes refrigerant piping used for air-conditioning applications.
- B. Related Sections include the following:
 - 1. Division 20 Section 20 05 29 "Hangers and Support Devices" for pipe supports and installation requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.
- C. Refrigerant piping indicated is schematic only. Manufacturer's installation instructions shall take precedence over contract drawings where a conflict may occur. Size piping and design the actual piping layout in accordance with equipment manufacturers instructions and recommendations, including oil traps, double risers, solenoids and other specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.
- D. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Welding/Brazing: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX; "Welding and Brazing Qualifications."
- B. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
- C. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."
- D. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Non-electrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION

- A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including plumbing and electrical.
- B. Coordinate pipe sleeve installations for penetrations in exterior walls.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Refrigerant piping shall be run in Type "ACR" hard drawn copper tubing (ASTM B280 compliant) attached with wrought copper fittings, utilizing 1000-degree silver solder and a non-corrosive flux. Refrigerant piping shall be sized and installed in strict accordance with the air conditioning unit manufacturer's recommendations and directions and shall be submitted to the Engineer for prior approval before installation. Pressure drops shall not exceed the equivalent of 2-psi. Refrigerant piping system shall be evacuated, charged with refrigerant holding charge. The refrigerant lines to be tested with nitrogen to a test pressure of not less than 450 psi and proved before final charge of refrigerant. Compressor shall not be subject to the 450 psi pressure test.

2.2 VALVES

- A. Provide valves as recommended by equipment manufacturer.

2.3 REFRIGERANT PIPING SPECIALTIES

- A. Provide refrigerant piping specialties as recommended by manufacturer.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

- A. Aboveground, within Building and Exterior: hard drawn-copper tubing.

3.2 VALVE APPLICATIONS

- A. Install a full-sized, three-valve bypass around each dryer.
- B. Install thermostatic expansion valves as close as possible to evaporator.
- C. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3.3 SPECIALTY APPLICATIONS

- A. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.
- B. Install permanent filter-dryers before each solenoid valve.
- C. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control.
- D. Install receivers, sized to accommodate pump-down charge, on systems and larger and on systems with long piping runs.

3.4 PIPING INSTALLATION

- A. Install refrigerant piping according to ASHRAE 15.
- B. Install refrigerant piping as recommended by the HVAC equipment manufacturer. Include liquid line solenoid, sight glass, filter drier, and thermostatic expansion valve (TXV) with by-pass and check valve assembly around TXV to allow liquid flow from the indoor unit coil to the outdoor unit during the heating mode.
- C. Basic piping installation requirements are specified in Division 23 Section 20 02 13 "Basic Piping".
- D. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- E. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
- F. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through walls or ceilings, sized to permit installation of full-thickness insulation.
- G. Belowground, install copper tubing in protective conduit. Vent conduit outdoors.
- H. Slope refrigerant piping as follows:
 - 1. Install horizontal suction lines with a uniform slope downward to compressor.
 - 2. Liquid lines may be installed level.
- I. Manufacturers installation instructions shall supercede contract drawings where a conflict may occur. Notify Architect before proceeding if a conflict does occur.
- J. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.
- K. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.
- L. Hanger, support, and anchor products are specified in Division 23 Section 20 05 29 "Hangers and Supports."
- M. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than long.
 - 2. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

3.5 PIPE JOINT CONSTRUCTION

- A. Braze joints according to Division 20 Section 20 02 13 "Basic Piping."
- B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.6 FIELD QUALITY CONTROL

- A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
- B. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.

3.7 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of the conditioned air to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Check compressor oil level above center of sight glass.
 - 2. Open compressor suction and discharge valves.
 - 3. Open refrigerant valves, except bypass valves that are used for other purposes.
 - 4. Check compressor-motor alignment, and lubricate motors and bearings.

3.8 CLEANING

- A. Before installing copper tubing, clean tubing and fittings with trichloroethylene.
- B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.9 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter-dryer after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to a vacuum. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up.
 - 4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.
 - 5. Measure amount of refrigerant required for each system. Include on close out documents.

END OF SECTION

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SECTION 23 3100 - METAL DUCTWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification section, apply to this section.
- B. Requirements of the following Division 20 Sections apply to this section:
 - 1. Section 20 01 00 "General Provisions"

1.02 SUMMARY

- A. This section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage.
- B. Related Sections: The following sections contain requirements that relate to this Section:
 - 1. Section 23 07 00 "Ductwork Insulation" for exterior duct and plenum insulation.
 - 2. Section 23 33 00 "Duct Accessories" for flexible duct materials, dampers, duct-mounted access panels and doors, and turning vanes.
 - 3. Section 23 37 00 "Air Outlets."
 - 4. Section 23 05 93 "Testing, Adjusting, and Balancing."

1.03 DEFINITIONS

- A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:
 - 1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
 - 2. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures,

1.04 SYSTEM PERFORMANCE REQUIREMENTS

- A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.05 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Duct Liner.
 - 2. Sealing Materials.
 - 3. Fire-Stopping Materials.
 - 4. Construction Methods.
- C. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:
 - 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 review. For exhaust ducts systems, indicate the classification of the 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 partitions.
 7. Terminal unit, coil, and humidifier installations.
 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- D. Coordination drawings for ductwork at congested areas or areas of interference shall be prepared to totally describe proposed installation and routings in accordance with Division 20 01 00 General Provisions." show the following:
1. Coordination with ceiling suspension members.
 2. Spatial coordination with other systems installed in the same space with the duct systems.
 3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.
 4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
- E. Welding certificates including welding procedures specifications, welding procedure qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.
- F. Record drawings including duct system routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 20 01 00 - General Provisions.

1.06 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code-Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."
- B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.
- C. NFPA Compliance: Comply with the following NFPA Standards:
 1. NFPA 90A: "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.
 2. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.
 3. Perform tests specified in "Field Quality Control." Modify mock-up construction and perform additional tests as required to achieve specified minimum acceptable results.
 4. Obtain approval of mock-ups before beginning final fabrication.
 5. Retain and maintain mock-ups during construction in undistributed condition as a standard for judging completed unit of work.
 6. Demolish and remove mock-ups from project site when directed.
 7. Accepted mock-ups that form a part of the actual duct system may remain and become part of completed unit of work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle sealant fire-stopping materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other cause.
- C. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

PART 2 PRODUCTS

2.01 SHEET METAL MATERIALS

- A. Sheet Metal, General: Provide sheet metal in thickness indicated, packaged and marked as specified in ASTM A 700.
- B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653/A653M, A924/A924M. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.
- C. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- D. Stainless Steel: ASTM A 480/A 480M, Type 316 & 304, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.
- E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- G. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- H. In general, the contract drawings are diagrammatic and are not intended to be scaled, nor indicate all details such as offsets, transitions, etc. for the fabrication/installation of work. It will be the responsibility of the contractor to completely coordinate with other trade systems, and all construction documents for the actual location and elevation of final install. The Mechanical Contractor means and methods of installation shall provide for operating efficiency, neatness of appearance, and ease of maintenance. Where information required to provide a complete working system is omitted or unclear, the contractor is responsible for requesting a clarification from the engineer prior to submission of bids. Bidding contractors must review all construction documents and be knowledgeable of all referenced codes and ordinances prior to submitting bids. The contractor should expect minor deviations from the contract documents and include additional labor & material for offsets and elbows including straight duct in his sheet metal bid. The sheet metal contractor should expect, and include in his bid, at least 5% in poundage (but not less than 7,500 pounds) of the total project poundage estimated. The contractor shall also include any required external insulation (material & labor) that may be required. All deviations shall be discussed and submitted to the engineer for approval. The contractors shall install his work in a manner so that interferences between the various trades are avoided. All deviations from sizes, locations, and from all other methods of the installation, shall be recorded.
 - 1. All uses of this allowance should be submitted to the mechanical engineer for record.
 - 2. All uses of this allowance are to be approved by the mechanical engineer prior to construction of ductwork.

2.02 DUCT INSULATION

- A. Refer to specification 23 07 00 for Duct Insulation specification.

2.03 FIRE-STOPPING

- A. Refer to Division 7 Section "Joint Sealers" for fire-stopping.

2.04 FIRE-STOPPING

- A. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Resistant Sealant: Provide one-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriter's Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:

- D. Products: Subject to compliance with requirements, provide one of the following:
1. "Dow Corning Fire Stop Foam"; Dow Corning Corp.
 2. "Pensil 851"; General Electric Co.
 3. "Dow Corning Fire Stop Sealant"; Dow Corning Corp.
 4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.
 5. "RTV 7403"; General Electric Co.
 6. "Fyre Putty"; Standard Oil Engineered Materials Co.

2.05 HANGERS AND SUPPORTS

- A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
- B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.
1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.
 2. Straps and Rod Sizes: Conform to Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for sheet steel width and gage and steel rod diameters.
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.
1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.
 2. For stainless steel ducts, provide stainless steel support materials.
 3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

2.06 RECTANGULAR DUCT FABRICATION

- A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.
1. Fabricate rectangular ducts in lengths appropriate to reinforced and rigidity class required for pressure classification.
 2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.
- B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:
1. Supply Ducts: 2 inches water gage.
 2. Return Ducts: 2 inches water gage, negative pressure.
 3. Exhaust Ducts: 2 inches water gage, negative pressure.
 4. Welding Booth & Woodworking Exhaust Duct 10 inches water gage, negative pressure.
- C. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of un-braced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

2.07 RECTANGULAR DUCT FITTINGS

- A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," Current Edition, Figures 2-1 through 2-10.

2.08 ROUND DUCT FABRICATION

- A. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," Most Current Edition, Figure 3-1, RL-1, RL-4, or RL-5. Seams Types RL-2 or RL-3 may be used if spot-welded on 1-inch intervals. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.
- B. Double-Wall (Insulated) Ducts (Medium to High Pressure Ductwork): Fabricate double-wall insulated ducts with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
 - 1. Thermal Conductivity: 0.27 Btu/sq. Ft./deg F/inch thickness at 75 deg F mean temperature.
 - 2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation, and in gages specified above for single-wall duct.
 - 3. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.
 - 4. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gages listed below. For rectangular flat oval ducts, the diameter in the table below is the equivalent "basic round diameter."
 - a. 3 to 8 inches: 28 gage with standard spiral construction.
 - b. 9 to 42 inches: 28 gage with single-rib spiral construction.
 - c. 44 to 60 inches: 26 gage with single-rib spiral construction.
 - d. 62 to 88 inches: 22 gage with standard spiral construction.
 - 5. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.09 ROUND SUPPLY AND EXHAUST FITTINGS FABRICATION

- A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," Most Current Edition, Figures 3-4 and 3-5 and with metal thickness specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.
- C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:
 - 1. Mitered Elbows: Fabricate mitered elbows with welded construction in gages specified below.
 - a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.
 - b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:
 - 1) 3 to 36 inches: 24 gage.
 - 2) 27 to 36 inches: 22 gage.
 - 3) 37 to 50 inches: 20 gage.
 - 4) 52 to 60 inches: 18 gage.
 - 5) 62 to 84 inches: 16 gage.
 - c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:
 - 1) 3 to 14 inches: 24 gage.
 - 2) 15 to 26 inches: 22 gage.
 - 3) 27 to 50 inches: 20 gage.

- 4) 52 to 60 inches: 18 gage.
- 5) 62 to 84 inches: 16 gage.
- d. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vanes.
2. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations of ½-inch-diameter (e.g. 3 ½ - and 4 ½ - inch) elbows with gored construction.
3. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or ½ - inch-diameter (e.g. 9 ½ - and 10 ½ -inch) elbows with gored construction.
4. Round Elbows: Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.
5. Round Gored Elbows Gages: Same as for non-elbow fittings specified above.
6. Flat Oval Elbows Gages: Same as longitudinal seam flat oval duct.
7. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches:
26 gage.
8. Not used.
- D. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.
 1. Thermal Conductivity: 0.27 Btu/sq. ft./deg F/inch thickness at 75 deg F mean temperature.
 2. Outer Shell: Base outer shell gage on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation. Gages for outer shell shall be same as for uninsulated fittings specified above.
 3. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation. Provide components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.
 4. Perforated Inner Liner: Construct round and flat oval inner liners with perforated sheet metal of the gages listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."
 - a. 3 to 34 inches: 24 gage.
 - b. 35 to 58 inches: 22 gage.
 - c. 60 to 88 inches: 20 gage.
 5. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

2.10 AUXILIARY DRAIN PAN

- A. Auxiliary Drain Pans: Fabricate of min. 16 gauge 304 stainless steel turned up four (4) inches all around and extend six (6) inches beyond all sides of equipment. All joints and seams to be of welded construction. This is applicable for all auxiliary drain pans under air handling units, hot water heaters, etc.
 1. Provide float switch in auxiliary drain line, unit to de-energize when float switch is tripped.
 2. Pipe safety pans to nearest floor drain.
 3. In air handling unit drain pan, provide ball valve in safety pan condensate drain line.

2.11 KITCHEN HOOD & DISHWASHER EXHAUST DUCT

- A. Exhaust duct shall be constructed of 16 gauge, Type 316 stainless steel with No. 4 finish on exposed surfaces and welded joints. All seam and joints shall be of welded construction.

Provide a 2" wide stainless steel ceiling collar around the duct at penetration through the ceiling. Contractor shall wrap exhaust duct with 3.0" thk. "Fyrewrap" fiberglass insulation, foil faced, installed in strict accordance with manufacturer's recommendations.

2.12 JOINT AND SEAM SEALANT

- A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
 - 1. All sealants shall be UL181A compliant.
- B. All ductwork joints and seams to be sealed with joint and seam hardcast. Water Based Duct Sealant to be Versa-Grip 102 as manufactured by HardCast, Miracle Kingco D-619 Water Based Duct Sealant or prior approved equal.
 - 1. All seams on exposed ductwork shall be neatly caulked with HardCast Iron-Grip 601 or prior approved equal. Contractor to seal one (1) duct joint/seam for aesthetic approval by architect prior to sealing entire duct system.
- C. Flange Gaskets Joints: Butyl rubber or EPDM polymer with polyisobutylene plasticizer to be installed at joint connection and then sealed with joint and seam hardcast.

2.13 ALUMINUM DUCTWORK CONSTRUCTION

- A. Not used.

2.14 DUCT LINER

- A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.
 - 1. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.
 - a. Thickness: 1 inch, 1.5lb.density
 - b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
 - c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
 - d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
 - 2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
 - 3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.15 APPLICATION OF LINER IN RECTANGULAR DUCTS

- A. Adhere a single layer of indicated thickness of duct liner with at least 100 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
- B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
- C. Butt transverse joints without gaps and coat joint with adhesive.
- D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
- E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.
- F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

- G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - 1. Fan discharges.
 - 2. Intervals of lined duct preceding unlined duct.
 - 3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.
- H. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - 1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
 - 2. Applicable where perforated liner is specified on drawings.
- I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used; secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.16 COATINGS FOR EXTERIOR DUCTWORK

- A. Not used.

2.17 NEGATIVE ISOLATION ROOM & NEGATIVE CORRIDOR DUCTWORK CONSTRUCTION

- A. Not used

2.18 ADDITIONAL STEEL SLEEVE FOR INSTALLATION OF SECURITY BARS

- A. Provide security bars at all roof penetrations.
- B. Where roof deck penetration is open to space below (Vault roof penetration, etc.) the contractor is to provide & install a 10 ga sheet metal sleeve (flanged & bolted (TORX security type) to concrete roof deck) as required to properly install security bars.

2.19 UNTREATED OUTSIDE AIR INTAKE DUCTWORK CONSTRUCTION

- A. Not used.

2.20 FUME HOOD EXHAUST DUCT

- A. Fume Hood Exhaust duct shall be constructed of 16 gauge, Type 316 stainless steel with No. 4 finish on exposed surfaces and welded joints. All seam and joints shall be of welded construction. Provide a 2" wide stainless steel ceiling collar around the duct at penetration through the ceiling. Contractor shall wrap exhaust duct with 1.5" thk. "Fyrewrap" fiberglass insulation, foil faced, installed in strict accordance with manufacturer's recommendations.

2.21 ROOF MOUNTED EXHAUST DUCT

- A. Roof mounted exhaust duct shall be 16ga. 316 doublewall stainless steel duct with 16ga. solid 316 stainless steel liner. Insulation shall be a minimum R-8.

2.22 WELDING BOOTH EXHAUST DUCT

- A. Exhaust duct shall be constructed of 16 gauge, Type 316 stainless steel with No. 4 finish on exposed surfaces and welded joints. All seam and joints shall be of welded construction. Duct to be built to 4"wg (Negative Pressure) static pressure class.

2.23 WOODWORKING DUST COLLECTION EXHAUST DUCT

- B. Exhaust duct shall be constructed of 16 gauge, Type 316 stainless steel with No. 4 finish on exposed surfaces and welded joints. All seam and joints shall be of welded construction. Duct to be built to 4"wg (Negative Pressure) static pressure class. SMOOTH INTERIOR TO PREVENT BUILDUP OF DEBRIS.

PART 3 EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated. All ducts shall be galvanized steel (G90) unless otherwise noted.
- B. Duct System Pressure Class: Construct and install each system for the specific duct pressure classification indicated.
 Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
 - 1. Supply Ducts: 2 inch wg.
 - 2. Return Ducts (Negative Pressure): 2 inch wg.
 - 3. Exhaust Ducts (Negative Pressure): 2 inch wg.
 - 4. Welding Booth & Woodworking Exhaust Duct (Negative Pressure): 10 inch wg.
- C. Install ducts with the fewest possible joints.
- D. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.
- E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
- F. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.
- I. Install insulated ducts with 1-inch clearance outside of insulation.
- J. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1 ½ inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Through-Penetration Firestop Systems."
- O. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
- P. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
- Q. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes.
- R. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."
- S. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel

primer. Paint materials and application requirements are specified in Division 9 painting Sections.

- T. All sections of duct work (Supply, Return, Exhaust, Fresh Air) are to be supplied to project in maximum lengths of 4'-0" as to allow for ease of field modifications and rerouting of ductwork.

3.02 SEAM AND JOINT SEALING

- A. General: Seal all duct seams and joints as follows:
- B. Pressure Classifications Greater Than 3 Inches Water Gage: All transverse joints, longitudinal seams and penetrations.
- C. Pressure Classifications Greater than 2 to 3 Inches Water Gage: All transverse joints and longitudinal seams.
 - 1. Pressure Classification Less than 2 Inches Water Gage: All transverse joints and longitudinal seams.
- D. Seal externally insulated ducts prior to insulation installation.
- E. Self-adhesive foil faced tape not acceptable as a means of ductwork sealant.
- F. Cover all sheet metal screws.
- G. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.
 - 1. All sealants shall be UL181A compliant.
- H. All ductwork joints and seams to be sealed with joint and seam hardcast. Water Based Duct Sealant to be Versa-Grip 102 as manufactured by HardCast, Miracle Kingco D-619 Water Based Duct Sealant or prior approved equal.
 - 1. All seams on exposed ductwork shall be neatly caulked with HardCast Iron-Grip 601 or prior approved equal. Contractor to seal one (1) duct joint/seam for aesthetic approval by architect prior to sealing entire duct system.
- I. Flange Gaskets Joints: Butyl rubber or EPDM polymer with polyisobutylene plasticizer to be installed at joint connection and then sealed with joint and seam hardcast.

3.03 HANGING AND SUPPORTING

- A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards (Most Current Edition)," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.
- B. Support horizontal ducts with 2 feet of each elbow and withing 4 feet of each branch intersection.
- C. Support vertical ducts at a maximum interval of 16 feet and at each floor.
- D. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specified methods indicated.
- E. Install concrete insert prior to placing concrete.
- F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

- A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Duct Accessories."
- B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards" (Most Current Edition), Figures 2-7 and 2-8.
- C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards" (Most Current Edition), Figures 2-16 through 2-18.
- D. Terminal Units Connections: Comply with SMACNA "HVAC Duct Construction Standards" (Most Current Edition), Figure 2-19.

3.05 FIELD QUALITY CONTROL

- A. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

- B. Conduct tests, in the presence of the Architect, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire systems at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure. Give 7 days advanced notice for testing.
- C. Determine leakage from entire system or section of the system by relating leakage to the surface area of the test section.
- D. Maximum Allowable Leakage: As described in ASHRAE (most current edition) Handbook, "Fundamentals" Volume, Chapter 32, Table 6 and Figure 10. Comply with requirements for leakage classification 3 for round and flat oval ducts, leakage classification 12 for rectangular ducts in pressure classifications less than and equal to 2 inches water gage (both positive and negative pressures), and leakage classification 6 for pressure classifications greater than 2 inches water gage and less than and equal to 10 inches water gage.
- E. Remarks leaking joint as required and apply sealants to achieve specified maximum allowable leakage.
- F. Leakage Test: Perform volumetric measurements and adjust air systems as described in ASHRAE (most current edition) "HVAC Systems and Applications" Volume, Chapter 57 and ASHRAE (most current edition) "Fundamentals" Volume, Chapter 13, and Division 15 Section "TESTING, ADJUSTING, AND BALANCING."
- G. Leakage tests shall be performed for the main trunk line up to the terminal units of each air handling unit. The tests shall be concluded as a requirement of Test and Balance Contract.

3.06 ADJUSTING

- A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 23 Section "TESTING, ADJUSTING, AND BALANCING" for requirements and procedures for adjusting and balancing air systems.

3.07 CLEANING NEW SYSTEMS

- A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- B. Use service openings, as required, for physical and mechanical entry and for inspection.
 - 1. Create other openings to comply with duct standards.
 - 2. Disconnect flexible ducts as needed for cleaning and inspection.
 - 3. Remove and reinstall ceiling sections to gain access during the cleaning process.
- C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
- D. Clean the following metal duct systems by removing surface contaminants and deposits:
 - 1. Air outlets and inlets (registers, grilles, and diffusers).
 - 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 - 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 - 4. Coils and related components.
 - 5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
 - 6. Supply-air ducts, dampers, actuators, and turning vanes.
- E. Mechanical Cleaning Methodology:
 - 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
 3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
 4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet.
 5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
- F. Cleanliness Verification:
1. Visually inspect metal ducts for contaminants.
 2. Where contaminants are discovered, re-clean and reinspect ducts.
- G. All ductwork shall be in accordance to SMACNA's (current edition) "Duct Cleanliness for New Construction Guidelines". All supply ducts should be considered intermediate level. If upon inspection or during construction it is deemed that the criteria per section 3 of SMACNA's "Cleanliness Guidelines" were violated and the contamination has been identified, NADCA (current edition) "Cleaning New Systems" shall be followed.

3.08 HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

1. Install ducts to allow for thermal expansion through 2000 deg F temperature range.
2. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
3. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.
4. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.
5. Perform grease duct test in accordance with IMC 2015 section 506.3.2.5 Grease duct test. Prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed. Ducts shall be considered to be concealed where installed in shafts or covered by coatings or wraps that prevent the ductwork from being visually inspected on all sides. The permit holder shall be responsible to provide the necessary equipment and perform the grease duct leakage test. A light test shall be performed to determine that all welded and brazed joints are liquid tight. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls. A test shall be performed for the entire duct system, including the hood-to-duct connection. The duct work shall be permitted to be tested in sections, provided that every joint is tested. For listed factory-built grease ducts, this test shall be limited to duct joints assembled in the field and shall exclude factory welds.

END OF SECTION

12-10-25

SECTION 23 3300 - DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Fire dampers.
 - 5. Turning Vanes.
 - 6. Duct-mounting access doors.
 - 7. Flexible connectors.
 - 8. Flexible Duct.
 - 9. Round Branch Takeoff to Diffusers.
 - 10. Cable Control System & Balancing Dampers.
 - 11. Misc Sheetmetal & Duct Accessory Hardware.
 - 12. Smoke Dampers
 - 13. Combination Fire/Smoke Dampers.
- B. Related Sections include the following:
 - 1. Division 26 Section "Fire Alarm" for duct-mounting fire and smoke detectors.
 - 2. Division 23 Section 23 09 00 "Building and Automatic Temperature Controls" for electric and pneumatic damper actuators.

1.03 SUBMITTALS

- A. Product Data: For the following:
 - 1. Backdraft dampers.
 - 2. Volume dampers.
 - 3. Motorized control dampers.
 - 4. Fire dampers.
 - 5. Turning Vanes.
 - 6. Duct-mounting access doors.
 - 7. Flexible connectors.
 - 8. Flexible Duct.
 - 9. Round Branch Takeoff to Diffusers.
 - 10. Cable Control System & Balancing Dampers.
 - 11. Misc Sheetmetal & Duct Accessory Hardware.
 - 12. Smoke Dampers
 - 13. Combination Fire/Smoke Dampers.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Special fittings.
 - 2. Manual-volume damper installations.
 - 3. Fire-damper installations, including sleeves and duct-mounting access doors.

4. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

1.04 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.05 EXTRA MATERIALS

- A. Furnish extra materials matching products installed as described below, packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.01 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Stainless Steel: ASTM A 480/A 480M.
- D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: ASTM B 221, alloy 6063, temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 BACKDRAFT DAMPERS

- A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.
- B. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners [and mounting flange].
- C. Blades: 0.050-inch- thick aluminum sheet.
- D. Blade Seals: Felt, Vinyl or Neoprene.
- E. Blade Axles: Nonferrous or Galvanized steel.
- F. Tie Bars and Brackets: Aluminum or Galvanized steel.
- G. Return Spring: Adjustable tension.

2.03 VOLUME DAMPERS

- A. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating,[with linkage outside airstream,] and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, [galvanized] [stainless] sheet steel.
 3. Aluminum Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: [Galvanized steel] [Stainless steel] [Nonferrous].
 7. Bearings: Oil-impregnated bronze or Molded synthetic sleeve].
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
- C. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating,[with linkage outside airstream,] and suitable for horizontal or vertical applications.
1. Steel Frames: Hat, U or Angle-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
 3. Aluminum Frames: Hat, U or Angle-shaped]-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
 4. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 6. Blade Axles: Galvanized steel, Stainless steel or Nonferrous.
 7. Bearings: Oil-impregnated bronze or Molded synthetic thrust or ball.
 8. Blade Seals: Felt, Vinyl, or Neoprene.
 9. Jamb Seals: Cambered stainless steel.
 10. Tie Bars and Brackets: Galvanized steel.
- D. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.
- E. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.04.01 MOTORIZED CONTROL DAMPERS

- A. Dampers shall bear the AMCA Certified Ratings Seal for Air Performance Air Leakage in accordance with AMCA 511 (Greenheck VCD-23).
- B. Dampers shall have a maximum leakage of Class 1 (8 cfm/sq. ft @ 4 in. wg at -40°F) as defined by AMCA and shall be tested in accordance with AMCA standard 500-D.
- C. Dampers shall have a maximum differential pressure rating of 5 in. wg. and a maximum velocity rating of 3000 FPM.
- D. Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.

- E. Damper blades shall be 16 ga. Galvanized steel strengthened by three longitudinal 1" deep Vee grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation shall be horizontal and shall be opposed blade or parallel blade as required.
- F. Each blade stop at the top and bottom of the damper frame shall occupy no more than 1/2" of the damper opening area.
- G. Provide TPE blade seals mechanically fastened to each blade, and flexible stainless steel jamb seals.
- H. All linkage shall be stainless steel, and concealed in the jamb. A stainless steel axle with stainless steel axle bearings shall be provided.
- I. Refer to control specifications for damper actuator.
- J. Control dampers shall be equal to Greenheck # VCD-23 with all options specified.

2.05 FIRE DAMPERS

- A. Fire dampers shall be labeled according to UL 555.
- B. Fire Rating: 1-1/2 hours.
- C. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- D. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 16 GA (0.0635) inch thick as indicated and of length to suit application. When security bars are factory supplied in the sleeve from the damper manufacturer, the sleeve shall be 10 GA (0.1382) inch thick.
- E. Mounting Orientation: Vertical or horizontal as indicated.
- F. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- G. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- H. Fusible Links: Replaceable, 165 deg F rated. General Description: Labeled according to UL 555C; comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."
- I. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- J. Blades: Galvanized sheet steel with refractory insulation.
- K. Fusible Links: Replaceable, 165 deg F rated.
- L. Fire dampers to be factory sealed Class "A", suitable to 4" static pressure.
- M. Contractor to provide fire dampers at all wall fire wall penetration, refer to architect life safety plan for rating of respective walls and contractor to provide 1-1.2 hr fire damper at all floor penetrations of ductwork (supply, return and/or exhaust).
- N. All ductwork housing fire dampers shall be equipped with access door of sufficient size to reset and change out fusible link as necessary. All fire dampers have to be check and tested every three (3) years, access doors of sufficient size are mandatory to reset the fusible link, refer to paragraph 3.1 of this specifications for require sizes of access doors, this will be based in actual size of ductwork.
- O. All fire dampers are to be dynamic type.
- P. All fire dampers to be type C unless otherwise indicated.
- Q. When security bars are factory installed in the sleeve, security bars are to be crossed bar design 0.5 inch diameter bars with 5 inch vertical and horizontal spacing.

2.06 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

- B. Manufactured Turning Vanes: Fabricate 1-1/2-inch- wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
- C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.07 DUCT-MOUNTING ACCESS DOORS

- A. General Description: Fabricate doors airtight and suitable for duct pressure class.
- B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.
 - 1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 2. Provide number of hinges and locks as follows:
 - a. Less Than 12 Inches Square: Secure with two sash locks.
 - b. Up to 18 Inches Square: Two hinges and two sash locks.
 - c. Up to 24 by 48 Inches: Three hinges and two compression latches[with outside and inside handles].
 - d. Sizes 24 by 48 Inches and Larger: One additional hinge.
- C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
 - 1. Frame: Galvanized sheet steel, with spin-in notched frame.
- D. Pressure Relief Access Door: Double wall and duct mounting; fabricated of galvanized sheet metal [with insulation fill and thickness] as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.
 - 1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- F. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.08 FLEXIBLE CONNECTORS

- A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
- B. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.
- C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. Yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. Yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- E. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. Yd..
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. Yd..

2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

2.09.01 LOW PRESSURE FLEXIBLE DUCT

- A. Core material shall be an acoustical transparent CPE fabric supported by helically wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesive.
- B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least 2-1/2 times the working pressure.
 1. Positive: 10 inches W.G.
 2. Negative: 5 inches W.G.
- C. The duct shall be rated for a velocity of at least 5500 feet per minute.
- D. Suitable for operating temperatures of at least 250 degrees F.
- E. Minimum Acoustic Performance:

1. The insertion loss (dB) of a 10 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2500 feet per minute shall be at least:

	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1000 Hz</u>	<u>2000 Hz</u>	<u>4000 Hz</u>
<u>8 inch dia.</u>	12	31	40	38	38	23
<u>12 inch dia.</u>	17	35	31	31	28	13

2. The radiated noise reduction (dB) of a 10 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2500 feet per minute shall be at least:

	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1000 Hz</u>	<u>2000 Hz</u>	<u>4000 Hz</u>
<u>8 inch dia.</u>	10	7	7	8	10	13
<u>12 inch dia.</u>	9	6	6	5	9	13

3. The self generated sound power levels (dB re: 10-12 watts) of a 10 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 1000 feet per minute shall not exceed:

	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1000 Hz</u>	<u>2000 Hz</u>	<u>4000 Hz</u>
<u>8 inch dia.</u>	41	34	27	19	18	21
<u>12 inch dia.</u>	54	45	38	31	27	23

- F. Factory insulate the flexible duct with flexible fiberglass insulation. The R value shall be at least 6.0 at a mean temperature of 75 degrees F.
- G. Cover the insulation with a reinforced aluminum pigmented vapor barrier jacket having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E96, procedure A.
- H. The ductwork shall be UL listed, Class 1 Air Duct and comply with NFPA 90A and 90B.
- I. Manufacturer: Flexmaster Type 1M, 8M, Thermaflex #MKE with Thermaflex #Flexflow Elbow, or prior approved equal. Sample required for prior approval.

2.09.02 ACOUSTICAL LOW PRESSURE FLEXIBLE DUCT

- A. Core material shall be an acoustical Spun Bond Nylon inner film supported by helically wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesive. The core shall maintain its free area and a center line radius of 1.0 or better.
- B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least 2-1/2 times the working pressure.
 1. Positive: 6 inches W.G.
 2. Negative: 5 inches W.G.
- C. The duct shall be rated for a velocity of at least 5500 feet per minute.
- D. Suitable for operating temperatures of at least 250 degrees F.
- E. Minimum Acoustic Performance:

1. Sound Attenuation - Straight Duct

Flexmaster U.S.A. Flexible Duct	Dia (in.)	Length (ft.)	Insertion Loss, dB Octave Band Center Frequency, Hz						
			63	125	250	500	1,000	2,000	4,000
Type 6	6	12	6.9	36	43	45	47	53	46
		9	5.5	24	28	29	30	33	29
		6	4.0	13	15	15	16	17	16
		3	2.3	4.9	5.3	5.3	5.5	5.8	5.4
		1	0.85	1.36	1.51	1.44	1.55	1.51	1.45
Type 6	8	12	11.3	39	37	46	49	55	49
		9	8.5	25	24	29	31	34	31
		6	5.7	14	13	15	16	18	16
		3	2.9	5.0	4.9	5.4	5.6	5.8	5.6
		1	0.98	1.39	1.37	1.45	1.48	1.52	1.48
Type 6	12	12	10.0	35	33	43	44	55	36
		9	8.1	23	22	28	28	34	24
		6	5.5	13	12	15	15	18	13
		3	2.8	4.8	4.7	5.3	5.3	5.8	4.9
		1	0.96	1.34	1.33	1.43	1.44	1.53	1.36

2. Sound Attenuation - 90° Elbow

Flexmaster U.S.A. Flexible Duct	Dia (in.)	Length (ft.)	Insertion Loss, dB Octave Band Center Frequency, Hz						
			63	125	250	500	1K	2K	4K
Type 6	6	12	21	46	47	52	56	55	55
		9	14	29	30	32	35	34	35
		6	9	15	16	17	18	17	18
		3	3.8	5.4	5.5	5.7	5.9	5.8	5.9
Type 6	8	12	25	44	50	55	50	56	57
		9	17	28	32	34	32	35	36
		6	10	15	16	17	16	18	18
		3	2.4	5.3	5.6	5.8	5.6	5.9	6.0
Type 6	12	12	29	40	43	47	46	49	43
		9	19	26	28	30	29	31	28
		6	11	14	15	16	15	16	15
		3	4.4	5.1	5.3	5.5	5.4	5.6	5.3

- F. Factory insulate the flexible duct with flexible fiberglass insulation. The R value shall be at least 6.0 at a mean temperature of 75 degrees F. (R4.2 not acceptable)
- G. Cover the insulation with a reinforced aluminum pigmented vapor barrier jacket having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E96, procedure A.
- H. The ductwork shall comply with UL Standard 181, as a Class 1 Air Duct and comply with NFPA 90A and 90B.

- I. Manufacturer: Flexmaster Type 6M, with Thermaflex #Flexflow Elbow, or prior approved equal. Sample required for prior approval.
 1. Maximum length: 12'0".

2.09.03 FLEXIBLE DUCT ELBOW SUPPORTS

- A. Flexible Duct Elbow Supports: "FlexRight" (Durable Elbow Support).
 1. Universal-mount, 1-piece, fully adjustable, radius-forming brace to support 4-inch (102-mm) through 16-inch (406-mm) diameter flexible air ducts.
 2. Classified: UL 2043.
 3. Material: 100 percent recycled copolymer polypropylene.
 4. Support Frame Radius: 8 inches.
 5. Compliance for Flexible Duct Radius:
 - a. SMACNA HVAC Duct Construction Standards.
 - b. ASHRAE Advanced Energy Design Guides.
 - c. ADC Flexible Duct Performance and Installation Standards.
- B. Manufacturer: Build Right Products (www.BuildRightProducts.com) or prior approved equal.

2.10 ROUND BRANCH TAKEOFF W/ DAMPER TO DIFFUSERS

- A. Furnish and install Flexmaster #STOD-BO3 45, Hamlin Sheetmetal, Spiral Pipe of Texas or approved equal degree side take off fittings with dampers for all round ducts connecting to the side of rectangular ducts. Construction shall be 26 gauge, G-90 galvanized steel. Mounting flanges must be pre-punched, 1" wide, and provided with corner clips and adhesive gaskets. Dampers shall have full length 3/8" square shafts connected with U-Bolts, nylon bearings, 2" insulation build outs and Duro Dyne #KR-3, Elgin Quadrant or approved equal heavy duty locking hand quadrants. Spin collar with wing nut dampers not allowed.

2.11 REMOTE ELECTRONIC BALANCING DAMPER ASSEMBLY FOR INACCESSIBLE MANUAL VOLUME DAMPERS

- A. Dampers above a hard ceiling, dampers located more than 10'-0" above finished floor, or in any inaccessible location shall be controlled with a remote electronic balancing damper positioner (EBDP). Damper positioner shall include an LCD visual indicator meter that shows blade position modulating over a range of 0-100% open via a voltage signal that is proportional to the blade angle. A non-rechargeable 9v lithium battery powers the positioner. Provide multiple EBDP Positioner as noted on drawing detail.
- B. The Electronic Balancing Damper (EBD) shall include a 12V DC motor and a positive feedback control system. When used for shut off, damper shall be provided with blade seals. Damper actuator shall not require electrical power connection.
- C. Round dampers shall be constructed of galvanized steel and shall be available in the following sizes and gages:
 - 4" through 9" (24 gage)
 - 10" through 16" (20 gage)
- D. Rectangular dampers shall be constructed of .050 aluminum extrusion frames and blades with reinforcing channels. Dampers shall be available in the following sizes:
 - Min size = 4" x 3"
 - Max size = 24" x 24"
- E. Damper actuator shall be connected to a wall plate available in 1,2,4,6, and 12 ports. This wall plate shall be installed in an accessible space, preferably above a lay in ceiling, or as noted on drawings. Connecting cable shall be plenum rated 5 conductor wire. This cable shall be provided by the manufacturer of the remote damper system. Field connection between 12V DC motor (Delphi end) and termination wall plate (RJ-12 end) shall be accomplished by connectors installed on the cable by the factory. Standard cable lengths shall be 10', 25', and 50' with longer lengths up to 1000' where required.
- F. The remote electronic balancing damper, wall plate, cable, and remote positioner shall be as manufactured by Young Regulator EBD series.

2.12 MISCELLANEOUS SHEETMETAL AND DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.
- C. Auxiliary Drain Pans: Fabricate of 16-gauge G90 galvanized steel iron turned up four (4) inches all around and extend six (6) inches beyond all sides of equipment (air handling units, hot water heaters, etc.). Size of auxiliary drain pans to be based on equipment size maintaining minimum 6" clearance all around. All auxiliary drain pans to be G90 galvanized steel. Provide float switch in auxiliary drain pan, unit to de-energize when tripped.

2.13 SMOKE DAMPERS

- A. General: Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules, and at all rated wall duct penetrations (refer to architectural life safety plan). Dampers shall meet the requirements of NFPA 92A, 92B, 101 & 105 and further shall be tested, rated, and labeled in accordance with the latest edition of UL Standards 555S. Dampers shall have a low leakage design qualified to UL555S Leakage Class I.
- B. Each damper /actuator combination shall have a UL555S elevated temperature rating of 350 F degree minimum and shall be operational at maximum design air flow at its installed location. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 24 volt AC, 2-position operation.
- C. Damper blades shall be 16 ga galvanized steel 3V type with three longitudinal grooves for reinforcement. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in polished extruded holes in the damper frame. Blade edge seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression type. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper. Airfoil blades shall be provided for all dampers with airflow velocities greater than 2000 FPM.
- D. The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal.
- E. Damper must be rated for mounting vertically (with blades running horizontal) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper.
- F. The basis of design is Greenheck Model SMD-201 (for ducts with velocities up to 2000 FPM and systems with pressure ratings of 4" w.g. or 6" w.g.) or Greenheck Model SMD-301 (for ducts with velocities greater than 2000 FPM and up to 4000 FPM and systems with pressure ratings of 4" w.g., 6" w.g. and up to 8" w.g.) or prior approved equal.
- G. All smoke dampers shall be provided with the following:
 - 1. Minimum 20 gauge galvanized sleeve. When security bars are factory supplied in the sleeve from the damper manufacturer, the sleeve shall be 10 GA (0.1382) inch thick.
 - 2. All ductwork housing smoke dampers shall be equipped with access door of sufficient size for damper maintenance and to reset and test actuation of smoke damper. All smoke dampers located in facility have to be check and tested every three (3) years, access doors of sufficient size are mandatory to check operation of smoke dampers, refer to paragraph 3.1 of this specifications for require sizes of access doors, this will be based in actual size of ductwork.
 - 3. Smoke dampers/sleeves must be sealed to a seal class A.
 - 4. All smoke dampers must be rated to 4" w.g. or 6" w.g. (depending on the duct system construction specified) and include velocity ratings that meet or exceed the actual velocity at the smoke damper.

5. Unless otherwise noted, all smoke dampers must fail to the closed position.
 6. All smoke dampers must be supplied with single point wiring for damper and specified test switches.
 7. All smoke dampers shall be provided with model OCI blade position indicator. Actuator end switches are not a replacement for blade position indicator switches.
 8. All smoke dampers must be provided with a factory wired and installed Greenheck #GTS-3 test switch with open/closed LED lights to enable one person to test the damper. Contractor must ensure test switch is accessible.
 9. Step-Down transformers: Include to transform from available voltage, single phase to 24V, single phase which comply with UL, FM NFPA Requirements for smoke control systems. Coordinate with Electrical Contractor prior to bid as to ensure a complete and working system.
 10. Smoke dampers located in all round ducts and in oval ducts with a minor axis less than 14" shall be supplied as square or rectangular dampers. The minimum damper size shall be 14" x 14" to allow for a minimum 12x12 duct access door for service and maintenance of internal smoke damper components. The sheet metal contractor shall provide and install square/rectangle to round/oval transitions as required.
 11. Smoke dampers located in square/rectangular ducts 12x12 and smaller shall be supplied as 14x14 dampers. The sheet metal contractor shall provide transitions from the damper to the duct size shown, as required.
 12. Where required for complete access to all damper components, sheet metal contractor shall provide an easily removable section of duct, length as required.
 13. Provide a smoke damper schedule with submittal data to include the following information:
 - a. Plan Page
 - b. Room Number
 - c. Duct system served (Exhaust, supply, primary supply, return)
 - d. Damper Tag
(Example #1: SMD-1-AHU 1-Rm #___)
(Example #2: SMD-2-EF-1-Rm #___)
 - e. Damper Size
 - f. Manufacturer's Model #_____
 - g. Install Arrangement (Vertical or Horizontal)
 - h. Wall/Floor thickness
 - i. Sleeve Length
 - j. Sleeve gage
 - k. Actuator voltage/action - 24 volt AC / PO/SR (Power Open/Spring Closed)
 - l. CFM through damper
 - m. Duct airflow velocity
 - n. Damper velocity rating
 - o. Duct access door size
 14. When security bars are factory installed in the sleeve, security bars are to be crossed bar design 0.5 inch diameter bars with 5 inch vertical and horizontal spacing.
- H. Contractor to coordinate with electrical contractor and fire alarm contractor (prior to bid and after award of project) to ensure a complete working and accessible system is installed. Smoke detectors shall be provided & installed by the fire alarm contractor to notify the fire alarm panel in the event of an alarm. Control of smoke damper is by the fire alarm contractor.

2.14 COMBINATION FIRE/SMOKE DAMPERS

- A. Combination Fire Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules and at all rated wall duct penetrations (refer to architectural life safety plan). Dampers shall meet the requirements of NFPA 80, 90A, 92A, 92B, 101 & 105 and further shall be tested, rated, and labeled in accordance with the latest edition of UL Standards 555 and 555S. Dampers shall have a UL555 fire rating of 1 1/2 hours and be of low leakage design qualified to UL 555S Leakage Class I.
- B. Each damper /actuator combination shall have a UL555S elevated temperature rating of 350 F minimum and shall be operational and dynamic rated to operate at maximum design air flow at its installed location. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 24 volt AC, 2-position operation.
- C. Damper blades shall be 16 ga galvanized steel 3V type with three longitudinal grooves for reinforcement. Damper frame shall be 16 ga. galvanized steel formed into a 5" x 1" structural hat channel. Dampers less than 17" high shall utilize low profile geometry and 20 ga. galvanized steel for the top and bottom frame members to maximize free area. Frame shall be 4-piece construction with 1 1/2" (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. No welding of damper frames shall be permitted. Bearings shall be stainless steel sleeve type rotating in polished extruded holes in the damper frame. Blade edge seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression type. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper. Airfoil blades shall be provided for all dampers with airflow velocities greater than 2000 FPM.
- D. The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal.
- E. Damper must be rated for mounting vertically (with blades running horizontal) or horizontally and be UL 555S rated for leakage and airflow in either direction through the damper. Each damper shall be supplied with a 165 F RRL/OCI (reusable resettable link with blade position indicator package). Actuator end switches are not a replacement for blade position indicator switches.
- F. The basis of design is Greenheck model FSD-211 (for ducts with velocities up to 2000 FPM and systems with pressure ratings of 4" w.g. or 6" w.g.) or Greenheck Model FSD-311 (for ducts with velocities greater than 2000 FPM and up to 4000 FPM and systems with pressure ratings of 4" w.g., 6" w.g. and up to 8" w.g.) or prior approved equal. Combination fire/smoke dampers located in 3 hour or greater walls shall be Greenheck #FSD-311 or prior approved equal.
- G. All combination/fire smoke dampers shall be provided with the following:
 1. Minimum 16 gauge galvanized sleeve for sizes up to 36" wide and/or 24" high. Minimum 14 gauge galvanized sleeve for sizes over 36" wide and/or 24" high. When security bars are factory supplied in the sleeve from the damper manufacturer, the sleeve shall be 10 GA (0.1382) inch thick.
 2. All ductwork housing smoke/fire dampers shall be equipped with access door of sufficient size for damper maintenance and to reset and test actuation of smoke damper and/or reset the fusible link. All smoke dampers located in facility have to be checked and tested every three (3) years, access doors of sufficient size are mandatory to check operation of smoke dampers, refer to paragraph 3.1 of this specifications for required sizes of access doors, this will be based in actual size of ductwork. Where required for complete access to all damper components, sheet metal contractor shall provide an easily removable section of duct, length as required.
 3. Combination fire/smoke dampers and sleeves must be sealed to a seal class A.
 4. Combination fire/smoke dampers must be rated to 4" w.g. and include velocity ratings that meet or exceed the actual velocity at the smoke damper.

5. Unless otherwise noted, all combination fire/smoke dampers must fail to the closed position.
 6. All combination fire/smoke dampers must be supplied with single point wiring for damper and specified test switches.
 7. All combination fire/smoke dampers shall be provided with model RRL/OCI (reusable resettable link with blade position indicator package). Actuator end switches are not a replacement for blade position indicator switches.
 8. All combination fire/smoke dampers must be provided with a factory wired and installed Greenheck #GTS-3 test switch with open/closed LED lights to enable one person to test the damper. Contractor must ensure test switch is accessible.
 9. Step-Down transformers: Include to transform from available voltage, single phase to 24V, single phase which comply with UL, FM NFPA Requirements for smoke control systems. Coordinate with Electrical Contractor prior to bid as to ensure a complete and working system.
 10. Combination fire/smoke dampers located in all round ducts and oval ducts with a minor axis less than 14" shall be supplied as square or rectangular dampers. The minimum damper size shall be 14" x 14" to allow for a minimum 12x12 duct access door for service and maintenance of internal smoke damper components. The sheet metal contractor shall provide and install square/rectangle to round/oval transitions as required.
 11. Smoke dampers located in square/rectangular ducts 12x12 and smaller shall be supplied as 14x14 dampers. The sheet metal contractor shall provide transitions from the damper to the duct size shown, as required.
 12. Where required for complete access to all damper components, sheet metal contractor shall provide an easily removable section of duct, length as required.
 13. Provide a combination fire/smoke damper schedule with submittal data to include the following information:
 - a. Plan Page
 - b. Room Number
 - c. Duct system served (Exhaust, supply, primary supply, return)
 - d. Damper Tag
(Example #1: SMD-1-AHU 1-Rm #____)
(Example #2: SMD-2-EF-1-Rm #____)
 - e. Damper Size
 - f. Manufacturer's Model #_____
 - g. Install Arrangement (Vertical or Horizontal)
 - h. Wall/Floor thickness
 - i. Sleeve Length
 - j. Sleeve gage
 - k. Actuator voltage/action - 24 volt AC / PO/SR (Power Open/Spring Closed)
 - l. CFM through damper
 - m. Duct airflow velocity
 - n. Damper velocity rating
 - o. Duct access door size
 14. When security bars are factory installed in the sleeve, security bars are to be crossed bar design 0.5 inch diameter bars with 5 inch vertical and horizontal spacing.
- H. Contractor to coordinate with electrical contractor and fire alarm contractor (prior to bid and after award of project) to ensure a complete working and accessible system is installed. Smoke detectors shall be provided & installed by the fire alarm contractor to notify the fire alarm panel in the event of an alarm. Control of smoke damper is by the fire alarm contractor.

2.15 CEILING FIRE SMOKE DAMPER

- A. Not used.

2.16 INSULATED MEDIUM AND HIGH PRESSURE DUCT

- A. Provide where indicated on drawings Flexmaster Type 4M UL181 Class I Air Duct. Approved equal: Thermaflex model MK-C or prior approved equal. The duct shall be constructed of a heavy coated fiberglass cloth fabric supported by helical wound galvanized steel. The fabric shall be mechanically locked to the steel helix without the use of adhesives or chemicals. The internal working pressure rating shall be at least 12" w.g. positive and 5" w.g. negative with a bursting pressure of at least 2½ time the working pressure. The duct shall be rated for a velocity of at least 5500 feet per minute. The duct must be suitable for continuous operation at a temperature range of -20° F to +250° F.
- B. Factory insulate the flexible duct with fiberglass insulation. The R value shall be at least 6 minimum (R-4.2 is not acceptable) at a mean temperature of 75° F.
- C. Cover the insulation with a fire retardant metalized vapor barrier jacket reinforced with crosshatched scrim having a permeance of not greater than 0.05 perms when tested in accordance with ASTM E96, Procedure A.
- D. Maximum length: 1'0".

2.17 BAG IN/ BAG OUT HEPA FILTER HOUSING & FILTER

- A. Not used.

2.18 ABSORPTIVE SILENCERS

- A. General - Furnish and install Price Silencers of the sizes, configuration and performance as described on plans and / or absorptive silencer schedules. Silencer inlet and outlet connections shall be equal to the duct sizes shown on the drawings. Duct transitions shall be provided by the contractor and are not permitted unless shown on the drawings and approved by the engineer. If discrepancies between the suggested specifications and the silencer schedule occur, the latter takes precedence.
 - 1. Performance - Silencer performance characteristics, including insertion loss, pressure drop, and generated noise, shall be attained through testing in accordance with the latest ASTM E477 test standard for acoustical duct silencers. Performance data shall be obtained from the manufacturer's NVLAP accredited laboratory. Laboratory performance verification in the manufacturer's test facility may be requested, in which case a comparative test report shall be made available to the engineer.
 - 2. Submittal - Manufacturer's performance data for dynamic insertion loss, generated noise and pressure drop shall be provided and shall be obtained in accordance with ASTM E477-13. Data for each scheduled silencer shall be provided with the size, configuration, air volume and air flow direction as it appears on the drawing and / or schedule.
- B. Construction
 - 1. Absorptive Silencers shall consist of solid steel casings, perforated sheet metal liners, absorptive acoustic fiberglass media, and fiberglass cloth as required. Suggested construction gauges are a minimum Stainless Steel or Aluminum gauges shall be adjusted accordingly.
 - 2. Absorptive Rectangular Silencers: RL, RM, RH, RLX, RMX, RHX.
 - 3. Absorptive Elbow Silencers: ERM, ERMX.
 - 4. (Standard) Construction Class 1: 22ga galvanized casing / 26ga galvanized perforated liner.
 - 5. Construction Class 2: 18ga galvanized casing / 26ga galvanized perforated liner.
 - 4. High Transmission Loss 1: 16ga galvanized casing / 26ga galvanized perforated liner.
 - 5. High Transmission Loss 2: 10ga galvanized casing / 26ga galvanized perforated liner.
 - 6. High Transmission Loss 3: For critical applications where high transmission loss is required, custom HTL3 construction shall be specified by the designing manufacturer to meet project requirements.
 - 7. Absorptive Circular Silencers: CH

Connection Diameter		Minimum Casing Gauge
Min	Max	
6	20	22
6	44	18
6	60	16

8. Construction Class 1: 22ga galvanized casing / 26ga galvanized perforated liner.
9. Construction Class 2: 18ga galvanized casing / 26ga galvanized perforated liner.
10. Construction Class 3: 16ga galvanized casing / 26ga galvanized perforated liner.
11. Acceptable methods of fastening include button lock, Pittsburgh lock and welds. In situations where these methods are not feasible, rivets can be used. Screws or other types of mechanical fasteners will not be acceptable.
12. The silencer perforated liners shall be rigidly fastened to the casing of the silencer on both ends, and attached to the outer casing with a minimum of two stiffeners.
 - a. Acoustic Media - Acoustic media shall be shot-free inorganic glass fiber with long, resilient fibers, bonded with thermosetting resin. Glass fiber shall be packed with a minimum 10% compression to eliminate voids and settling; density shall be consistent with that used to generate cataloged test data.
 - b. Fiberglass Cloth - For absorptive silencers with internal velocities that exceed 4000 fpm, a fiberglass cloth shall be added to the silencer between the internal perforated liner and the acoustic media to protect the media from erosion. If Fiberglass Cloth Bagged is required, the acoustic media will be fully encapsulated.
 - c.. Combustion Ratings - Combustion ratings for acoustic media shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL723 and NFPA255.
 - d. Flame Spread Classification: < 25
 - e. Smoke Development Rating: < 50

2.19 SECURITY DUCT/BARRIER BARS

A. Furnish and install Price model MSBG duct / barrier grille, Krueger 1390, or prior approved equal. 3/16 in. sleeve with two 1 in. x 1 in. x 3/16 in. 4 sided angle frames (one frame welded 1 in. from one end, one frame shipped loose for field welding). Barrier bars shall be 1/2 in. hot rolled steel bars located on maximum 6 in. x 6 in. centers. Bars are to be welded to frame and at all crosspoints. The grille shall be painted with a powder coat process and be finished in white. Paint finish shall pass 500 hours of salt spray exposure with no measurable creep in accordance with ASTM D1654 and 1000 hours with no rusting or blistering as per ASTM D610 and ASTM D714.

B. Provide security bars within ductwork at all roof penetrations & security wall penetrations. Security walls are walls that are extended up to the respective building roof deck. Refer to architectural drawings for exact location of all security walls.

PART 3 EXECUTION

3.01 APPLICATION AND INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

- E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.
- F. Provide test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers, with fusible links, according to manufacturer's UL-approved written instructions.
- H. Install duct silencers independent of ducts with flexible duct connectors.
- I. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
 - 1. On both sides of duct coils.
 - 2. Downstream from volume dampers, turning vanes, and equipment.
 - 3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
 - 4. To interior of ducts for cleaning; before and after each change in direction, at maximum 40-foot spacing.
 - 5. On sides of ducts where adequate clearance is available.
 - 6. Install the following sizes for duct-mounting, rectangular access doors:
 - a. One-Hand or Inspection Access: 8 by 5 inches.
 - b. Two-Hand Access: 12 by 6 inches.
 - c. Head and Hand Access: 18 by 10 inches.
 - d. Head and Shoulders Access: 21 by 14 inches.
 - e. Body Access: 25 by 14 inches.
 - f. Body Plus Ladder Access: 25 by 17 inches.
 - 7. Install the following sizes for duct-mounting, round access doors:
 - a. One-Hand or Inspection Access: 8 inches in diameter.
 - b. Two-Hand Access: 10 inches in diameter.
 - c. Head and Hand Access: 12 inches in diameter.
 - d. Head and Shoulders Access: 18 inches in diameter.
 - e. Body Access: 24 inches in diameter.
 - 8. Install the following sizes for duct-mounting, pressure relief access doors:
 - a. One-Hand or Inspection Access: 7 inches in diameter.
 - b. Two-Hand Access: 10 inches in diameter.
 - c. Head and Hand Access: 13 inches in diameter.
 - d. Head and Shoulders Access: 19 inches in diameter.
 - 9. Label access doors according to Division 23 05 53 Section "Mechanical Identification."
- J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- K. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Low Pressure Flexible Duct Length Limitation: Connect diffusers to low pressure ducts with maximum 36-inch lengths of flexible duct clamped or strapped in place. Coordinate with owner/architect/engineer for locations requiring 10'-0" of flex duct for owner air device relocation flexibility.
- N. Acoustical Low Pressure Flexible Duct Length Limitation: Connect diffusers to acoustical low pressure ducts with maximum 12'-0" lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands.

- P. Install duct test holes where indicated and required for testing and balancing purposes.
- Q. Not used.
- R. Not used.
- S. Provide security bars within ductwork at all roof penetrations & security wall penetrations. Security walls are walls that are extended up the respective building roof deck. Refer to architectural sheets for exact locations of all security walls.
 - 1. Refer to architectural sheet for wall partition types. Provide security bars at all duct penetrations thru the following wall partition types.
- T. Install flexible duct elbow supports at all flexible duct connections to air devices, typical entire project. Install in accordance with manufacturer's instructions. Install over outer flexible ducts to form smooth, 90° bends to eliminate flexible duct kinks and airflow restrictions. Ake bends in flexible ducts with minimum of 1-duct diameter centerline radius.
- U. Where security bars are to be provided at rated wall duct penetrations the security bars shall be factory supplied with the respective damper. Typical of fire dampers, smoke dampers, & combination fire/smoke dampers.
- V. Provide security bars at roof penetrations, not within the roof curb.

3.02 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in Division 23 Section 23 05 93 "Testing, Adjusting and Balancing."

3.03 FIRE, SMOKE, FIRE/SMOKE DAMPER FIELD VERIFICATION

- A. Fire dampers, smoke dampers, & combination fire/smoke dampers shall not be ordered and delivered to the site until field measurements have been taken and ceiling space has been coordinated with other trades. Figure in bid rush delivery for all fire, smoke, & combination fire/smoke dampers in bid in order to accommodate construction schedule. No exception.

END OF SECTION

12-10-25

SECTION 23 34 00 - AIR DISTRIBUTION EQUIPMENT (FANS)

PART 1 - GENERAL

1.1 GENERAL

- A. Fan Accessories
- B. In-Line Fans
- C. Roof Mounted Centrifugal Exhaust Fan
- D. Cabinet Fans
- E. Kitchen Hood Makeup Air Fans
- F. Kitchen Hood Exhaust Fans
- G. Wall Propeller Supply/Exhaust Fans
- H. Roof Mounted Centrifugal Supply Air Fan
- I. Upblast Roof Exhausters
- J. Kitchen Fan Control Center
- K. Temperature Interlock
- L. Dishwasher Hood Exhaust Fan

1.2. SUMMARY

- A. Section Includes: HVAC Power Ventilators
- B. This section includes units with integral Direct Gas-Fired heating with cooling. Integral cooling source shall be Packaged DX cooling Airflow arrangement shall be Outdoor Air only. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.
- C. Related Sections:
 - 1. 01 30 00 Submittal Procedures
 - 2. Div 23 Heating, Ventilating, and Air-Conditioning (HVAC)
 - 3. Div 26 Electrical
 - 4. Section 22 0100: General Provisions
 - 5. Section 22 0700: Insulation
 - 6. Div. 22 Plumbing
 - 7. Section 23 0900: Controls and Instrumentation

1.3. REFERENCES

- A. Air Movement and Control Association Inc. (AMCA):
 - 1. 99 - Standards Handbook
 - 2. 200 - Publication, Air Systems
 - 3. 201-90 - Publication, Fans and Systems
 - 4. 202-88 - Publication, Troubleshooting
 - 5. 203-90 - Publication, Field Performance Measurement of Fan Systems
 - 6. 211-05 - Publication, Certified Ratings Program - Product Rating Manual for Fan Air Performance
 - 7. 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
 - 8. 311-05 - Publication, Certified Ratings Program - Product Rating Manual for Fan Sound Performance
 - 9. 99-0401-86 - Classification for Spark Resistant Construction

10. 99-2408-69 - Operating Limits for Centrifugal Fans
- B. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):
 1. 204-05 - Standards Balance Quality and Vibration Levels for Fans
 2. 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
- C. American National Standards Institute (ANSI):
 1. 11-r1999 - Method of Evaluating Load Ratings of Bearings
- D. American Society of Civil Engineers (ASCE):
 1. 7-02 - Minimum Design Loads for Building and Other Structures
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
 1. Chapter 45 - 2003 Handbook, HVAC Applications
 2. Chapter 7 - 2001 Fundamentals handbook, Sound-Vibration
 3. Chapter 32 - 2001 Fundamentals handbook, Duct Design
 4. Chapter 18 - 1992 HVAC System and Equipment handbook, Fans
- F. American Society for Testing and Materials (ASTM):
 1. E330-02 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylight and Curtain Walls by Uniform Static Air Pressure Differences
- G. National Fire Protection Association (NFPA):
 1. 70 - National Electrical Code
 2. 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating Systems
 3. 92A-06 - Recommend Practice for Smoke-Control System
 4. 92B-05 - Standard for Smoke Management System in Malls, Atria, and Large Areas
 5. 96-04 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- H. Occupational Safety and Health Administration (OSHA):
 1. 1910.212 - General requirements for Machine Guarding
 2. 1910.219 - General requirements for guarding safe use of mechanical power transmission apparatus
 3. 1926.300 - General requirements for safe operation and maintenance of hand and power tools
- I. Underwriters Laboratories (UL):
 1. 507 - Electric Fans
 2. 555 - Fire Dampers
 3. 555S - Smoke Dampers
 4. 705 - Standard Power Ventilators
 5. 762 - Standard Power Roof Ventilators for Restaurant Exhaust Appliances
 6. 793 - Snow Load

1.4. SUBMITTALS

- A. General: Submit in accordance with Section 01 33 00 Submittal Procedures
- B. Provide dimensional drawings and product data on each fan
- C. Provide fan curves for each fan at the specified operation point, with the flow, static pressure, and horsepower clearly plotted

- D. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones
- E. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.04 of this specification
- F. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance
- G. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty, and electrical wiring diagrams
- H. Provide the following for KSF-1&2:
 - 1. Product Data: For each type or model, include the following:
 - 1. Complete fan performance curves for Supply Air, with system operating conditions indicated, as tested in an AMCA Certified Chamber.
 - 2. Sound performance data for Supply Air, as tested in an AMCA Certified chamber.
 - 3. Motor ratings, electrical characteristics and motor and fan accessories.
 - 4. Performance ratings for all cooling coils.
 - 5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 6. Estimated gross weight of each installed unit.
 - 7. Installation, Operating and Maintenance manual (IOM) for each model.
 - 8. Coils shall be Recognized Components per UL 1995, CAN/CSA C22.2 No. 236.05. Coil performance shall be calculated in accordance with AHRI 410.

1.5. QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for sound and air performance seal
- B. Classification for Spark Resistant Construction, levels A, B and C, conform to AMCA 99
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3)
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories
- E. The High Wind models have been analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes
- F. Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard
- G. All High Wind models have been analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150MPH) winds over the surface of objects
- H. The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads
- I. Applicable to KSF-1,2:
 - 1. Source Limitations: Obtain Packaged Make-Up Air Unit with Integral Heating and Cooling with all appurtenant components or accessories from a single manufacturer.

2. Product Options: Drawings must indicate size, profiles and dimensional requirements of Make-Up Air Units and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
3. Certifications:
 - a. Entire unit shall be ETL Certified per ANSI Z83.4 or ANSI Z83.18 and bear an ETL mark.
 - b. Coils shall be Recognized Components per UL 1995, CAN/CSA C22.2 No. 236.05. Coil performance shall be calculated in accordance with AHRI 410.

1.6. DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation
- B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual
- C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer

1.7. WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents
 1. The warranty of this equipment is to be free from defects in material and workmanship for a period of 1 Yr (Standard) from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid
 2. Motor Warranty is warranted by the motor manufacturer for a period of 1 year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station

1.8. MAINTENANCE

- A. Refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures

PART 2 - PRODUCTS

2.1 GENERAL

- A. Drives: V-belt drives shall be designed for not less than 150% of connected driving capacity and motor sheaves shall be adjustable to provide not less than 20% speed variation. Sheaves shall be selected to drive the fan at a speed to produce the scheduled capacity indicated on the drawings when set at the approximate midpoint of the sheave adjustment. Motors with V-belt drives shall be provided with adjustable bases.
- B. Disconnects: Safety disconnect switches shall conform to requirements of division 26 - Electrical.

2.2 SELECTING AND BALANCING

- A. Provide fans capable of accommodating static pressure variations of plus or minus ten percent.
- B. Statically and dynamically balance fans to eliminate vibration or noise transmission to occupied areas of building.

- C. Provide safety grille where inlet or outlet is exposed of aluminum wire guard construction. Provide belt guards on all belt-driven fans where drive is exposed.
- D. Integral roof mounted and/or wall mounted fans to have aluminum dome type housing, and of all aluminum construction.
- E. Fans shall be tested and rated in accordance with AMCA 210.

2.3 WALL PROPELLOR FAN – SUPPLY/EXHAUST

- 1. Belt/direct driven, axial type sidewall fans shall provide as follows:
- 2. Propellers shall be constructed with fabricated steel or fabricated aluminum. Propellers shall be securely attached to fan shafts. All propellers shall be statically and dynamically balanced.
- 3. Motors shall be permanently lubricated, heavy duty type, carefully matched to the fan load and furnished at the specified voltage, phase, and TEFC enclosure.
- 4. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speeds. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to wheel and motor shafts. Motors sheaves shall be adjustable for system balancing.
- 5. Drive frame and panel assemblies shall be galvanized steel or painted steel. Drive frames shall be formed channels and fan panels shall have pre-punched mounting holes, formed flanges, and a deep formed inlet venturi. Drive frames and panels shall be bolted construction or welded construction (level 3 fans only).
- 6. The axial exhaust fans shall bear the AMCA Certified Ratings Seals for both sound and air performance.
- 7. Wall propeller supply/exhaust fans shall be supplied with the following accessories:
 - 1. Wall collar with OSHA guard
 - 2. Motorized Backdraft damper with transformer (Supply Fan)
 - 3. Gravity backdraft damper (Exhaust Fan)
 - 4. 90 degree weather hoods (Supply Fan)
 - 5. 45 degree weather hood (Exhaust Fan)
 - 6. Baked enamel finish entire unit-color by owner/architect
 - 7. TEFC motor
- 8. Fans shall be Model SBS/SS (Supply) SBE/SE (Exhaust) as manufactured by Greenheck.

2.4 ROOF MOUNTED CENTRIFUGAL EXHAUST FAN

- A. Centrifugal roof type, curb mounted, power ventilators of type, size and capacity as scheduled, and herein specified. Fans shall be rated and constructed in accordance with A.M.C.A. and ASHRAE Standard Test Codes. Fans shall be A.M.C.A. certified, all fans units shall bear the A.M.C.A. Certified Rating Seal.
- B. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum weatherproof housings. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start induction-run type motor for belt driven fans.

- C. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
- D. Motors shall be for operation on the current characteristics as specified.
- E. Curb: Provide insulated metal curbs to fit base of roof ventilator, height as indicated, and type to suit roof connection.
- F. Birdscreen: Provide removable bird screen, 1/2" mesh. 16 ga. aluminum or brass wire.
- G. Dampers: Provide gravity-actuated louvered dampers in curb bases.
- H. Direct drive fans shall be provided with an electronic speed controller.
- I. Fans shall be Model G or GB as manufactured by Greenheck or approved equal.

2.5 CABINET TYPE FANS

- 1. Provide cabinet type fan of type, size and capacity as scheduled in the plans and herein specified. Fans shall be A.M.C.A. certified and all fans shall bear the A.M.C.A. Certified Rating Seal. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with 1/2" acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- 2. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protection motor and solid state speed controller.
- 3. Grille (Ceiling Mount Fans): Molded white aluminum grille with baked white enamel finish.
- 4. 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. Fan motor shall be suitably grounded and mounted on vibration isolators.
- 5. Direct drive fans shall be provided with an electronic speed controller.
- 6. Fan to be Greenheck model SP-A or approved equal.

2.6 IN-LINE FANS

- 1. Fans shall be in-line cabinet type with square or rectangular housing and backdraft damper. Fan shall be designed for horizontal or vertical mounting. Where indicated on the drawings to be spark resistant, fans shall comply with AMCA 99-401 for type B construction.
- 2. Fan housing shall be steel with factory applied baked enamel paint on exterior. Housing shall be internally insulated with 1/2" thk. (minimum) coated fiberglass insulation. Insulation shall comply with ASTM E84 and NFPA 255 for maximum ratings of flame - 25 and smoke - 50. housing shall have mounting brackets at each corner.
- 3. Fan wheel shall be backward inclined centrifugal type with aluminum construction. On belt driven units, shaft bearings shall be self-aligning, pillow block ball type. Bearings not permanently sealed and lubricated shall have grease fittings.
- 4. Where fan is indicated to be spark resistant, motor shall be explosion proof type. motor and drive shall be mounted on vibration isolators. Fan shall have a factory installed disconnect switch mounted on exterior of housing and pre-wired to fan motor.
- 5. Direct driven fans shall be provided with an electronic speed controller.
- 6. Greenheck model SQ or BSQ, refer to schedules.

2.7 UPBLAST ROOF EXHAUSTERS

- 1. Roof exhaust fans shall be upblast centrifugal direct driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a

wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Windbands shall have a rolled bead for added strength and shall be joined to curbcaps with a leakproof, continuously welded seam.

2. Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
3. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
5. Accessories:
Nema 1 disconnect switch, toggle, junction box mounted and wired Heat baffle
Grease trap with drain connection Mounted hinged base with cables Lifting lugs
UL/cUL-762 – “Power Vent. For Rest. Exh. Appliances”
6. Fans shall be Model CUBE as manufactured by Greenheck or approved equal.

2.8 KITCHEN HOOD MAKEUP AIR FAN

A. MANUFACTURERS

1. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - a. Greenheck Fan Corporation

B. MANUFACTURED UNITS

1. Units with Integral Heating and Cooling shall be fully assembled at the the factory and consist of an insulated metal cabinet, an outdoor air intake weatherhood with aluminum mesh, a motorized intake damper, a packaged DX cooling coil module, supply air blower assembly, electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

C. CABINET

1. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvanized steel. Base rail is 12 gauge, galvanized (G90) steel. Components that receive a painted finish per A/E specification shall be painted with a polyester urethane powder coat.

- b. Internal Assemblies: 24 gauge galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- 2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - 1) Thickness: 1 inch (25 mm)
 - 2) Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 3) Location and application: Floor of each unit shall be insulated with fiberglass insulation. Full interior coverage from "Cooling on".
 - 4) Access panels: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Access panels shall be fabricated of 18 gauge galvanized G90 steel.
 - 5) Supply Air blower assembly options:
 - Forward curve blower: Blower assembly consists of an electric motor and a belt driven, double width, and double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125 inch thick neoprene vibration isolators.
- 3. Control center / connections:
 - a. Unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
- 4. Direct Gas-Fired Furnace:
 - a. Unit shall be factory assembled, piped, and wired. Direct gas-fired system will be 92% efficient while supplying a burner that is capable of providing 25:1 turndown. Unit will utilize a draw through design and incorporate adjustable burner baffles plates for field adjustments. Unit will have a EconomyPilot ignition system.
 - b. Burner construction shall consist of a cast aluminum burner manifold and 400 series stainless steel mixing plates. No air from inside the space shall be allowed to pass across the burner at any time. Flame sensing shall be provided by a flame rod. Burner control shall have a digital coded fault indicator capable of storing the last five faults.
 - c. Shall be equipped for operation on Natural gas with a maximum rated inlet gas pressure of 1/2 PSI.
 - d. Burner control option to include the following: Discharge temperature.
 - e. Shall include the following safety controls:
 - 1) Manual Reset, High Limit Switch: Main gas valve closes if high-limit temperature is exceeded.
 - 2) Dual safety shutoff valves shall be provided that do not exceed 120 VAC control signals.
 - 3) FM Global Requirements: Includes high and low gas pressure switches and visual indication gas valves.
- 5. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be double-pitched, sloped in opposite directions to provide positive draining. Drain connector shall be sealed at penetration through cabinet wall.
- 6. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.

7. Packaged DX: Unit shall be equipped with a Packaged DX system to include compressor(s), evaporator and condenser coil(s), condenser fans, and all appurtenant controls as specified elsewhere in this section. The Packaged DX system is to be an integral module, incorporated into the unit. Stand-alone Packaged DX systems that are connected to the unit, or systems that require hardware or equipment that is not integral to the unit are not acceptable.
8. Motorized Inlet Air Dampers: to be of low leakage type and shall be factory installed.
9. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.

D. BLOWER-FC

1. Blower section construction, Supply Air: Belt drive motor and blower shall be assembled onto a minimum 14 gauge galvanized steel platform and must have neoprene vibration isolation devices, minimum of 1-1/8 inches thick.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
5. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

E. MOTORS

1. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPA's minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase, and enclosure.

F. UNIT CONTROLS

1. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by a factory-supplied remote panel, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS).
2. Variable Frequency Drive (VFD): Unit shall have factory installed variable frequency drives for modulation of the blower motors. The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
3. Sensors to be provided with the unit:
 1. Heating Inlet Air Sensor
 2. Cooling Inlet Air Sensor

2.8 KITCHEN HOOD EXHAUST FAN:

A. General Description:

1. Discharge air directly away from the mounting surface.
2. Upblast fan shall be for roof mounted applications for fan sizes 060-300 or wall mounted applications for fan sizes 060-200.

3. Performance capabilities up to 14,700 cubic feet per minute (cfm) and static pressure to 3 inches of water gauge.
 4. Fans are available in twenty-two sizes with nominal wheel diameters ranging from 9 inches through 30 inches (060 - 300 unit sizes).
 5. Maximum continuous operating temperature for fan sizes 098-300 is 400 Fahrenheit (204.4 Celsius) and for fan sizes 060-095 is 160 Fahrenheit (71.1 Celsius)
 6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number
- B. Wheel:
1. Material Type: Aluminum
 2. Non-overloading, backward inclined centrifugal wheel
 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- C. Motors:
1. AC Induction Motor
 - a. Motor Enclosure: Totally enclosed fan cooled (TEFC) - no opening in the frame or brackets. Equipped with an external fan to blow air over the motor
 - b. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
 - c. Mounted on vibration isolators, out of the airstream
 - d. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants
 - e. Accessible for maintenance
- D. Housing:
1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable
 2. Housing shall have a rigid internal support structure
 3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing
 4. Windband to include an integral rolled bead for strength
 5. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable
 6. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb
 7. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators
 8. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it
- E. Motor Cover:
1. Constructed of aluminum
- F. Vibration Isolation:
1. Double studded or pedestal style true isolators
 2. No metal to metal contact
 3. Sized to match the weight of each fan
- G. Disconnect Switches:

1. NEMA rated: NEMA 3R: outdoor application falling rain water.
 2. Positive electrical shut-off
 3. Wired from fan motor to junction box installed within motor compartment
- H. Drain Trough:
1. Allows for one-point drainage of water, grease, and other residues
- I. Options/Accessories:
1. Birdscreen:
 - a. Material Type: Aluminum
 - b. Protects fan discharge
 2. Curb Extension:
 - a. Type: VCE - Vented Curb extension
 - b. Material Type: Aluminum

2.9 KITCHEN FAN CONTROL CENTER:

- A. Provide Accurex Kitchen Fan Control Center Model (XFCC) as shown on plans and in accordance with the following specification:
- B. The XFCC shall be constructed of 16 gauge 300 series stainless steel, and UL Listed to Standard 891. The pre-engineered control center shall include, but not be limited to, fan motor starters, light and fan switches, fire relay which controls both the supply and exhaust fan(s), quarter turn latch, color coded wiring with wiring diagram, grounding terminal blocks, and distribution terminal control strip for control wiring connection. All electrical components shall be UL listed or classified where applicable and wired in compliance with the National Electrical Code.
- C. The control center and control switching have two typical mounting locations. 1) The panel will be remote mounted with the switches mounted on the panel face, or 2), utility cabinet mounted with the switches face mounted on the utility cabinet. Other options are available.
- D. Three, standard overall dimensions for the control cabinets are 12 in. x 18 in. x 6 in., 18 in. x 18 in. x 6 in., and 25 in. x 18 in. x 6 in. Minimum control center dimensions are 12 in. x 18 in. x 6 in. for up to four fan motor starters. Minimum control center dimensions are 18 in. x 18 in. x 6 in. for up to eight fan motor starters. For single phase control panels, the maximum horsepower for 120V is 5 hp; the maximum horsepower for 208V is 10 hp; the maximum horsepower for 240V is 10 hp. For three phase control panels, the maximum horsepower for 208V is 30 hp; the maximum horsepower for 480V is 50 hp, the maximum horsepower for 575V is 100 hp. Panel is available with mixed fan voltages and mixed phase. Each fan will receive its own, dedicated motor starter. Other options are available.
- E. The control centers may be equipped with temperature interlock(s), which is compliant with International Mechanical Code (IMC) 2006 section 507.2.1.1. The temperature interlock(s) consist of either a thermostat style probe and off-delay time relay, or a temperature controller and resistive temperature detector (RTD). With both options the sensor/probe a junction box and fire proof/leak proof threaded fitting (Evergreen Quik-Seal® and/or Evergreen Compression Seal) will be provided. The interlock(s) shall power the fans when the sensor detects the temperature set point. The interlock(s) shall hold the circuit closed upon the fan switch being turned off until the temperature sensor detects a temperature below the set point.
- F. If exhaust hood includes an automatic fire damper, damper switch will be mounted on hood front if control center is remote mounted. The damper switch will be mounted on front of utility cabinet if control panel is mounted in a utility cabinet.
- G. The electrical contractor is to follow field-wiring requirements listed in the installation instructions. If the control center is mounted in the utility cabinet and the light and fan switches are mounted on the either the face of the hood or side of the utility cabinet, they will be factory wired. If there is a fire suppression system also mounted in the same utility cabinet, wiring to the micro switch is to be completed at the factory unless otherwise specified.

2.10 TEMPERATURE INTERLOCK

- A. International Mechanical Code (IMC) 2015 section 507.2.1.1 Compliant Electrical Package
- B. Provide Accurex Temperature Interlock electrical package as shown on plans and in accordance with the following specification:
- C. The Temperature Interlock(s) shall be U.L. 710 Listed and consist of a temperature controller, RTD, junction box, Evergreen threaded fitting, and shall be a self-contained unit or as part of another preengineered electrical control package. Hood systems should always be turned on manually before cooking equipment is turned on. The temperature interlock is intended as a backup system and the auto-on feature should only be utilized when the fans are forgotten to be turned on. The Temperature Interlock package shall close a relay powering the fans when the temperature set point is reached at the temperature sensor. The Interlock shall hold the circuit closed upon fan switch being turned off until the temperature at the sensor decreases below the set point plus hysteresis. Once the temperature is below the set point plus hysteresis, the fans shall shut down.
- D. In the event that the cooking equipment is started without the fans being manually turned on, the fans shall automatically activate and remain running with the presence of heat under the hood. The temperature controller shall open the relay after the temperature at the temperature sensor in the exhaust duct or capture tank has dropped below the set point plus hysteresis. Once the temperature is below the set point plus hysteresis, the fans shall shut down.
- E. Due to continuous research Accurex reserves the right to change specifications without notice.

2.11 DISHWASHER HOOD EXHAUST FAN

- A. Provide Accurex Exhaust Fan Model XRUD as shown on plans and in accordance with the following specification:
- B. Roof exhaust fans shall be upblast centrifugal direct drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
- C. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. Wind bands shall have a rolled bead for added strength and shall be joined to curb caps with a leak proof, continuously welded seam.
- D. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance.
- E. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
- F. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
- G. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number for future identification.
- H. Fans shall be listed by Underwriters Laboratory for UL/cUL 762 Listed for all electrical components and grease removal.
- I. Fans shall be Model XRUD as manufactured by Accurex.

2.12 ROOF MOUNTED CENTRIFUGAL SUPPLY AIR FAN

- A. Provide supply fan of the size, type and capacity as scheduled on the drawings and specified herein. Supply fan shall be A.M.C.A certified and bear the A.M.C.A. Certified Rating Seal.
- B. Supply fan shall be roof-mounted, filtered, and be of the belt-driven, double width, double inlet (DWDI), forward curved centrifugal blower type. The unit's blower assembly shall be

mounted on vibration isolators. Motor pulleys shall be machine cast iron and adjustable. Belts shall be non-static and oil resistant.

- C. Both motor and blower bearings shall be permanently lubricated with sealed ball bearings.
- D. The blower housing shall be fabricated of heavy gauge galvanized steel. A wind band of adequate size shall be included to prevent moisture from entering the building. An insulated cover shall be held in place with four secure latches for quick and easy access.
- E. Filters shall be of the permanent, one-inch, washable, aluminum type and shall be easily removed for cleaning.
- F. Supply shall be installed minimum 10'0" away from any exhaust fan.
- G. Fans shall be Model RSF as manufactured by Greenheck or approved equal.

2.13 FUME HOOD EXHAUST FANS

1. Refer to specification 23 34 01 "Fume Exhaust with Integral Stack".

PART 3 - EXECUTION

3.1 INSTALLATION:

1. Supply and install sheaves as necessary for final air balancing.
2. Set roof mounted fans on factory fabricated curbs, minimum 24" high. Provide acoustical insulation on roof curb and on fan inlet plenum.
3. Install fans as per manufacturer's recommendations.
4. Provide manual volume damper within exhaust air discharge ductwork, applicable all cabinet fans.
5. In-line centrifugal fan units shall be supported as indicated on detail (all corners) in drawings. All supports shall be equipped with vibration isolators (spring type).
6. Upblast centrifugal roof exhausts shall be mounted on prefabricated roof curb. Fan curb cap shall be secured to roof curb with cadmium plated steel screws a max. 12" on center. Kitchen exhaust fan shall maintain min. 52" clearance between exhaust and roof deck, provide vented extension to curb as required. Units to meet all requirement as specified by Louisiana State Fire Marshal.
7. Secure rooftop fan assemblies to curbs with minimum 1/4" diameter, stainless steel hex-head lag screws with cadmium-plated washers; provide minimum 2 lag screws per side, but no less than one for each factory-drilled hole provided by the fan manufacturer.
8. Provide complete structural, mechanical, and electrical connections and install in strict accordance with manufacturer's recommendations.
9. Hoods to be built in compliance with the following codes and standards: NFPA 96, SBCCI, UL #710, BOCA, UMC, & NSF #2.

3.2 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions

3.3 EXAMINATION

- A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected

3.4 PREPARATION

- A. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance
- B. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Air Distribution (Division 23)

3.5 INSTALLATION

- A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings
- B. Install fans in accordance with manufacturer's instructions

3.6 SYSTEM STARTUP

- A. Refer to Installation, Operation, and Maintenance Manual (IOM)

3.7 ADJUSTING

- A. Adjust exhaust fans to function properly
- B. Adjust Belt Tension
- C. Lubricate bearings
- D. Adjust drive for final system balancing
- E. Check wheel overlap

3.8 CLEANING

- A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction

3.9 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction
- B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

3.10 CONNECTIONS

- 1. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
 - a. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
 - b. Duct installation and connection requirements are specified in Division 23 of this document.
 - c. Electrical installation requirements are specified in Division 26 of this document.

3.11 FIELD QUALITY CONTROL

- 1. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup

checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

3.12 START-UP SERVICE

1. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Verify water source for compliance with manufacturer's requirements for flow and temperature. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.13 DEMONSTRATION AND TRAINING

1. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION

12-10-25

SECTION 23 35 00 - AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and/or equipment schedules.

1.2 REFERENCED CODES & STANDARDS

- A. The following codes and standards are referenced through out. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.
 - 1. ASHRAE Standards 62 & 52
 - 2. National Electric Code NFPA 70
 - 3. UL 867 including ozone chamber test required as of December 21, 2007
 - 4. UL 2998 Environment – No Ozone Certification
 - 5. The cold plasma equipment and power supply shall be UL listed.
 - 6. The technology shall have been tested to DO-160 by an independent lab and successfully passed all requirements for shock, vibration, EMF and line noise. Manufacturers not tested to DO-160 shall not be acceptable. DO-160 is normally used to test devices in aviation applications, but this standard is applicable to confirm EMF and line noise in HVAC applications.

1.3 RELATED WORK

- A. Testing, Adjusting and Balancing
- B. Facility Access and Protection
- C. Ductwork
- D. Filters
- E. Water and Refrigerant Piping
- F. Electrical Wiring
- G. Control Wiring

1.4 QUALITY & IP ASSURANCE

- A. Basis of design is Global Plasma Solutions. All other manufacturers requesting prior approval must submit product drawings, specifications and test results specified in section 2.2 at least four weeks prior to bid date.
- B. The Air Purification System shall be a product of an established manufacturer within the USA. Direct Current (DC) Ion modules manufactured outside the USA and assembled in the USA on mounting plates or formed channels shall not be acceptable.
- C. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.
- D. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable. Any system containing titanium dioxide (TiO₂), which has been listed by the CDC as a known carcinogen, shall not be acceptable.
- E. Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation performed within the last two years and in a similar application, that proves compliance to ASHRAE 62 and the accuracy of the calculations. The data shall be based on the manufacturer's use of the same make and model number as the equipment submitted on this project.
- F. The Air Purification Technology shall have been tested by UL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested

in accordance with the newest UL 867 standard with the ozone amendment shall not be acceptable. All manufacturers requesting prior approval shall submit their independent UL 867 test data with ozone results to the engineer for preliminary review and during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

- G. The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.001 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the electronic air cleaner's output shall be no more than 0.001 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.
- H. All manufacturers shall have their product tested to UL 2998 Environmental Standard for confirmation of no ozone with certificate available. The final report shall indicate the ozone levels and high voltage output the device's electrode(s) were operating during the test. Reports that do not include high voltage output during the UL 2998 testing shall not be acceptable.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for ion generators including:
 - 1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
 - 2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
 - 3. Performance data for each type of plasma device furnished.
 - 4. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air Scheduled (when projects are designed with outside air reduction).
 - 5. Product drawings detailing all physical, electrical and control requirements.
 - 6. Copy of UL 867 independent ozone test.
 - 7. Copy of UL 2998 conformance certificate.
 - 8. Statement on the manufacturer's letterhead stating that the technology contains no titanium dioxide (TiO₂).
- B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage.

1.7 WARRANTY

- A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of thirty-six months after shipment or eighteen months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturer specified.
- B. Basis of Design: Global Plasma Solutions
- C. All other Suppliers of comparable products requesting prior approval shall:
 - 1. Submit for prior approval four weeks in advance in accordance with the requirements of Section 20 0100.
 - 2. In addition, manufacturers submitting for prior approval for Bi-Polar Ionization must as part of the prior approval request provide their ASHRAE 62.1-2007 calculations that prove conformance to the ASHRAE Standard with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE

- compliant. A third party validation study performed on a previous installation of the same application using the same make and model equipment shall also be included.
3. Submit independent test data from UL showing ozone levels produced during the UL 867 ozone chamber test. Manufacturers without this test data shall not be acceptable.
 4. Submit UL 2998 Environmental Claim Certificate proving no ozone output.
 5. Submit pathogen testing per section 2.2.
 6. Submit at least two other end user references in the same application with contact phone number, email, equipment used and application for the equipment at that facility. Manufacturers not having the above references in similar applications using the same equipment models as proposed on the current project shall not be acceptable.
 7. Ionization bars manufactured using DC output ionization modules shall not be permitted due to corrosion, ion short-circuiting, and intermittent coil coverage and shock hazard.
 8. Ionization bars manufactured using ion modules not having epoxy coating all circuit boards and internal components shall not be acceptable.
 9. Manufacturers submitting as an alternate shall include their DO-160 test results.
 10. It is the responsibility of any alternate manufacturer and mechanical contractor proposing an alternate to the basis of design to confirm any proposed substituted product does not infringe on the patented intellectual property of the basis of design. The engineer and owner recognize the basis of design holds multiple patents and multiple patents are pending.

2.2 BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA

- A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.
- B. The Bi-polar Ionization system shall be capable of:
 1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
 2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
 3. Capable of reducing static space charges.
 4. Effectively reducing space particle counts.
 5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
 6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
 - A. MRSA - >96% in 30 minutes or less
 - B. E.coli - > 99% in 15 minutes or less
 - C. TB - > 69% in 60 minutes or less
 - D. C. diff - >86% in 30 minutes or less
 - E. Noro Virus -> 93.5% in 30 minutes or less
 - F. Legionella -> 99.7% in 30 minutes or less

Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELAC accredited independent lab confirming kill rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C. Products tested only on Petri dishes to prove kill rates shall not be acceptable. Products being sold under different trade names than those tested shall not be acceptable.
 7. Capable of modular field assembly in six inch (150mm) sections.
- C. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable. Ionizers with positive and negative output (DC type) shall not be acceptable. All ionizers provided shall be AC type ionizers with one electrode pulsing between positive and negative.
 1. Air exchange rates may vary through the full operating range of a constant

Volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.

2. Velocity Profile: The air purification device shall not have maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

E. Equipment Requirements:

1. Electrode Specifications (Bi-polar Ionization):

- a. Each alternating current (AC) Ionization Bar with Bi-polar Ionization output shall include a minimum of eighteen carbon fiber cluster ion needles per foot of coil face width shall be provided. The entire cooling coil width shall have equal distribution of ionization across the face. Systems without ion needles at least 0.50" (12.5mm) apart shall not be acceptable. The plasma electrode shall require no more than 1.0" (25mm) in the direction of airflow for mounting. All hardware required for mounting shall be provided by the air purification manufacturer except self-tapping screws for the power supply. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, and performance output reduction over time, ozone production and corrosion.
- b. Electrodes shall be provided in 6.0" (150mm) increments, epoxy filled for an IP55 rating and utilizing brass connection hardware that is recessed into the connection joint once fully engaged and assembled.
- c. Electrodes shall be energized when the main unit disconnect is turned on.
- d. The ionization output shall be a minimum of 60 million ions/cc per inch of cooling coil width as measured 1 inch from the cold plasma needles.
- e. Ionization bars shall be provided with magnet mounting kits to prevent penetration into cooling coils.
- f. Ionization bars shall be constructed of UL 94VO and UL746C composite material.

F. Air Handler & Plenum Mounted Units (non-ductless mini-split units):

1. Plasma Generator(s) shall be supplied and installed at all air handling systems. The mechanical contractor shall mount the Plasma Generator and wire it to the AHU control power (24VAC) as instructed by the Air Purification Manufacturer's instructions or line voltage subject to power available. Each unit shall be designed with a molded casing, self-cleaning system, weather proof housing with clear cover, integral digital display that provides unit status, self-cleaning test button, power status LED and dry contacts to prove ion output is operating properly. The dry contacts shall close to prove the ion generator is working properly and may be daisy chained in series such that only one dry contact per AHU is required to interface to the BAS or the DDC controller. Dry contacts proving power has been applied in lieu of the ion output is actually operating, are not acceptable. Manufacturers providing multiple ion modules that have alarm status wired in parallel, and not in series, shall not be acceptable.

G. Ionization Requirements:

1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
 - a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and integral power supply. The Bi-polar system shall be installed at all air handling systems. The device shall be capable of being powered by 18VAC to 260VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
 - b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.

- c. Ionization output from each electrode shall be a minimum of 200 million ions/cc when tested at 2" from the ionization generator.
 - d. All manufacturers shall provide documentation by an independent NELAC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
 - A. MRSA - >96% in 30 minutes or less
 - B. E.coli - > 99% in 15 minutes or less
 - C. TB - > 69% in 60 minutes or less
 - D. C. diff - >86% in 30 minutes or less

Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELEC accredited independent lab confirming kill rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C. Products tested only on Petri dishes to prove kill rates shall not be acceptable.
- 2. Ozone Generation:
 - a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation. There shall be no ozone generation during any operating condition, with or without airflow.
- J. Electrical Requirements:
 - 1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 18VAC to 260VAC, universal input, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.
- K. Control Requirements:
 - 1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset circuit breakers. Systems with manual fuses shall not be allowed.
 - 2. Integral airflow sensing shall modulate the Plasma output as the airflow varies or stops. A mechanical airflow switch shall not be acceptable as a means to activate the Plasma device due to high failure rates and possible pressure reversal.
 - 3. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown on the plans. The contractor shall follow all manufacturer IOM instructions during installation.
 - 4. All Plasma devices shall have a means to interface with the BAS system. Dry contacts shall be provided to prove there are ions being produced. Systems providing indication that power is applied to the Plasma device, but not directly sensing the power at the ion output, shall not be acceptable.
- L. VRF Units:
 - 1. Where so indicated on the drawings and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the cables provided by the air purification manufacturer. A 24VAC, 115VAC or 208-230VAC circuit shall be provided to the plasma generator power supply panel. No more than 15 watts shall be required per power supply. Each power supply shall be capable of powering up to 6 ionization bars or a total of 100 linear feet of bar. Each plasma generator shall be designed with powder coated metal casing, liquid tight flexible conduit and a high voltage quick connector.
- G. Plasma Requirements:
 - 3. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
 - a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 24VAC, 115VAC or 208-230VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.

- b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced (AC ionizers only are acceptable). Imbalanced levels shall not be acceptable.
 - c. Ionization output from each bar shall be a minimum of 60 million ions/cc per inch of bar when tested at 1" from the ionization bar. Bars with needles spaced further apart than 0.5" shall not be acceptable.
 - d. Each plasma electrode shall be made from an all composite, UL 94V0 and UL 746C rated material for prevention of corrosion and electrical insulation.
 - 4. Ozone Generation:
 - a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 2998 as tested by UL proving no ozone output.
- H. Electrical Requirements:
 - 1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 24VAC, 115 VAC or 208-230VAC, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.
- I. Control Requirements:
 - 1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset. Systems requiring fuses shall not be acceptable.
 - 2. The Plasma Generator power supply shall have internal circuitry to sense the ionization output and provide dry contact alarm status to the BMS as well as a local "Plasma On" indication light.
 - 3. If scheduled, the ionization system shall be provided with a stand-alone, independent ion sensor designed for duct mounting to the ionization bar to monitor the ion output and report to the BAS system that the ion device is working properly. Ion systems provided without an independent ion sensor, shall not be permitted. The control voltage to power the ion sensor shall be 24VAC to 260VAC and draw no more than 150mA of current. The sensor shall provide at minimum, dry contact status to the BAS and optionally a BacNet or Lonworks interface as specified on the control drawings. If scheduled, manufacturers not providing a stand-alone ion sensor shall not be acceptable.
 - 4. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown on the plans. The contractor shall follow all manufacturer IOM instructions during installation.
 - 5. An optional fiberglass NEMA 4X panel with Plasma On/Off Indicator Light (interfaced with stand-alone ionization detector), Ionization Output On/Off Indicator Light and an On/Off Illuminated Switch shall be provided to house the power supply, if noted on the schedule.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY & ERECTION: PLASMA GENERATOR WITH BI-POLAR IONIZATION

- A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.
- B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.
- C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.3 TESTING

- A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING & TRAINING

- A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION

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SECTION 23 3700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 GENERAL

- A. Grilles and Diffusers
- B. Louvers

1.02 RELATED WORK

- A. Section 20 01 00: General Provisions
- B. Section 23 31 00: Metal Ductwork

1.03 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. ARI 650 - Air outlets and inlets.
- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- F. SMACNA - Low Pressure Duct Construction Standard.

1.04 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.05 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.06 SUBMITTALS

- A. Submit product data under provisions of Section 01300.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, application, and noise level.
- D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.
- E. Submit diffuser, grille and register color data to Architect of approval.

1.07 JOB CONDITIONS

- A. Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlets.
- B. Check location of outlets and make sure necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Base air outlet application of space noise level of NC 35 maximum.
- B. Provide supply outlets with sponge rubber seal around edge.
- C. Provide appropriate frame for all outlets compatible with ceiling/wall construction.
- D. Finish
 - 1. Aluminum grilles, registers, and diffusers which are ceiling mounted shall be provided with a factory applied white baked enamel finish unless otherwise, herein or on the drawings.
 - 2. Aluminum grilles and registers which are wall or floor mounted shall be factory etched to a satin finish and coated with a clear lacquer.
- E. Mounting

1. Model numbers indicated herein are for surface mounting in exposed tee-bar grids or for integral mounting in exposed tee-bar grids. Where grilles, registers or diffusers are to be installed in concealed spine ceilings or plaster ceilings the mounting frame shall be adjusted to match the ceiling requirements. In plaster ceilings, provide plaster frames.

2.02 LOUVER FACE CEILING DIFFUSER

- A. Ceiling diffuser shall be round, square or rectangular with to provide 1, 2, 3, or 4-way air patterns as indicated on the drawings. All items to be of aluminum construction. Frame and directional core to have baked white enamel finish.
- B. Frame style for fixed ceiling shall be raised "V" type. Frame style for lay-in ceilings shall be lay-in matching frames, panel size 24-inch x 24-inch unless otherwise required. For spline or other type ceiling systems, use appropriate matching frame styles. Diffusers shall be sized as indicated on the drawings.

2.03 SIDEWALL SUPPLY GRILLES

- A. Provide sidewall supply grilles with streamlined and individually adjustable blades, maximum 3/4" spacing. Provide spring tension or other device to set blades. Provide units with vertical face, double Deflection bar style grilles.
- B. Provide 1/4" margin frame with counter sunk screw holes.
- C. Fabricate of steel 20 gage minimum frames and 22 gage blades, or of all aluminum with 20 gauge for frames and blades.
- D. Provide grille with integral gang-operated opposed blade dampers with removable key operators, operable from face.
- E. Finish for steel construction in standard baked enamel finish.

2.04 RETURN GRILLES

- A. Provide sidewall and ceiling return grilles having fixed vee blades. Provide units with horizontal face.
- B. Provide 1/4" margin frame countersunk screw holes.
- C. Fabricate of steel with 20 gage minimum frames and 22 gage minimum blades, or all aluminum construction, 20 gage minimum for frames and blades.
- D. Provide return grilles, where not individually connected to return fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face.
- E. Finish steel outlets in factory baked enamel finish.

2.05 DOOR GRILLES

- A. Door grilles shall be inverted bee shaped on 1/2 inch centers with telescoping frame. Louvers and frame to be steel construction with prime coat or aluminum as indicated on Air distribution Schedule in the drawings.
- B. Where required on drawings, contractor shall provide filter housing on back side of door grille.

2.06 OUTSIDE LOUVERS

- A. Greenheck #ESD-435X:
 1. Construction Features: Louvers shall be model #ESD-435X as manufactured by Greenheck. Louver frame shall be 4 inch deep channel style with 0.081 inch extruded aluminum wall thickness. Louver blades shall be horizontal stationary drainable style and shall be located on 3 1/4 inch centers and 37.5 degree angles with 0.081 inch extruded aluminum wall thickness. Bird screen shall be internally mounted 3/4 inch x 0.051 inch flattened expanded aluminum unless specified otherwise. Finish of all materials shall be mill aluminum only unless specified otherwise.
 2. Performance Requirements: Louvers shall be AMCA Licensed when tested in accordance with AMCA 500-L Air Performance and Water Penetration. Free area for a size 48 inch louver shall not be less than 9.98 square feet. Airflow resistance at 1000 feet per minute free area intake velocity shall not be greater than 0.163 inches water gauge. Airflow resistance at 1000 feet per minute. Beginning point of water penetration shall not be less than 1151 feet per minute area intake velocity.

3. Louvers shall be Florida Product Approved and shall be approved for use in Florida's High Velocity Hurricane Zone. Louvers shall be AMCA Licensed when tested in accordance with AMCA 540 (Basic Protection, Missile Level D). Louvers shall be tested in accordance with and pass the following Florida test protocols: TAS 201 (Large Missile Impact), TS 202 (Uniform Static Air Pressure) and TAS 203 (Cyclic Wind-Loading). Louvers must be designed to withstand the wind loads specified on the structural drawings. Structural drawings must indicate all applicable positive and negative wind loads using methods prescribed by ASCE 7 (version 05 or 10 where applicable) in pound per square foot units. All louvers must be installed in accordance with the manufacturer's published installation instructions.
4. Louvers shall be supplied with a 70% Kynar finish applied following a thorough cleaning and pretreatment of the metal surface. Dry film thickness of the Kynar shall be approximately 1.2 mils after baking at 450 F. Color shall be custom, selected by architect.
5. Refer to plans for type louvers and controls, fixed, hand (crank) operated, motor operated, etc.
6. Provide heavy duty screen/mesh in front of unit (inside) for louver protection, color same as louver. Screen to be 0.5" square constructed of stainless steel.
7. Refer to schedules for louvers required flanges & louvers requiring channel frames with sub sills. Provide blankoffs panels as noted within contract documents.
8. Ruskin approved equal.
9. All louvers to be provided with security bars. Security bars to be 0.5 inch diameter bars with 5 inch vertical and horizontal spacing.

B. Greenheck #EHV-901D:

1. Louvers shall be stationary high velocity wind driven rain style with Horizontal front blades and Vertical rear blades and shall have Florida Product Approval and/or Miami-Dade Notice of Acceptance to ensure a tested and qualified installation. Louver blades shall be contained within a 9-inch frame and shall be fully factory assembled. Extended sill pans shall be provided to capture and drain water to exterior of building. Louver components (heads, jamps, sill and blades) shall be factory assembled by the louver manufacturer.
2. Louver performance shall be certified in accordance with the AMCA 511 Certified Ratings Program for AMCA 500-L Air Performance, Water Penetration and Wind Driven Rain and shall be licensed to bear the AMCA Seal. Free area for a size 48 in. x 48 in. louver shall not be less than 8.32 Sq. Ft. (52.0%).
3. Louvers shall allow for sizes up to 60" wide x 120" high. Openings larger than the maximum section width may comprise of multiple individual louver panels without the need for additional structural reinforcing members as per the manufacturers installation instructions. Where louvers are required to be multiple sections high, adequate structural supports shall be provided in order to install the louver in accordance with the manufacturers installation instructions. Structural supports for multi-high assemblies, if required, shall be considered as part of the building structure and not provided by the louver manufacturer.
4. Vertical mullions shall be visible for openings wider than the maximum allowable single section width. Recessed mullions for continuous blade appearance shall be provide where noted on drawings.
5. Static pressure drop shall not be greater than 0.34 in. WG at 8500 cfm intake through a 48" x 48" louver.
6. Any manufacturer that has a higher pressure drop shall be responsible for resizing the louvers to meet the specified pressure drop, or the pressure drop scheduled on drawings.
7. Beginning point of water penetration shall not be less than 1250 FPM free area intake velocity.
8. Louvers shall maintain Class A wind driven rain performance up to 900 FPM core velocity with an external wind speed of 29 MPH and an external rainfall rate of 3 in. per hour.

Louvers shall maintain Class A wind driven rain performance up to 900 FPM core velocity with an external wind speed of 50 MPH and an external rainfall rate of 8 in. per hour.

9. Louvers shall comply with Florida test protocols TAS 201 (Large Missile Impact), TAS 202 (Uniform Static Air Pressure) and TAS 203 (Cyclic Wind Loading). Louvers shall be AMCA 540 Listed for Enhanced Protection Impact Resistance of Missile Level E and AMCA 550 Listed for High Velocity Wind Driven Rain. Louvers shall be capable of withstanding both positive and negative wind pressure loads up to 130 PSF when installed in accordance with the manufacturer's published installation instructions.
10. Louvers shall be Greenheck #EHV-901D, Construction Specialties #DC-9614, or prior approved equal, extruded aluminum alloy shall be 6063T5 construction, or as required to meet the louvers structural requirements as follows:
 - a. Frame: 0.081 inch (minimum) wall thickness, caulking surfaces provided.
 - b. Front Blades: 0.081 inch (minimum) wall thickness, installed horizontally on approximately 4" inch centers.
 - c. Rear Blades: 0.063 inch (minimum) wall thickness, installed vertically on approximately 1.5" inch centers.
 - d. Extended Sill Pan: 0.060 inch (minimum) aluminum sheet wall thickness, with upturned side panels to help prevent water leakage.
 - e. Screen: 1/2" x .063" aluminum mesh bird screen in removable frame, mounted on interior (rear) of louver.
 - f. Finish: 70% 2-coat baked Kynar, custom color, color as selected by Architect.
11. Provide "blank-off" panel(s) where noted within contract documents. Panel shall consist of 1" thick mineral wool insulation sandwiched between sheet metal panels. Exterior and Interior (facing) panels shall be 0.032 inch (minimum) thickness aluminum; conceal edges of insulation with sheet metal or heavy plastic closure. Insulation shall comply with ASTM C612, with a minimum R-value of 4.2 at 75° F.
12. Exterior side shall have a black kynar finish.
13. All louvers to be provided with security bars. Security bars to be 0.5 inch diameter bars with 5 inch vertical and horizontal spacing.

2.07 EXHAUST GRILLES

- A. Register (Wall): 35 degree deflection register with horizontal bars, opposed blade damper and plaster frame. All items to be aluminum construction. Register and plaster frame to have an anodized finish.
- B. Register (Ceiling): Grid core register with 1/2x1/2x1/2 inch core spacing and opposed blade damper. All items to be of aluminum construction. Register to have an anodized finish. Frames shall be appropriate to type ceiling used in project.

2.08 LINEAR DIFFUSERS

- A. Linear diffuser shall be extruded aluminum. Diffuser face shall be natural anodized aluminum with narrow surface mounted border. Interior air pattern controller shall be painted flat black. Diffusers shall be furnished in one piece up to a maximum of four feet; where diffuser exceeds four feet, multiple sections shall be butted with hairline joints and provided with alignment spines. Diffusers shall have concealed fastening. Linear diffusers shall be furnished in lengths, and number of 1 inch slots, as required for CFM as indicated on the drawings.
- B. Contractor to figure in bid field fabrication of internally insulated plenum on rear of linear slot diffuser in the event the structure does not allow for the proper installation of the factory fabricated plenum boxes. Verify exact locations of plenum boxes with structure prior to ordering plenums.

2.09 SQUARE PLAQUE CEILING DIFFUSER

- A. Ceiling diffuser shall be round, square or rectangular with to provide 1,2,3, or 4-way air patterns as indicated on the drawings. All items to be of aluminum construction. Frame and directional core to have baked white enamel finish.

- B. Frame style for fixed ceiling shall be raised "V" type. Frame style for lay-in ceilings shall be lay-in matching frames, panel size 24-inch x 24-inch unless otherwise required. For spline or other type ceiling systems, use appropriate matching frame styles. Diffusers shall be sized as indicated on the drawings.

2.10 PERFORATED CEILING DIFFUSERS

- A. Ceiling diffusers shall be aluminum with removable perforated face panel, adjustable diffusion louvers, and round neck or round neck adapter. Face panel shall fit 24" x 24" lay-in tee-bar ceiling grid. Throw pattern assembly shall be removed, air shall drop/dump into space.. Perforated ceiling diffusers to be located in kitchen cooking area only.

2.11 THERMALLY POWERED VAV DIFFUSERS

- A. Thermally powered variable air volume diffusers shall be Therma-Fuser™ model ST manufactured by Acutherm, and shall have separate set points for VAV Heating and VAV Cooling.
- B. Thermally powered VAV diffusers shall be a complete VAV terminal and thermostat self-contained in nominal 24"x24"/600mm square diffuser. They shall be thermally powered with one room thermostat/actuator and one changeover thermostat/actuator. External wiring or pneumatics shall not be allowed.
- C. The VAV diffusers shall have a thumbwheel and temperature scale to adjust the cooling set point and a separate thumbwheel and temperature scale for the heating set point. The adjustment shall be right above the hinged appearance panel and shall not require tools. Each set point shall be separately adjustable between 70°F/21°C and 78°F/26°C. The initial set point shall be factory set at 74°F/23°C..
- D. In the cooling mode the VAV diffusers shall open on a rise in room temperature and in the heating mode they shall close on a rise in room temperature. The changeover thermostat shall be factory installed and adjusted to engage the heating mode when the supply air temperature rises above 80°F/27°C and return to the cooling mode when the supply air temperature falls below 68°F/20°C. During changeover the diffuser shall close or, if a minimum flow is set, go to the minimum. Nothing including the changeover mechanism shall extend above the inlet of the diffuser.
- E. All VAV diffusers shall have a dial and scale to adjust minimum flow between 5 cfm/2.4 l/s and 50% of maximum flow without tools. Minimum flow shall be factory set at 10%. A fixed maximum flow stop shall be factory set for the full open air flow of the specified inlet size.
- F. All VAV diffusers shall have a lever which will open the damper for balancing without tools. The balancing lever shall be accessible from the outside of the diffuser without folding down the appearance panel or removing any part of the diffuser.
- G. All VAV diffusers shall have a solid (no holes or slots), hinged appearance panel that can be unlatched and folded down to hang allowing hands to be free for adjusting temperature set points. Instructions for the VAV diffuser shall be on the inside of the appearance panel.
- H. The VAV diffusers shall have positive induction of secondary room air over the room thermostat/actuator at all flows from fully closed to fully open.
- I. The manufacturer shall warrant that all VAV diffusers shall be free from defects in materials and workmanship for a period of ten years from date of shipment.
- J. Supply air to the VAV diffuser shall be constant temperature (may be reset to another constant temperature). Supply air shall be limited to no lower than 50°F/10°C on cooling and no higher than 120°F/49°C on heating. The heating high limit shall be as low as possible but no lower than 80°F/27°C.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with manufacturer's recommendations.
- B. Paint ductwork visible behind air outlets flat black, if not inherently black.
- C. Install items in accordance with manufacturer's instructions.

- D. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- E. Install diffusers to ductwork with air tight connection.
- F. Provide balancing dampers on duct take-off to diffusers, and grilles and register, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.
- G. Furnish and install necessary frames, bucks, sponge rubber gasketed, etc. to make a neat setting job.
- H. Diffusers shall be placed to insure that air does not blast against columns and lights.
- I. All diffusers, registers etc. shall have external volume controls and deflecting grids.
- J. Ceilings in areas where plaster or gypsum board ceiling are used, shall be surfaced mounted.

3.02 AIR OUTLET SCHEDULE

- A. Refer to schedules within contract documents.

END OF SECTION

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SECTION 23 3716 – FABRIC DUCT

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.
- B. Types of non-metal ductwork required for this project include the following:
 - 1. Textile Air Dispersion Products.

1.2 QUALITY ASSURANCE:

- A. Building Codes and Standards:
 - 1. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518. Also Classified by UL-C (Canada) S102.2, BS 5867 Part 2, 1980; GB8624-2006.
 - 2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
- B. Design & Quality Control
 - 1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.
- B. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for both NFPA 90-A and UL 2518.
- C. Provide detailed drawings confirming configuration of Textile Dispersion System (diameter, lengths, airflow, pressure, and textile permeability).
- D. Provide detailed installation instructions for components to be installed.
- E. Provide warranty and maintenance documentation.

1.4 WARRANTY:

- A. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Protect textile air dispersion system and Hoops (IHS) components from damage during shipping, storage, and handling.
- B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

Subject to compliance with requirements, choose one of the following:

- A. DuctSox® Corporation IHS, Verona fabric
- B. KE-Fibertech Safe 360°, Trevira CS 025700 fabric

2.2 TEXTILE AIR DISPERSION SYSTEM:

- A. Hoops (IHS) System: Air diffusers shall be constructed with internal retention system.
 - 1. System shall consist of an internal 360 degree hoop system, spaced 5' on center. Partial arcs are not acceptable.

2. System shall be installed with a one row suspension system located 1.5" above top-dead-center of the textile system.
3. System attachment to cable shall be made using Gliders spaced 12 inches.
4. Available for diameters from 8" – 60"
5. One row suspension
 - a. U-Track suspension hardware to include 8' sections of aluminum track, aluminum splice connectors, track endcaps and vertical cable support kits – consisting of a length of cable with cable connectors. Radius aluminum track must be included for all horizontal/flat radius sections.
 1. U-Track suspension
 - a. Galvanized steel cable
 2. Support lengths available in 5'(standard), 10', 15', & 30

B. TEXTILE

1. Verona
 - a. Textile Construction: Filament/filament twill polyester, fire retardant in accordance with UL 2518.
 - b. Air Permeability: 2 (+2/-1) CFM/ft² per ASTM D737, Frazier
 - c. Weight: 6.8 oz. /yd² per ASTM D3776
 - d. Warranty: 10 years
2. Textile Color
 - a. Custom: To be selected by architect & owner; provide full color spectrum range.

C. TEXTILE SYSTEM FABRICATION REQUIREMENTS:

1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips along the length of the system.
2. Integrated air dispersion shall be specified and approved by manufacturer.
 - a. Linear Vents
 1. Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
 2. Size of vent openings and location of linear vents to be specified and approved by manufacturer.
 3. Linear mesh vents are not acceptable.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
4. Inlet connection includes zipper for easy removal / maintenance.
5. Lengths to include required intermediate zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
7. End cap includes zipper for easy maintenance.

8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

D. DESIGN PARAMETERS:

1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
3. System overall design; diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
4. Do not use textile diffusers in concealed locations.
5. Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

PART 3 – INSTALLATION

3.1 INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM:

- A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.2 CLEANING AND PROTECTION:

- A. Clean air handling unit and ductwork prior to the Fabric Duct system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
- C. If Fabric Duct systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

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SECTION 23 3723 - ROOF HOODS, ROOF EQUIPMENT CURBS & ROOF PENETRATION HOUSING

PART 1 GENERAL

1.1 GENERAL

- A. Roof Hoods
- B. Equipment Curbs
- C. Equipment Rails
- D. "VAULT" Roof Penetration Housing.

1.2 SUBMITTALS

- A. General: all submittals shall comply with the requirements of Division 1 - General Requirements and Section 200100 - General Provisions.
- B. Product data: Data shall be submitted on the following items.
 - 1. Roof Curbs
 - 2. Equipment Curbs
 - 3. Equipment Rails
 - 4. "VAULT" Roof Penetration Housing.

1.3 QUALITY ASSURANCE

- A. Standards:
 - 1. American Society for Testing Materials (ASTM):
 - a. Standard E84, Surface Burning characteristics of Building Materials, 1980 Edition.

PART 2 EXECUTION

2.1 ROOF HOODS

- A. Roof Hoods shall be all aluminum construction with a factory applied baked enamel coating (figure in bid custom color to be selected by architect; architect to have full color spectrum to choose color from). Relief and exhaust hoods shall have perimeter to throat ratios of 1 to 1. Intake hoods shall have perimeter to throat ratios of 2 to 1. Hoods shall have a base curb cap for mounting on roof curb and corners of curb cap shall be welded. Each hood shall have a factory installed 1" wide x 1/4" thick foam rubber gasket applied around the entire underside of the curb cap.
- B. Perimeter opening of each hood shall be equipped with aluminum welded mesh birdscreen.
- C. The underside of hood and the interior of air shaft shall be insulated with factory applied 1" thick (minimum), 1-1/2" lb. density fiberglass insulation with flame retardant foil-reinforced kraft facing vapor barrier; insulation shall be attached to hood using mechanical fasteners and waterproof adhesives.
- D. The throat of each hood shall be equipped with a damper mounting frame to permit installation of a damper. The damper shall be as specified on the drawings.
- E. The top of the hood shall be hinged and latched for access to the damper.
- F. Intake hood shall be equipped with a 1" thick cleanable filter at the perimeter opening.
- G. Pressure drop at indicated air quantity and throat dimensions shall not exceed 0.1/in. w.g. Shop drawings shall indicate dimensions of each unit, installed weight and pressure drop at rated flow.
- H. Roof hoods shall be:

	Exhaust or Relief	Supply
Greenheck	FGR	FGI

2.2 EQUIPMENT CURBS – FLAT ROOF

- A. General: The following items shall be mounted on prefabricated equipment curbs:
 - 1. Exhaust/Supply Fans
 - 2. Roof hoods.
- B. Prefabricated roof curbs shall have the base designed to match the slope of the roof shown on the architectural and structural design so that the top of the curb is horizontal and level.

- C. Prefabricated roof curbs shall be of box section design and shall be constructed of not less than 18 gauge aluminum with continuous welded corner seams, factory installed wood nailer and shall be insulated with 1-1/2" thick, 3 lb. density rigid fiberglass insulation board. Insulation exposed to the air stream shall have a smoke developed rating not to exceed 50 and a flame spread rating not to exceed 25 when tested in accordance with ASTM E84. Curbs shall be the surface mount type. Curb overall length and width dimensions shall fit the curb cap of the equipment to be mounted on the curb. Curb height shall be 18" minimum.
- D. Prefabricated roof curbs shall be by: Roof Products and Systems Corp., Conn-Fab Products, Inc., Greenheck, Creative metals, Inc., Thy Curb, or Custom Curbs, Inc.
- E. Contractor shall refer to architectural drawings for exact slope requirements and adjust roof curbs accordingly.

2.3 "VAULT" ROOF PENETRATION HOUSING

- 1.1 Section Includes:
 - A. Pipe and Duct Penetrations in Roofing
- 1.2 Not used.
- 1.3 References:
 - A. ICC-500, FEMA 320/361 – Third Party Tested to 225 mph and 250 mph (tornado). For Tornado Rated applications, see 077250
 - B. ICC 2015/2018 Energy Code – Third Party Tested to ASTM E 2078-13 Standard Test Method for Air Permeance of Building Materials.
 - C. ASTM E 1980 Solar Reflectance Index (SRI).
 - D. FEMA P749 – Seismic Provisions.
- 1.4 Submittals:
 - A. Submit under provisions of Section 01 30 00 – Administrative Requirements.
 - B. Product Data: Manufacturer's Data Sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Installation methods.
 - C. Shop drawings: physical size, installation and working space required.
 - D. Proof of Product Liability Insurance.
 - E. Third Party Testing Identification for Wind and Air Permeance Levels.
- 1.5 Quality Assurance:
 - Manufacturer – Product to be manufactured by an ISO 9001 Facility.
- 1.6 Delivery, Storage, and Handling:
 - A. Deliver and store products in Manufacturer's original packaging bearing the brand name and Manufacturer's identification until ready for installation.
 - B. Handle materials to avoid damage. Protect from construction conditions.
- 1.7 Warranty:
 - A. Product to carry a 20-Year Limited Insured Warranty.
- 2.1 Manufacturer:
 - A. Acceptable Manufacturer: Roof Penetration Housings, San Antonio, Texas 1-800-994-0945, TomK@Roofpenetrationhousings.com or www.Roofpenetrationhousings.com
 - B. Substitutions – See Section 016000.
- 2.2 The Vault:
 - A. Product: The Vault by Roof Penetration Housings.
 - B. Construction:
 - 1. 0.080 inch (2mm) thick aluminum housing and curb.
 - 2. UV protected powder coated finish (2 mil (.05 mm) thick).
 - 3. Stainless steel vandal proof fasteners.
 - 4. Gasketed lid to housing and housing to curb connection joints to ensure compliance to ICC 2015/2018 Air Permeance Levels.
 - 5. Standard Color: White – To meet an initial SRI of 88

6. Seismic available upon request. Seismic calculations, conditions to be furnished to RPH by engineer.
 7. Constructed to withstand wind to 225 MPH, third party tested.
- C. Style & Sizes:
1. Series AWI Vault: All aluminum construction, (zero plastic), wind rated to 225 mph and pre-insulated (R-2 for Condensate), vandal proof stainless steel fasteners with pre-insulated curb 6" thick R-40 factor meet ICC-2015/2018 Energy Code. AWI Vault meets ICC 2015/2018 Energy Code for Air Permeance Levels.
 - a. Vault Model: AWI Custom Size
Sized for project specific requirements, Series 5000 Exit Seals.
- NOTES:
1. Provide 18" roof curb.
 2. Exit Seal capacities are dependent on size of seals required based on Series 5000 Exit Seals.
 3. Products shown may not reflect current design refinements. Dimensions may vary.
 4. AWI includes all AW components plus the ICE pre-insulated curb extension. Aluminum extension between housing and curb is 7" wide on each side of Vault® to accommodate 6" insulation (R-40 Rating) supplied by RPH on the outside of the curb, +1" to accommodate roofing material.
- NOTE: Sizes above – housing only – provide 18" curb.
Add curb height to housing height less 3" for overlap
- 2.3. Exit Seals
- A. Design: Weather tight seal for vertical surface/plane penetrations. Exit Seal construction to be manufactured in all aluminum construction and 100% Sil-X-14 silicone gaskets.
 - a. Series 5000 - .25" to 1.90"
Series 6000 – 2" to 3.125"
Series 7000 – 3.5" large diameter double gasketed inside and out.
 - b. Penetration pipe type as applicable: copper K and L, copper ACR, steel Schedule 40, PVC Schedule 40 and 80, electrical EMT, electrical rigid, aluminum, liquid light, and A/C or plumbing ducts.
- 2.4 GENERAL
1. Provide roof pipe support at all piping on roof within 4" of the "Vault". Offset piping once in building as to support pining from roof structure.
- 2.5. CLOSEOUT & WARRANTY
1. At project closeout the contractor shall complete and return the "Vault" warranty information card to the following address:
Roof Penetration Housings, LLC. 12423 Blanco Rd, #120, San Antonio, Texas 78216 Phone: 1-800-994-0945
<http://roofpenetrationhousings.com>

PART 3 EXECUTION

3.1 INSTALLATION

- A. Roof hoods shall be secured to roof curb with aluminum lag bolts and washers, a max. of 12 inched on centers.
- B. Roof curbs shall be flashed and counterflashed to roof to match type roof, see architectural drawings.
- C. "Vault" roof penetration housing to be installed in strict accordance with manufacturer's recommendations.

END OF SECTION

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SECTION 23 5123 - BREECHINGS, CHIMNEY, AND STACKS FOR CONDENSING APPLIANCES

PART 1- GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Venting for the removal of products of combustion for Category II, III, IV gas burning appliances

1.2 REFERENCES

- A. Underwriters Laboratories (UL):
 - 1. UL1738
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 54 - National Fuel Gas Code
 - 2. NFPA 211 – Standard for Chimneys, fireplaces, Vents, and Solid Fuel-Burning Appliances.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 54
- B. Must install duct in accordance to manufacturer's listings and installation instructions.
- C. Components coming in contact with the products of combustion shall carry the appropriate UL or cUL listing, mark or label.

1.4 WARRANTY

- A. Condensing Appliance vent listed to UL1738 shall have a limited lifetime warranty to begin at the date of installation. Any portion of the vent repaired or replaced under warranty shall be warranted for the remainder of the original warranty period.

PART 2- PRODUCTS

2.1 AVAILABLE MANUFACTURERS

- A. Listed Double-Wall vent for condensing appliances, Model CG as manufactured by Metal-Fab, Inc.

2.2 LISTED VENTING FOR CONDENSING APPLIANCES

- A. The condensing appliance vent shall be double-wall for use with Category II natural draft appliances and Category III or IV positive pressure appliances.
- B. Maximum temperature shall not exceed 550° F (288° C).
- C. Vent shall be listed for an internal static pressure of 6 inch w.g. and tested to 15 inch w.g. for diameters 6 inch - 36 inch and 10 inch w.g. for diameters 3 inches - 5 inches.
- D. Vent shall be constructed of AL29-4C material tested to UL1738, .015 thickness for 3 inch - 12 inch diameters, .024 thickness for 14 inch to 24 inch diameters, and .035 thickness for 26 inch to 36 inch diameters.
- E. Outer casing shall be constructed of 316 stainless steel of .018 inch thickness for 3 inch to 12 inch diameters, .024 inch thickness for 14 inch to 24 inch diameters, and .035 thickness for 26 inch to 36 inch diameters.
- F. Joint assembly utilizes flanged mating surfaces, with a self-guiding sleeve for diameters 6 inch – 24 inch. P070 sealant will be used on the flange surface and in the vee band. Flanges are joined with a vee band secured by tightening draw bolts. Diameters 3 inch - 5 inch utilize an overlapping, gasketed joint connection.
- G. Contractor has option to vent appliances with Polypropylene (Centotherm, DuraVent, or prior approved equal). Where approved by the appliance manufacturer. Install in strict accordance with manufacture recommended installation guidelines.

PART 3-EXECUTION

3.1 STORAGE AND CONSTRUCTION

- A. Protect materials from accidental damage.

- B. All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings required to install the vent system shall be included.
- C. Where exposed to weather, the outer closure band shall be sealed to prevent moisture from entering the space between the walls.
- D. All parts exposed to the weather shall be protected by one (1) coat of corrosion and heat resistant base primer and one (1) coat of heat resistant paint unless constructed of 430, 304 or 316 stainless steel.
- E. Vent shall terminate in accordance with installation instructions and local codes.
- F. Installation shall conform to manufacturer's installation instructions.

END OF SECTION

12-10-25

SECTION 23 7313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

- A. Section Includes:
 - 1. Constant-air-volume, single zone air-handling units.

1.4 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Filters with performance characteristics.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- B. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each air-handling unit.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI
- D. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.9 WARRANTY

- A. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start at the date of substantial completion. Contractor to extend manufacturer warranties to start from this date.
- B. The installing contractor shall provide labor warranty during the unit's first year of operation, from date of substantial completion.

PART 2 - PRODUCTS

2.0 MANUFACTURERS

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

2.01 GENERAL DESCRIPTION

- A. Units shall ship in the number of sections necessary to meet project requirements and shall ship in as many splits as specified in selection software. Split options as follows:
 - 1. Shipped in sections — shipping split.
 - 2. Shipped assembled.
- B. Unit shall be factory-supplied, central station air handler. The air-handling unit may consist of a fan with the factory-installed components as indicated on the equipment schedule & details.

2.02 CASING

- A. Construction:
 - 1. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit.
 - 2. All units shall be supplied with 14-gage or heavier, G-90 galvanized steel base rails. Bolton legs are NOT acceptable. Perimeter lifting lugs for overhead lifting shall be provided on each shipping section. Slings in place of lifting lugs shall not be acceptable.
 - a. Base rail to be 10" height as to properly trap condensate drain piping.
 - 3. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.
 - 4. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall have one of the following exterior finishes as specified:
 - a. Pre-painted with a baked enamel finish passing 500-hour salt spray test (ASTM B-117) for pre-painted steel and 125-hour marine level 1 cohesion test (ASTM G-85.A5) for pre-painted steel.
 - 5. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel, and shall have one of the following interior finishes as specified:
 - a. Pre-coated with a silver zeolite antimicrobial material registered by the US EPA for use in HVAC applications.
 - 6. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
 - 7. Casing deflection shall not exceed a 1:200 ratio when subject to an internal pressure of ± 8 -in. wg. Casing leakage rate shall be less than 1% at 8 in. wg of nominal unit airflow or 50 cfm, whichever is greater. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available.

8. Side panels shall be easily removable for access to unit and shall seal against a full perimeter automotive style gasket to ensure a tight seal.
 9. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.
 10. Accessibility options shall be as follows:
 - a. Hinged double-wall access door on either side with removable access panel(s) on the other side.
 11. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.
 13. All coil sections shall be double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.
 14. Blow-thru sections shall have a diffuser plate as an integral part of the fan section.
- B. Access Doors:
- Access doors shall be one piece, double-wall construction with insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.
- C. Drain Pans:
- Drain pans shall be insulated double-wall stainless steel construction. The pan shall be sloped toward the drain connection. Drain pan shall have 1 1/2-in. MPT connection exiting through the hand side or opposite side of the casing as specified. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE Standard 62.1-2010. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

2.03 FANS

- A. General:
1. Direct drive plenum fan sections shall have TWO single width single inlet (SWSI) airfoil fan wheel. Airfoil blades shall be double thickness design continuously welded to the back plate and the front plate. Fan wheel shall be constructed of aluminum. Airfoil blades shall be aluminum extrusions and shall be top welded to the back plate and front plate of the wheel. Fan wheel shall be dynamically balanced per ISO standard 1940 quality grade G6.3.
 2. Fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. Accelerometers shall be mounted on the motor near the bearing locations.
 3. All fan sled components shall provide corrosion protection to pass 100-hour salt spray test per ASTM B-117.
 4. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with a maximum operating speed 25% below the first critical.
- B. Performance Ratings:
- Fan performance shall be rated and certified in accordance with AHRI Standard 430, latest edition.
- C. Sound Ratings:
- Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound. Sound ratings shall be tested in accordance with AHRI 260.
- D. Mounting:

Fan scroll, wheel, shaft, bearings, drives, and motor shall be mounted on a common base assembly. The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable. Units shall use 2-in. deflection spring isolators.

E. Fan Accessories:

1. Direct Drive Plenum Fans:

- a. Variable frequency drives.
- b. Motor protection box for motor current protection with a single VFD driving multiple motors.
- c. Airflow measuring piezo ring.
- d. Piezo ring transducer.
- e. Motor shaft grounding ring.
- f. Inlet guard.
- g. Outlet guard.

F. Flexible Connection:

The base assembly is isolated from the outer casing with factory-installed isolators and rubber vibration absorbent fan discharge seal. A canvas style duct connection between fan discharge and cabinet is not acceptable.

2.04 BEARINGS AND DRIVES

A. BEARINGS

All plenum fans shall be direct drive.

B. Shafts:

Fan shafts shall be solid steel, turned, ground, polished and coated with a rust inhibitor.

2.05 COILS

- A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.
- C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- D. Construct coil casings of 16GA stainless steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- E. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.
- F. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.
- G. Hydronic Coils
 1. Not used.
- H. Refrigerant Coils:
 1. Headers shall be constructed of copper with brazed joints.

2. Standard circuiting selections include:
 - A. Row split intertwined, multiple distributor arrangement for sizes 03-110.
3. Replaceable nozzle, brass refrigerant distributors and seamless copper distribution tubes are supplied to ensure uniform flow.
4. Submittals must include a DX coil and condensing unit cross plot to show that the coil and condensing unit capacity match at the rated design conditions.

2.06 FILTER SECTIONS

- A. Angle filter sections shall accept either 2-in. or 4-in. filters of standard sizes, arranged in a horizontal V formation.
- B. Magnehelic Gages:
 1. Housing shall be constructed of a die cast aluminum case and bezel with acrylic cover. Exterior finish shall be coated gray to withstand 168 hr salt spray corrosion test.
 2. Accuracy shall be $\pm 2\%$ of full scale throughout range at 70 F (21.1 C).
 3. Pressure limits shall be -20 in. Hg to 15 psig (0.677 bar to 1.034 bar).
 4. Overpressure relief plugs shall open at approximately 25 psig (1.72 kPa).
 5. Temperature limits shall be 20 to 140 F (-6.67 to 60 C).
 6. Diameter of dial face shall be 4 in. (101.6 mm).
 7. Process connections shall be 1/8-in. female NPT duplicate high and low pressure taps — one pair side and one pair back.

2.07 DAMPERS

Factory-supplied dampers shall be warranted to be free from defects in material and workmanship for a period of 12 months after being installed or placed in service, but in no instance shall the period of warranty be longer than 18 months from the date of the original shipment by the manufacturer.

- A. Mixing boxes, filter-mixing boxes, and exhaust boxes shall have parallel or opposed blades and interconnecting outside-air and return-air dampers.
 1. Premium Dampers:

Damper blades shall be constructed of galvanized steel with a double-skin airfoil design, with blade seals and stainless steel jamb seals. Blades shall be mechanically fastened to axle rods rotating in self-lubricating synthetic bearings. Maximum leakage rate shall be 2 cfm/ft² at 1 in. wg (0.25 kPa) differential pressure.

2.08 FACTORY MOUNTED MOTOR REMOVAL TROLLEY SYSTEM

1. All direct drive & belt drive plenum fan sections shall have a factory provided/mounted motor removal trolley system to facilitate fan motor replacement and maintenance. The trolley system shall be suspended from the ceiling of the fan section and be rated to handle the maximum total weight of the fan motor and trolley system.

2.09 DISCHARGE PLENUM

- A. Units to be equipped with discharge plenum, same construction as unit casing. Provide factory opening with unit mounted electric heater.

2.10 ELECTRIC HEATING SECTION

- A. Not used.

2.11 NOT USED

2.12 ELECTRICAL ACCESSORIES:

- A. Disconnects:
 1. Fused and non-fused disconnects shall have the following characteristics:
 - a. Visible blades.
 - b. Quick-make, quick-break operating mechanism.
 - c. Cover padlock hasp and handle lock "OFF."

- d. 240 vac maximum.
 - e. Factory supplied and installed class RK5 fuses (fused disconnects only).
 - f. Up to 100,000 rms symmetrical amperes SCCR, utilizing appropriately rated, factory-supplied Class R fuses.
 - g. Horsepower rated for motor applications.
 - h. Tangential combination knockouts for field wiring.
 - i. Spring reinforced plated copper fuse clips.
 - j. NEMA type 1 enclosures.
 - k. Insulated, bondable solid neutral assemblies.
 - l. UL listed, File E2875.
 - m. Meet or exceed NEMA KS1-1990.
- B. Variable Frequency Drives (unit mounted):
- 1. Refer to specification 23 05 14 "Variable Frequency Drives".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for refrigerant and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on 1" neoprene waffle pads on auxiliary drain pan directly on mechanical room/mezzanine floor.

3.3 CONNECTIONS

- B. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to air-handling unit to allow service and maintenance.
- D. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- E. Connect condensate drain pans using, ASTM B 88, Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping". Install refrigerant piping in strict accordance with manufacturer's recommendations.
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- H. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- I. Tests and Inspections:
 - 1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Filter Operational Test: Pressurize housing to a minimum of 6-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
- J. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- K. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that zone dampers fully open and close for each zone.
 7. Verify that face-and-bypass dampers provide full face flow.
 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

3.9 The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:

1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
2. On all field-joined units, that all interconnections have been completed, i.e., electrical

and control wiring, piping, casing joints, bolting, welding, etc.

3. All refrigerant/water/steam piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.
4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
6. All automatic temperature and safety controls have been completed.
7. All dampers are fully operational.
8. All shipping materials have been removed.

3.10 LEVELING

1. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

END OF SECTION

12-10-25

SECTION 23 74 33 - TEMPERED SUPPLY FAN (WSF-1)

PART 1 - GENERAL

1.1. SUMMARY

- A. This section is applicable to the following equipment tags: "WSF-1".
- B. This section includes units with integral Direct Gas-Fired heating Airflow arrangement shall be Outdoor Air with Variable Air Volume. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.
- C. Related sections include the following:
 - 1. Section 22 0000: Scope of Work
 - 2. Section 22 0100: General Provisions
 - 3. Section 22 0700: Insulation
 - 4. Section 22 1000: Plumbing
 - 5. Section 23 0900: Controls and Instrumentation
 - 6. Section 23 0000: Electrical

1.2. SUBMITTALS

- A. Product Data: For each type or model, include the following:
 - 1. Complete fan performance curves for Supply Air, with system operating conditions indicated, as tested in an AMCA Certified Chamber.
 - 2. Sound performance data for Supply Air, as tested in an AMCA Certified chamber.
 - 3. Motor ratings, electrical characteristics and motor and fan accessories.
 - 4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 5. Estimated gross weight of each installed unit.
 - 6. Installation, Operating and Maintenance manual (IOM) for each model.

1.3. QUALITY ASSURANCE

- A. Source Limitations: Obtain Packaged Make-Up Air Unit with Integral Heating with all appurtenant components or accessories from a single manufacturer.
- B. Product Options: Drawings must indicate size, profiles and dimensional requirements of Make-Up Air Units and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".
- C. Certifications:
 - 1. Entire unit shall be ETL Certified per ANSI Z83.4 or ANSI Z83.18 and bear an ETL mark.

1.4. COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated ducting, plumbing and electrical systems.
- B. Coordinate sequencing of construction of associated plumbing, HVAC, and electrical supply.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - 1. Greenheck Fan Corporation, JCI, York, Trane, Daikin, Carrier or prior approved equal.

2.2. MANUFACTURED UNITS

- A. Units with Integral Heating shall be fully assembled at the factory and consist of an insulated metal cabinet, a curb assembly, an outdoor air intake weatherhood with bird screen, a motorized intake damper, supply air blower assembly, electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.3. CABINET

- A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvanized steel. Base rail is 12 gauge, galvanized (G90) steel. Components that receive a painted finish per A/E specification shall be painted with a polyester urethane powder coat.
 - 2. Internal Assemblies: 24 gauge galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - 1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - a. Thickness: 1 inch (25 mm)
 - b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - c. Location and application: Floor of each unit shall be insulated with fiberglass insulation. Full interior coverage of entire cabinet to include walls and roof of unit shall be semi-rigid type and installed between inner and outer shells of all cabinet exterior components when double walls are specified.
 - d. Access panels: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Access panels shall be fabricated of 18 gauge galvanized G90 steel.
 - e. Supply Air blower assembly options:
 - 1 Direct-drive fan(s): Blower assembly shall consist of an electric motor as specified by A/E. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on minimum 1.125 inch thick neoprene vibration isolators. Blower motor(s) shall be capable of continuous speed modulation and controlled by a factory supplied VFD.
- C. Control center / connections:
 - 1. Unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
- D. Direct Gas-Fired Furnace:
 - 1. Unit shall be factory assembled, piped, and wired. Direct gas-fired system will be 92% efficient while supplying a burner that is capable of providing 25:1 turndown. Unit will utilize a draw through design and incorporate adjustable burner baffles plates for field adjustments. Unit will have a EconomyPilot ignition system.
 - 2. Burner construction shall consist of a cast aluminum burner manifold and 400 series stainless steel mixing plates. No air from inside the space shall be allowed to pass across the burner at any time. Flame sensing shall be provided by a flame rod. Burner control shall have a digital coded fault indicator capable of storing the last five faults.
 - 3. Shall be equipped for operation on Natural gas with a maximum rated inlet gas pressure of 1/2 PSI.
 - 4. Burner control option to include the following: Discharge temperature.
 - 5. Shall include the following safety controls:

- a. Manual Reset, High Limit Switch: Main gas valve closes if high-limit temperature is exceeded.
- b. Dual safety shutoff valves shall be provided that do not exceed 120 VAC control signals.
- c. FM Global Requirements: Includes high and low gas pressure switches and visual indication gas valves.
- E. Motorized Inlet Air Dampers: to be of low leakage type and shall be factory installed.
- F. Sensors are considered to be part of various operational modes or device controllers and are to be factory supplied and installed.
- G. Curb Assembly: A curb assembly shall be made of galvanized steel provided by the factory for field assembly and installation as part of this division. The curb shall include a duct adapter for supply air. The installing contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly.
- H. Frost Control for optional water coil.

2.4. BLOWER

- A. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower and must have neoprene vibration isolation devices, minimum of 1-1/8 inches thick.
- B. Fan: Mixed flow fan statically and dynamically balanced, AMCA certified for air and sound performance.
- C. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".
- D. Proceed with installation only after all unsatisfactory conditions have been corrected.

2.5. MOTORS

- A. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPA's minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase, and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.
- B. Motors shall be 60 cycle, 3 phase, 460 volt.

2.6. UNIT CONTROLS

- A. The unit shall be constructed so that it can be operated as a heating system controlled by a Building Management System (BMS). Provide BACNet interface card for integration into building management system.
- B. Variable Frequency Drive (VFD): Unit shall have factory installed variable frequency drives for modulation of the blower motors. The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- C. Sensors to be provided with the unit:
 - 1. Heating Inlet Air Sensor

2.7. FILTERS

- A. Unit shall have 2" thick permanent metal filters following the outdoor air intake in a V-bank arrangement and shall be accessible from the exterior of the unit.

PART 3 - EXECUTION

3.1. EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
- B. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2. INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

3.3. CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
 - 1. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
 - 2. Duct installation and connection requirements are specified in Division 23 of this document.
 - 3. Electrical installation requirements are specified in Division 26 of this document.

3.4. FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

3.5. START-UP SERVICE

- A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Verify water source for compliance with manufacturer's requirements for flow and temperature. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.6. DEMONSTRATION AND TRAINING

- A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION

12-10-25

SECTION 23 81 27 - DUCTLESS SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Ductless Split Air Conditioning Unit
- B. Refrigeration Cooling Coil
- C. Controls

1.2 RELATED WORK

- A. Section 200100: General Provisions

1.3 QUALITY ASSURANCE

- A. Conform to requirements of AGA, UL and applicable codes.
- B. B. Cooling system tested and rated to ARI Standard 210.

1.4 SUBMITTALS

- A. Submit manufacturer's installation instructions.
- B. Submit manufacturer's descriptive literature, operating instructions, and maintenance and repair data.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM AIR CONDITIONER(S)

- A. General: Indoor, direct-expansion, wall mounted fan coil or ceiling cassette, as noted on schedule. Unit shall be complete with cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket, mounting hardware, and thermistor interconnection cable .
- B. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- C. Fans: Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard. Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.
- D. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header. NOTE: The units use the accessory AccuRatert piston refrigerant metering device in the indoor unit (for cooling) and at the outdoor unit liquid lineservice valve for heating.
- E. Motors: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection. Fan motors shall be 3-speed.
- F. Controls: Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self diagnostics. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum:
 - 1. An automatic restart after power failure at the same operating conditions as at failure.
 - 2. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
 - 3. Temperature-sensing controls shall sense return-air temperature. Indoor-air high discharge temperature shutdown shall be provided.

4. Indoor coil freeze protection.
 5. Wireless infrared remote control to enter set points and operating conditions.
 6. Auto Stop features shall have integral setback control.
 7. Automatic airsweep control to provide on or off activation of airsweep louvers.
 8. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.
 9. Fan-only operation to provide room air circulation when no cooling is required.
 10. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
 11. An indoor to outdoor thermistor connection cable shall be provided with the fan coil unit.
 12. Fan speed control shall be user-selectable: high, medium, low, or microprocessor automatic operation during all operating modes.
 13. A time delay shall prevent compressor restart in less than 3 minutes.
 14. Automatic heating-to-cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
 15. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
 16. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.
 17. Refrigerant to be R-410a.
- G. Filters: Unit shall have filter track with factory-supplied cleanable filters.
- H. Electrical Requirements: Refer to schedule on drawings.
- I. Refrigerant Lines: All units shall have rotatable refrigerant lines for penetration through the wall using flare connections. All units shall have flare connections.
1. All refrigerant lines material & installation shall be in accordance with manufacturers recommendation.
 - a. Refrigerant piping shall be Type "ACR" hard drawn copper tubing attached with wrought copper fittings, utilizing 1000- degree silver solder and a non-corrosive flux. Refrigerant piping shall be sized and installed in strict accordance with the air conditioning unit manufacturer's recommendations and directions and shall be submitted to the Engineer for prior approval before installation. Pressure drops shall not exceed the equivalent of 2-psi. Refrigerant piping system shall be evacuated, charged with refrigerant holding charge. The refrigerant lines to be tested with nitrogen to a test pressure of not less than 450 psi and proved before final charge of refrigerant. Compressor shall not be subject to the 450 psi pressure test.
- J. Special Features (Field Installed):
1. Condensate Pump: The condensate pump shall remove condensate from the drain pan when gravity drainage cannot be used. Pump shall be designed for quiet operation. Pump shall consist of two parts: an internal reservoir/sensor assembly, and a remote sound-shielded pump assembly. The lift capability of the condensate pump shall be 1 to 10 ft (009 size unit) or 3 to 25 ft (012-024 size units). A level sensor on the condensate pan shall stop cooling operation if the level in the condensate pan is unacceptable.
 2. Not used.
- K. Warranty: Unit to include five year warranty, compressor along with all parts, including labor and refrigerant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in strict accordance with manufacturer's recommendations.
- B. Pipe condensate drain as shown on the drawings or to nearest plumbing bent if not shown with "P" trap.
- C. System(s) shall be installed according to manufacturer's instructions & recommendations, as well as, all governing local & national codes. System(s), as well as the infrared remote controller, shall be mounted & placed as shown on plans within all minimum clearances as specified by manufacturer's instructions, & secured to provide for safe operation. Refrigerant tubing size shall not vary from manufacturer's specifications, and shall be properly secured & insulated. Installer shall insulate both liquid & suction lines individually on Low Ambient specified system(s). High voltage & low voltage communication wiring between indoor & outdoor unit(s) shall be run separately from each other in their own enclosures per manufacturer's instructions. Outdoor condensers shall be mounted & secured to accommodate for extreme weather conditions. Distance between indoor & outdoor unit(s) shall not exceed manufacturer's recommendations.

END OF SECTION

12-10-25

SECTION 23 81 28 - 100% OUTSIDE AIR VARIABLE REFRIGERANT VOLUME HVAC SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/Condensing unitS:
 - 2. Indoor Units

1.02 RELATED REQUIREMENTS

- A. N/A

1.03 REFERENCES

- A. N/A

1.04 SUBMITTALS

- A. N/A

1.05 QUALITY ASSURANCE

- A. MANUFACTURER QUALIFICATIONS:
 - 1. The units shall be tested by a National Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
 - 2. All wiring shall be in accordance with the National Electric Code (NEC).
 - 3. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
 - 4. The condensing unit will be factory charged with R410A.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.07 WARRANTY

- A. STANDARD LIMITED WARRANTY
 - 1. Complete warranty details available from your local Daikin representative or at www.daikincomfort.com.
 - 2. Daikin North America LLC warrants original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the "installation date" which is one of the two dates below:
 - a. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.
 - b. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. DESIGN BASIS:
 - 1. The HVAC equipment basis of design is Daikin North America. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Appendix A HVAC Equipment Alternate

General Information). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

2.02 HVAC SYSTEM DESIGN

A. SYSTEM DESCRIPTION:

1. The variable capacity heat pump air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat or cool model) system as specified.
2. The system shall consist of multiple evaporators using PID control, REFINET™ joints and headers, a two-pipe refrigeration distribution system and Daikin VRV® condenser unit.
3. The condenser shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.

B. VRV IV X FEATURES AND BENEFITS

1. Voltage Platform - Heat pump condensing units shall be available with a 460V/3ph/60Hz power supply.
2. Gas Furnace Connectivity – Heat Pump condensing units shall be connectable to Daikin Communicating gas furnaces with AFUE ranging from 80% to 97%.
3. System shall be capable of connecting to multiple VRV A-coils (CXTQ) paired with Daikin Communicating gas furnaces allowing for options of gas or heat pump heating to optimize operational costs.
4. The system shall be able to switch between heat pump heating and gas furnace heating at a field selectable change-over temperature which can be configured via condensing unit field settings.
5. Each system shall be able to enlarge from single to dual module or dual to triple module without the need for installed main pipe size changes. The manufacturer shall provide predefined pipe sizes and design rules ensuring reliable system operation and offering design flexibility in phased installation applications.
6. Stable Operation – System shall provide stable inverter operation at varied ambient conditions.
7. Auto Changeover – System shall, below the field selected outdoor ambient temperature provide signal to initiate auxiliary or back up heat.
8. Advanced Zoning - A single system shall provide for up to 64 zones.
9. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.
10. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
 - a. Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
11. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.

- a. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
- 12. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
- 13. Flexible Design –
 - a. Systems shall be capable of up to 540ft (165m) [623 ft. (190m) equivalent] of linear piping between the condensing unit and furthest located indoor unit.
 - b. Systems shall be capable of up to 3,280ft (1,000m) total “one-way” piping in the piping network.
 - c. Systems shall have a vertical (height) separation of up to 295ft (90m) between the condensing unit and the indoor units.
 - d. Systems shall be capable of up to 295ft from the first REFNET™ / branch point.
 - e. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit nominal capacity.
 - f. Systems shall be capable of 98ft (30m) vertical separation between indoor units.
 - g. Condensing units shall be supported with a fan motor ESP up to 0.32” WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.
- 14. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
- 15. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.
- 16. Outside Air – Systems shall provide outside air capability.
- 17. Space saving – Each system shall have a condensing unit module footprint no larger than 48-7/8” x 30-3/16” (1694mm x 1242mm x 767mm).
- 18. Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
- 19. Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
- 20. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
- 21. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.
- 22. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
- 23. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
- 24. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).
- 25. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
- 26. .

C. PERFORMANCE:

1. The VRV IV X RXYQ_XA system shall perform as indicated below:

MODEL NUMBER	SYSTEM IEER (Ducted)
RXYQ96XAYD*	22.5
RXYQ120XAYD*	22.0

MODEL NUMBER	SYSTEM COP@47°F (Ducted)
RXYQ96XAYD*	3.49
RXYQ120XAYD*	3.30

MODEL NUMBER	SYSTEM COP@17°F (Ducted)
RXYQ96XAYD*	2.50
RXYQ120XAYD*	2.40

2. Performance Conditions:
 - a. Cooling: Indoor temperature of 80°FDB (26.7°CDB), 67°FWB (19.5°CWB) and outdoor temperature of 95°FDB (35°CDB).
 - b. Heating: Indoor temperature of 70°FDB (21.1°CDB) and outdoor temperature of 47°FDB (8.3°CDB), 43°FWB (6.1°CDB).
 - c. Equivalent piping length: 25ft (7.5m)
3. Cooling Operation:
 - a. The operating range in cooling will be 23°F DB ~ 122°F DB (-5°CDB ~ 50°CDB).
 - b. Cooling mode indoor room temperature range will be 57-77°FWB (13.8 - 25°CWB).
 - c. Cooling operation may be extended down to 10°F DB when the system is designed with the following limitations:
 - 1) The system must be a single module outdoor unit: RXYQ72/96/120/144/168XA.
 - 2) The smallest capacity indoor unit connected to the system must be 12,000 Btu/h.
 - 3) The system must run continuously in cooling operation with a minimum of 1.5 tons of indoor units in operation.
4. Heating Operation:
 - a. The operating range in heating will be -4°F WB – 60°F WB (-20°CWB – 15.5°CWB).
 - b. Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

2.03 EQUIPMENT

A. ELECTRICAL:

1. The power supply to the condensing unit shall be:

POWER SUPPLY VOLTAGE	VOLTAGE RANGE
460V / 3ph / 60 Hz	187V – 253V (±10%)

MODEL	MCA	MOP	COMPRESSOR RLA
RXYQ96XAYD*	20.6	25	10.2
RXYQ120XAYD*	20.6	25	11.7

B. WIRING:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
3. The control wiring maximum lengths shall be as shown below:

	CONDENSER TO INDOOR UNIT	CONDENSER TO CENTRAL CONTROLLER	INDOOR UNIT TO REMOTE CONTROL
CONTROL WIRING LENGTH	6,560 ft (2,000 m)	3,280 ft (1,000 m)	1,640 ft (500 m)
WIRE TYPE	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

C. REFRIGERANT PIPING:

1. The system shall be capable of refrigerant piping up to 540ft (165m) actual or 623ft (190m) equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft (1,000m) of piping between the condensing and indoor units with 295ft (90m) maximum vertical difference, without any oil traps or additional components.
 2. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.
 - a. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.
- D. PAINT/CORROSION RESISTANCE:
1. Paint and corrosion resistance shall be at a minimum per the table below:

COMPONENT	VRV IV X		
	BASE MATERIAL	SURFACE TREATMENT	COATING THICKNESS
			External & Internal Surface
EXTERNAL PANEL BASE	Galvanized steel	POLYESTER	≥1.5 mils
EXTERNAL FRONT PANEL	Galvanized steel	POLYESTER	≥1.5 mils
PILLAR	Galvanized steel	POLYESTER	≥1.5 mils
COMPRESSOR COVER	ASTM material	Resin Paint	≥0.78 mils
FIN GUARD	Iron wire	Resin Paint	≥0.79 mils
FAN GUARD AND DRUM	Polypropylene	No treatment required	N/A
FAN	Acrylonitrile - glass	No treatment required	N/A
FAN MOTOR FRAME	Resin	No treatment required	N/A
FAN MOTOR SHAFT	Carbon steel	No treatment required	N/A
FAN MOTOR SUPPORT	Galvanized steel	POLYESTER	≥1.5 mils
HEAT EXCHANGERS (FIN ONLY)	Aluminum	Polymer Anti-corrosion surface treatment	Salt Spray 1000 hours, blister rating 10
ELECTRICAL PARTS BOX	Hot-dip zinc-coated steel	No treatment required	N/A
ELECTRICAL PARTS BOARD	Glass cloth / Glass nonwoven cloth material	Insulation Varnish	No specific thickness
SCREWS	Carbon steel wire rods	High corrosion resistance treatment	≥0.28 mils

2.04 OUTDOOR/CONDENSING UNIT

A. GENERAL:

1. The condensing unit is designed specifically for use with VRV series components.

2. The condensing unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls.
 3. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant accumulator.
 4. Liquid and suction lines must be individually insulated between the condensing and indoor units.
 5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
 6. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.
 7. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.
 8. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.
 9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
 10. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
 11. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 12. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
 13. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
 14. The condensing unit shall be capable of heating operation at -4°F (-20°C) wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
- B. UNIT CABINET:
1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.

C. FAN:

1. The condensing unit shall consist of one or more propeller type, direct-drive 500 or 600 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Reference table below.

MODEL NUMBER	FAN MOTOR OUTPUT (W) & QUANTITY
RXYQ96XAYD*	600 x 2
RXYQ120XAYD*	600 x 2

2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 22,283 CFM dependent on model specified.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. SOUND:

1. Nominal sound pressure levels shall be as shown below.

MODEL NUMBER	SOUND PRESSURE LEVEL dB(A)
RXYQ96XAYD*	61
RXYQ120XAYD*	61

2. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

OPERATION SOUND dB(A)	NIGHT MODE SOUND PRESSURE LEVEL dB(A) APPROX.
Level 1	55
Level 2	50
Level 3	45

E. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM test standards.
5. The condensing unit shall be factory equipped with condenser coil guards on all sides.

F. COMPRESSOR:

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
 - a. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.
 - 1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type”.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type.
 - a. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 10% to 100%.
5. The compressor’s motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
9. In the event of compressor failure, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manually activated to specifically address this condition for single module and manifolded systems.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

11. Compressor configurations:

MODEL NUMBER	COMPRESSOR MOTOR OUTPUT (W)	QUANTITY	COMPRESSOR TYPES
RXYQ96XAYD*	4,100	1	Inverter controlled
RXYQ120XAYD*	5,200	1	Inverter controlled

2.05 INDOOR/EVAPOTATOR UNITS

A. FAN COIL TYPE AND ARRANGEMENT

A. The vertical blower coil shall be furnished as a draw-through style DX air handler.

B. GENERAL CONSTRUCTION

A. The blower coil shall be furnished as a draw-through style DX air handler.

B. The blower coil unit shall include a blower, fan housing, coil, and drain-pan enclosed within and mounted to a rigid cabinet. Steel parts exposed to moisture shall be galvanized and insulated to prevent condensation. The complete fan assembly shall be wired via quick connect electrical contacts and easily removable for service and maintenance

C. Unit will be supplied with 1-inch, double-wall panels. The cabinet is to be thermally isolated through injected foam insulation inside each cabinet. Single wall cabinets with fiberglass insulation exposed in the airstream are not acceptable. Frame channels which allow heat conductance between the inside and outside of the cabinet are not acceptable. Base rails used for unit mounting/hanging are acceptable. Panel shall have a minimum thermal insulation of R6. Foam injected insulation conforms to: a. a. ASTM C1071 (including C665)b. b. UL 181 for erosionc. c. 25/50 rating for flame spread/smoke developed per ASTM E-84, UL 723 and NFPA 90A

C. SUPPLY FAN

A. Supply fans shall be a DWDI forward-curved type. Fan assemblies shall be balance tested dynamically by the manufacturer. Manufacturer must ensure maximum fan RPM is below the first critical speed.

B. The complete fan assembly, including motor and main drain pan shall be easily removable.

C. Fan motor(s) assembly shall be direct-drive style and not include belts, pulleys, or sheaves.

D. Fan motor(s) shall be of Direct Current Brushless type of minimum motor efficiency of 85 percent when rated in accordance of NEMA Standard MG 1-2016 at full load conditions.

E. Manufacturer's supply fan motor must have means to adjust motor speed for field balancing.

F. Units shall be certified in accordance with the Central Station Air Handler certification program that is based on AHRI Standard 430.

G. Supply fan must be capable of delivering 1.5" w.g. external static pressure and 3.0" w.g. total static pressure at nominal cabinet CFM

D. ELECTRICAL

A. Supply fans shall be driven by Electrically Commutated motors that are run-tested in the assembled unit and permanently lubricated. All motors shall have integral thermal overload protection with a maximum ambient operating temperature of 55°C. Motors shall be capable operating at 90 percent of rated voltage on all speed settings. Motors can operate up to 10 percent overvoltage.

B. Motor wires shall include a quick-disconnect motor plug.

C. All controls equipment including ECM control module, low voltage transformers, safety switches, disconnects, fusing, and terminal strips must be located inside the main unit cabinet.

E. COOLING AND HEATING

A. Cooling/Heat Pump Coils

1. Cooling performance shall be as specified on the unit schedule.
2. All steel parts exposed to moisture shall be galvanized.
3. Unit shall include a stainless steel primary and secondary drain pan. The primary drain pan to be positively sloped in every plane. Primary and secondary drain pans to be insulated with anti-microbial closed-cell insulation. The drain pan shall be designed to ensure no pooling of condensate water per ASHRAE 62.2.

B. Aux Electric Heat

1. Aux electric heaters shall be SCR controlled.

F. FILTERS

- A. Filters shall be arranged in a flat manner.
- B. Filters shall be 2" in depth.
- C. Filter shall be of disposable type with a minimum arrestance of greater than 90% and rating of MERV 8.
- D. Filters shall be easily accessible through a door located on the side of the unit.

G. CONTROLS

- A. Unit shall be supplied with a microprocessor controller with BACnet interface. Unit shall control to a leaving air temperature.
- B. Unit shall be furnished with a disconnect switch and inline fusing to protect vital electrical components. The disconnect switch shall be operable from the outside of the cabinet to reduce hazards during field service and commissioning.

2.08 DCM601A71: intelligent Touch Manager (iTM)

- A. Refer to Section 23 81 30 Variable Refrigerant Volume Control System FOR Additional Control systems for Variable Refrigerant Volume Systems.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The VRF system shall be installed by a licensed mechanical contractor trained by the VRF equipment manufacturer.
- B. Commissioning shall be performed by the manufacturer as to ensure all aspects of the systems are being installed per manufacturer recommended installation guidelines. Provide inspection & report at all milestone construction periods prior to closing up work.

PART 4 HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)

4.1 The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package.

- a) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.
- b) The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.

- c) The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.
 - d) All equipment must have visible and permanent label clearly identifying the original manufacturer of the equipment. These labels shall have original manufacturer's name and contact information and be located both inside and outside the equipment and on all equipment-related literature. Submittals shall include the above statement as confirmation by supplier that all conditions are agreed to and complied to. Failure to comply with these requirements shall be sufficient cause for rejection of the submittal and product with no further consideration.
- 2) The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation.
- a) The drawing format shall be .dxf or equivalent, on 30"x42" sheets.
 - b) The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings.
 - c) The alternate equipment supplier shall prepare the following drawings:
 - i) XXX HVAC Floor Plan
 - ii) XXX HVAC Refrigerant Piping Plan
 - iii) XXX HVAC Refrigerant Piping/Controls Details
 - iv) XXX HVAC Details
 - v) XXX HVAC Schedules
 - d) The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.
 - e) Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.
 - f) The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.
- 3) The equipment supplier shall submit, as part of the equipment data package, condensing unit data sheets. Data sheets to include the following:
- a) COOLING capacities at project design conditions:
 - i) Cooling (Btu/h)
 - ii) Cooling Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
 - iii) Part Load IEER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - iv) SCHE
 - v) Full Load EER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed

- b) HEATING capacities at project design conditions:
 - i) Heating (Btu/h)
 - ii) Heating Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
 - iii) Full Load COP @ 47°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - iv) Full Load COP @ 17°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
- c) The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.
 - i) OPERATING TEMPERATURE RANGE:
 - (1) Cooling
 - (2) Heating
 - ii) POWER SUPPLY:
 - (1) Maximum Circuit Amps (MCA)
 - (2) Maximum Overcurrent Protection Amps (MOP)
 - (3) Maximum Starting Current (MSC)
 - (4) Condenser Fan Motor
 - iii) REFRIGERANT:
 - (1) Refrigerant type and charge details including field charge for piping to ensure code compliance.
 - (2) Control of refrigerant temperature based on weather and load or alternative function.
 - iv) UNIT DATA:
 - (1) Max. number of indoor units
 - (2) Sound pressure level at 3ft (dBA)
 - (3) Weight (lbs)
 - (4) Dimensions
 - (5) Demand limit function description
 - (6) Details on sequential start functionality
 - (7) Coil anticorrosion data
- 4) The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.
 - a) Room Temperature (Cooling)
 - b) Room Temperature (Heating)
 - c) Ambient Temperature (Summer)
 - d) Ambient Temperature (Winter)
 - e) Defrost De-rate Factor
 - f) Refrigerant Piping Loss
- 5) The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:

- a) Capacities at project design conditions:
 - i) Cooling (Btu/h)
 - ii) Cooling Input Power (kW)
 - iii) Part Load IEER
 - iv) SCHE
 - v) Full Load EER
 - vi) Heating (Btu/h)
 - vii) Heating Input Power (kW)
 - viii) Full Load COP@47°F
 - ix) Full Load COP@17°F
 - x) Air Flow (CFM)
- b) External Static Pressure (ESP)
- c) Electrical Data (MAC, MOP, MSC, RLA)
- d) Weight (lbs)
- e) Dimensions
- 6) The equipment supplier shall provide a certificate which states that the equipment has a minimum salt spray resistance of 1000 hours.
- 7) The equipment supplier shall submit the warranty certificate to the mechanical contractor.

END OF SECTION

12-10-25

SECTION 23 81 29 - VARIABLE REFRIGERANT VOLUME HVAC SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable refrigerant volume HVAC system includes:

1. Outdoor/Condensing unit(s):
 - a. Size Range: 6 to 38 Tons Nominal

1.02 RELATED REQUIREMENTS

A. N/A

1.03 REFERENCES

A. N/A

1.04 SUBMITTALS

A. N/A

1.05 QUALITY ASSURANCE

A. MANUFACTURER QUALIFICATIONS:

1. The units shall be tested by a National Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.
2. All wiring shall be in accordance with the National Electric Code (NEC).
3. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
4. The condensing unit will be factory charged with R410A.

1.06 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

1.07 WARRANTY

A. STANDARD LIMITED WARRANTY

1. Complete warranty details available from your local Daikin representative or at www.daikincomfort.com.
2. Daikin North America LLC warrants original owner of the non-residential building, multifamily residence or residence in which the Daikin products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty applies to compressor and all parts and is limited in duration to ten (10) years starting from the "installation date" which is one of the two dates below:
 - a. The installation date is the date that the unit is originally commissioned, but no later than 18 months after the manufacture date noted on the unit's rating plate.
 - b. If the date the unit is originally commissioned cannot be verified, the installation date is three months after the manufacture date.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. DESIGN BASIS:

1. The HVAC equipment basis of design is Daikin North America. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Appendix A HVAC Equipment Alternate General Information). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

2.02 HVAC SYSTEM DESIGN

A. SYSTEM DESCRIPTION:

1. The variable capacity heat pump air conditioning system shall be a Daikin Variable Refrigerant Volume Series (heat or cool model) system as specified.
2. The system shall consist of multiple evaporators using PID control, REFNET™ joints and headers, a two-pipe refrigeration distribution system and Daikin VRV® condenser unit.
3. The condenser shall be a direct expansion (DX), air-cooled heat pump, multi-zone air-conditioning system with variable speed inverter driven compressors using R-410A refrigerant.
4. The condensing unit may connect an indoor evaporator capacity up to 200% of the condensing unit capacity. All zones are each capable of operating separately with individual temperature control.
5. The Daikin condensing unit shall be interconnected to indoor unit models CXTQ, FXFQ, FXHQ, FXUQ, FXEQ, FXMQ, FXLQ, FXNQ, FXSQ, FXTQ, FXDQ, FXZQ, FXAQ and FXMQ_MF, and shall range in capacity from 5,800 Btu/h to 96,000 Btu/h in accordance with Daikin's engineering data book detailing each available indoor unit.
 - a. The indoor units shall be connected to the condensing unit utilizing Daikin's REFNET™ specified piping joints and headers to ensure correct refrigerant flow and balancing. T style joints are not acceptable for a variable refrigerant system.
6. Operation of the system shall permit either cooling or heating of all of the indoor units simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a local remote controller, an Intelligent Manager, an Intelligent Controller or a BMS interface.
7. The RXYQ_XA condensing unit model numbers and the associated number of connectable indoor units per RXYQ_XA condensing unit is indicated in the following table. Each indoor unit or group of indoor units shall be independently controlled.

MODEL NUMBER	NOMINAL CAPACITY (Tons)	MAXIMUM NUMBER OF INDOOR UNITS
RXYQ72XAYD*	6	12
RXYQ96XAYD*	8	16
RXYQ120XAYD*	10	20
RXYQ144XAYD*	12	25
RXYQ168XAYD*	14	29
RXYQ192XAYD*	16	33
RXYQ216XAYD*	18	37
RXYQ240XAYD*	20	41
RXYQ264XAYD*	22	45
RXYQ288XAYD*	24	49
RXYQ312XAYD*	26	54
RXYQ336XAYD*	28	58
RXYQ360XAYD*	30	62
RXYQ384XAYD*	32	64
RXYQ408XAYD*	34	64

B. VRV IV X FEATURES AND BENEFITS

1. Voltage Platform - Heat pump condensing units shall be available with a 460V/3ph/60Hz power supply.

2. Gas Furnace Connectivity – Heat Pump condensing units shall be connectable to Daikin Communicating gas furnaces with AFUE ranging from 80% to 97%.
3. System shall be capable of connecting to multiple VRV A-coils (CXTQ) paired with Daikin Communicating gas furnaces allowing for options of gas or heat pump heating to optimize operational costs.
4. The system shall be able to switch between heat pump heating and gas furnace heating at a field selectable change-over temperature which can be configured via condensing unit field settings.
5. Each system shall be able to enlarge from single to dual module or dual to triple module without the need for installed main pipe size changes. The manufacturer shall provide predefined pipe sizes and design rules ensuring reliable system operation and offering design flexibility in phased installation applications.
6. Stable Operation – System shall provide stable inverter operation at varied ambient conditions.
7. Auto Changeover – System shall, below the field selected outdoor ambient temperature provide signal to initiate auxiliary or back up heat.
8. Advanced Zoning - A single system shall provide for up to 64 zones.
9. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.
10. VFD Inverter Control and Variable Refrigerant Temperature - Each condensing unit shall use high efficiency, variable speed all “inverter” compressor(s) coupled with inverter fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions.
 - a. Indoor shall use PID to control superheat to deliver a comfortable room temperature condition and optimize efficiency.
11. Configurator software - Each system shall be available with configurator software package to allow for remote configuration of operational settings and also for assessment of operational data and error codes.
 - a. If this software is not provided by an alternate manufacturer, for each individual outdoor unit the contractor shall do the settings manually and keep detailed records for future maintenance purposes.
12. Independent Control - Each indoor unit shall use a dedicated electronic expansion valve for independent control.
13. Flexible Design –
 - a. Systems shall be capable of up to 540ft (165m) [623 ft. (190m) equivalent] of linear piping between the condensing unit and furthest located indoor unit.
 - b. Systems shall be capable of up to 3,280ft (1,000m) total “one-way” piping in the piping network.
 - c. Systems shall have a vertical (height) separation of up to 295ft (90m) between the condensing unit and the indoor units.
 - d. Systems shall be capable of up to 295ft from the first REFNET™ / branch point.
 - e. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 200% of the condensing unit nominal capacity.
 - f. Systems shall be capable of 98ft (30m) vertical separation between indoor units.

- g. Condensing units shall be supported with a fan motor ESP up to 0.32" WG as standard to allow connection of discharge ductwork and to prevent discharge air short circuiting.
- 14. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
- 15. Simple wiring – Systems shall use 16/18 AWG, 2 wire, stranded, non-shielded and non-polarized daisy chain control wiring.
- 16. Outside Air – Systems shall provide outside air capability.
- 17. Space saving – Each system shall have a condensing unit module footprint no larger than 48-7/8" x 30-3/16" (1694mm x 1242mm x 767mm).
- 18. Each condensing unit shall include a multi-functional digital display that can provide system operation status such as operating refrigerant temperatures, pressures, outdoor electronic expansion valve opening and compressor operation time.
- 19. Each condensing unit shall include a service window that can provide easy access to system field settings and operation status without completely removing the condensing unit panel.
- 20. Advanced diagnostics – Systems shall include a self-diagnostic, auto-check function to detect a malfunction and display the type and location.
- 21. Each condensing unit shall incorporate contacts for electrical demand shedding with optional 3 stage demand control with 12 customizable demand settings.
- 22. Advanced controls – Each system shall have at least one remote controller capable of controlling up to 16 indoor units.
- 23. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
- 24. Low sound levels - Each system shall use indoor and condensing units with quiet operation as low as 27 dB(A).
- 25. The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.

C. PERFORMANCE:

- 1. The VRV IV X RXYQ_XA system shall perform as indicated below:

MODEL NUMBER	SYSTEM IEER (Ducted)	SYSTEM IEER (Non-Ducted)
RXYQ72XAYD*	20.7	25.9
RXYQ96XAYD*	22.5	27.3
RXYQ120XAYD*	22.0	25.4
RXYQ144XAYD*	22.6	24.8
RXYQ168XAYD*	19.8	22.6
RXYQ192XAYD*	21.2	22.2
RXYQ216XAYD*	21.1	20.5
RXYQ240XAYD*	20.9	20.8
RXYQ264XAYD*	19.6	20.3
RXYQ288XAYD*	19.6	20.1
RXYQ312XAYD*	18.8	19.9
RXYQ336XAYD*	18.5	20.6
RXYQ360XAYD*	18.5	19.4
RXYQ384XAYD*	18.5	21.1
RXYQ408XAYD*	19.0	21.1

MODEL NUMBER	SYSTEM EER (Ducted)	SYSTEM EER (Non-Ducted)
RXYQ72XAYD*	12.7	14.8
RXYQ96XAYD*	12.6	14.3
RXYQ120XAYD*	11.6	12.4
RXYQ144XAYD*	11.5	12.3
RXYQ168XAYD*	10.6	10.6
RXYQ192XAYD*	11.6	11.5
RXYQ216XAYD*	10.9	10.7
RXYQ240XAYD*	11.2	11.3
RXYQ264XAYD*	9.9	10.8
RXYQ288XAYD*	10.1	10.5
RXYQ312XAYD*	9.6	9.8
RXYQ336XAYD*	9.5	9.5
RXYQ360XAYD*	9.8	10.3
RXYQ384XAYD*	9.5	9.5
RXYQ408XAYD*	9.5	9.5

MODEL NUMBER	SYSTEM COP@47°F (Ducted)	SYSTEM COP@47°F (Non-Ducted)
RXYQ72XAYD*	3.30	3.89
RXYQ96XAYD*	3.49	4.21
RXYQ120XAYD*	3.30	3.56
RXYQ144XAYD*	3.34	3.67
RXYQ168XAYD*	3.20	3.41
RXYQ192XAYD*	3.29	3.68
RXYQ216XAYD*	3.50	3.83
RXYQ240XAYD*	3.33	3.63
RXYQ264XAYD*	3.27	3.33
RXYQ288XAYD*	3.30	3.25
RXYQ312XAYD*	3.21	3.30
RXYQ336XAYD*	3.20	3.22
RXYQ360XAYD*	3.20	3.46
RXYQ384XAYD*	3.20	3.30
RXYQ408XAYD*	3.20	3.24

MODEL NUMBER	SYSTEM COP@17°F (Ducted)	SYSTEM COP@17°F (Non-Ducted)
RXYQ72XAYD*	2.25	2.50
RXYQ96XAYD*	2.50	2.70
RXYQ120XAYD*	2.40	2.30
RXYQ144XAYD*	2.20	2.30
RXYQ168XAYD*	2.30	2.30
RXYQ192XAYD*	2.20	2.30
RXYQ216XAYD*	2.50	2.60
RXYQ240XAYD*	2.30	2.40
RXYQ264XAYD*	2.30	2.40
RXYQ288XAYD*	2.10	2.10
RXYQ312XAYD*	2.20	2.30
RXYQ336XAYD*	2.30	2.40
RXYQ360XAYD*	2.40	2.50
RXYQ384XAYD*	2.30	2.30
RXYQ408XAYD*	2.10	2.20

2. Performance Conditions:

- Cooling: Indoor temperature of 80°FDB (26.7°CDB), 67°FWB (19.5°CWB) and outdoor temperature of 95°FDB (35°CDB).
- Heating: Indoor temperature of 70°FDB (21.1°CDB) and outdoor temperature of 47°FDB (8.3°CDB), 43°FWB (6.1°CDB).
- Equivalent piping length: 25ft (7.5m)

3. Cooling Operation:

- The operating range in cooling will be 23°F DB ~ 122°F DB (-5°CDB ~ 50°CDB).
- Cooling mode indoor room temperature range will be 57-77°FWB (13.8 - 25°CWB).
- Cooling operation may be extended down to 10°F DB when the system is designed with the following limitations:
 - The system must be a single module outdoor unit: RXYQ72/96/120/144/168XA.
 - The smallest capacity indoor unit connected to the system must be 12,000 Btu/h.
 - The system must run continuously in cooling operation with a minimum of 1.5 tons of indoor units in operation.

4. Heating Operation:

- The operating range in heating will be -4°F WB – 60°F WB (-20°CWB – 15.5°CWB).
- Heating mode indoor room temperature range will be 59°FDB - 80°F DB (15°CDB – 26.7°CDB).

2.03 EQUIPMENT

A. ELECTRICAL:

1. The power supply to the condensing unit shall be:

POWER SUPPLY VOLTAGE	VOLTAGE RANGE
460V / 3ph / 60 Hz	187V – 253V (±10%)

MODEL	MCA	MOP	COMPRESSOR RLA
RXYQ72XAYD*	12.3	20	7.1
RXYQ96XAYD*	20.6	25	10.2
RXYQ120XAYD*	20.6	25	11.7
RXYQ144XAYD*	25.9	35	7.6 + 7.6
RXYQ168XAYD*	25.9	35	8.5 + 8.5
RXYQ192XAYD*	12.3 + 20.6	20 + 25	7.1 + 11.7
RXYQ216XAYD*	20.6 + 20.6	25 + 25	10.2 + 11.7
RXYQ240XAYD*	20.6 + 20.6	25 + 25	11.7 + 11.7
RXYQ264XAYD*	20.6 + 25.9	25 + 35	11.7 + (7.6 + 7.6)
RXYQ288XAYD*	25.9 + 25.9	35 + 35	(7.6 + 7.6) x 2
RXYQ312XAYD*	25.9 + 25.9	35 + 35	(7.6 + 7.6) + (8.5 + 8.5)
RXYQ336XAYD*	25.9 + 25.9	35 + 35	(8.5 + 8.5) x 2
RXYQ360XAYD*	20.6 + 20.6 + 20.6	25 + 25 + 25	11.7 + 11.7 + 11.7
RXYQ384XAYD*	20.6 + 20.6 + 25.9	25 + 25 + 35	10.2 + 11.7 + (8.5 + 8.5)
RXYQ408XAYD*	20.6 + 25.9 + 25.9	25 + 35 + 35	10.2 + (7.6 + 7.6) + (8.5 + 8.5)

B. WIRING:

1. The control voltage between the indoor and condensing unit shall be 16VDC non-shielded, stranded 2 conductor cable.
2. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one condensing unit with one 2-cable wire, thus simplifying the wiring installation.
3. The control wiring maximum lengths shall be as shown below:

	CONDENSER TO INDOOR UNIT	CONDENSER TO CENTRAL CONTROLLER	INDOOR UNIT TO REMOTE CONTROL
CONTROL WIRING LENGTH	6,560 ft (2,000 m)	3,280 ft (1,000 m)	1,640 ft (500 m)
WIRE TYPE	16/18 AWG, 2 wire, non-polarity, non-shielded, stranded		

C. REFRIGERANT PIPING:

1. The system shall be capable of refrigerant piping up to 540ft (165m) actual or 623ft (190m) equivalent from the condensing unit to the furthest indoor unit, a total combined liquid line length of 3,280ft (1,000m) of piping between the condensing and indoor units with 295ft (90m) maximum vertical difference, without any oil traps or additional components.
2. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance.

- a. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

D. PAINT/CORROSION RESISTANCE:

1. Paint and corrosion resistance shall be at a minimum per the table below:

COMPONENT	VRV IV X		
	BASE MATERIAL	SURFACE TREATMENT	COATING THICKNESS
			External & Internal Surface
EXTERNAL PANEL BASE	Galvanized steel	POLYESTER	≥1.5 mils
EXTERNAL FRONT PANEL	Galvanized steel	POLYESTER	≥1.5 mils
PILLAR	Galvanized steel	POLYESTER	≥1.5 mils
COMPRESSOR COVER	ASTM material	Resin Paint	≥0.78 mils
FIN GUARD	Iron wire	Resin Paint	≥0.79 mils
FAN GUARD AND DRUM	Polypropylene	No treatment required	N/A
FAN	Acrylonitrile - glass	No treatment required	N/A
FAN MOTOR FRAME	Resin	No treatment required	N/A
FAN MOTOR SHAFT	Carbon steel	No treatment required	N/A
FAN MOTOR SUPPORT	Galvanized steel	POLYESTER	≥1.5 mils
HEAT EXCHANGERS (FIN ONLY)	Aluminum	Polymer Anti-corrosion surface treatment	Salt Spray 1000 hours, blister rating 10
ELECTRICAL PARTS BOX	Hot-dip zinc-coated steel	No treatment required	N/A
ELECTRICAL PARTS BOARD	Glass cloth / Glass nonwoven cloth material	Insulation Varnish	No specific thickness
SCREWS	Carbon steel wire rods	High corrosion resistance treatment	≥0.28 mils

2.04 OUTDOOR/CONDENSING UNIT

A. GENERAL:

1. The condensing unit is designed specifically for use with VRV series components.
2. The condensing unit shall be factory assembled in the USA and pre-wired with all necessary electronic and refrigerant controls.
3. The refrigeration circuit of the condensing unit shall consist of Daikin inverter scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant accumulator.

4. Liquid and suction lines must be individually insulated between the condensing and indoor units.
 5. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
 6. The connection ratio of indoor units to condensing unit shall be permitted up to 200% of nominal capacity.
 7. Each condensing system shall be able to support the connection of up to 64 indoor units dependent on the model of the condensing unit.
 8. The sound pressure level standard shall be that value as listed in the Daikin engineering manual for the specified models at 3 feet from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input.
 9. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
 10. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
 11. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 12. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
 13. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.
 14. The condensing unit shall be capable of heating operation at -4°F (-20°C) wet bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
- B. UNIT CABINET:
1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed galvanized steel panels coated with a baked enamel finish.

C. FAN:

1. The condensing unit shall consist of one or more propeller type, direct-drive 500 or 600 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter. Reference table below.

MODEL NUMBER	FAN MOTOR OUTPUT (W) & QUANTITY
RXYQ72XAYD*	500 x 1
RXYQ96XAYD*	600 x 2
RXYQ120XAYD*	600 x 2
RXYQ144XAYD*	600 x 2
RXYQ168XAYD*	600 x 2
RXYQ192XAYD*	(500 x 1) + (600 x 1)
RXYQ216XAYD*	(600 x 2) + (600 x 2)
RXYQ240XAYD*	(600 x 2) + (600 x 2)
RXYQ264XAYD*	(600 x 2) + (600 x 2)
RXYQ288XAYD*	(600 x 2) + (600 x 2)
RXYQ312XAYD*	(600 x 2) + (600 x 2)
RXYQ336XAYD*	(600 x 2) + (600 x 2)
RXYQ360XAYD*	(600 x 2) + (600 x 2) + (600 x 2)
RXYQ384XAYD*	(600 x 2) + (600 x 2) + (600 x 2)
RXYQ408XAYD*	(600 x 2) + (600 x 2) + (600 x 2)

2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
3. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 5,544 CFM to 22,283 CFM dependent on model specified.
4. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.

D. SOUND:

1. Nominal sound pressure levels shall be as shown below.

MODEL NUMBER	SOUND PRESSURE LEVEL dB(A)
RXYQ72XAYD*	58
RXYQ96XAYD*	61
RXYQ120XAYD*	61
RXYQ144XAYD*	64
RXYQ168XAYD*	65
RXYQ192XAYD*	63
RXYQ216XAYD*	64
RXYQ240XAYD*	64
RXYQ264XAYD*	66
RXYQ288XAYD*	67
RXYQ312XAYD*	68
RXYQ336XAYD*	68
RXYQ360XAYD*	68
RXYQ384XAYD*	68
RXYQ408XAYD*	68

2. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps.

OPERATION SOUND dB(A)	NIGHT MODE SOUND PRESSURE LEVEL dB(A) APPROX.
Level 1	55
Level 2	50
Level 3	45

E. CONDENSER COIL:

1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
3. The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tube with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design.
4. The fins shall be coated with an anti-corrosion hydrophilic blue coating as standard from factory with a salt spray test rating of 1000hr per ASTM test standards.
5. The condensing unit shall be factory equipped with condenser coil guards on all sides.

F. COMPRESSOR:

1. The Daikin inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
 - a. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.
 - 1) Non –inverter-driven compressors, which may cause starting motor current to exceed the nominal motor current (RLA) and require larger wire sizing, shall not be allowed.
2. The inverter driven compressors in the condensing unit shall be of highly efficient reluctance DC (digitally commutating), hermetically sealed scroll “G-type” or “J-type”.
3. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type.
 - a. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
4. The capacity control range shall be as low as 10% to 100%.
5. The compressor’s motor shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
6. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
7. Oil separators shall be standard with the equipment together with an intelligent oil management system.
8. The compressor shall be mounted on vibration dampening rubber grommets to minimize the transmission of vibration, eliminating the standard need for external spring isolation.
9. In the event of compressor failure, the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be manually activated to specifically address this condition for single module and manifolded systems.
10. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours. When connected to a central control system sequential start is activated for all system on each DIII network.

11. Compressor configurations:

MODEL NUMBER	COMPRESSOR MOTOR OUTPUT (W)	QUANTITY	COMPRESSOR TYPES
RXYQ72XAYD*	3,400	1	Inverter controlled
RXYQ96XAYD*	4,100	1	Inverter controlled
RXYQ120XAYD*	5,200	1	Inverter controlled
RXYQ144XAYD*	2,900 + 3,300	2	All inverter controlled
RXYQ168XAYD*	3,600 + 3,700	2	All inverter controlled
RXYQ192XAYD*	3,400 + 5,200	2	All inverter controlled
RXYQ216XAYD*	4,100 + 5,200	2	All inverter controlled
RXYQ240XAYD*	5,200 + 5,200	2	All inverter controlled
RXYQ264XAYD*	5,200 + (2,900 + 3,300)	3	All inverter controlled
RXYQ288XAYD*	(2,900 + 3,300) + (2,900 + 3,300)	4	All inverter controlled
RXYQ312XAYD*	(2,900 + 3,300) + (3,600 + 3,700)	4	All inverter controlled
RXYQ336XAYD*	(3,600 + 3,700) + (3,600 + 3,700)	4	All inverter controlled
RXYQ360XAYD*	5,200 + 5,200 + 5,200	3	All inverter controlled
RXYQ384XAYD*	4,100 + 5,200 + (3,600 + 3,700)	4	All inverter controlled
RXYQ408XAYD*	4,100 + (2,900 + 3,300) + (3,600 + 3,700)	5	All inverter controlled

2.05 FXZQ-TAVJU –VISTA™ 2x2 CASSETTE UNIT

- A. General: Daikin indoor unit model FXZQ-TAVJU shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with a decoration panel grille. It shall be available in capacities from 5,800 Btu/h to 18,000 Btu/h. Model numbers are FXZQ05TAVJU, FXZQ07TAVJU, FXZQ09TAVJU, FXZQ12TAVJU, FXZQ15TAVJU, FXZQ18TAVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ / RWEQ heat pump and REYQ / RELQ / RWEYQ / RWEQ heat recovery model. The decoration panel shall be a four-way air distribution type, with fresh white (Munsell N9.5) or Daikin Silver color, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote controls. The indoor units sound pressure shall range from 25.5 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.
- B. Performance: Each unit's performance is based on nominal operating conditions:

Model Number	Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	Heating (Indoor 70°F DB / 60°F WB, Outdoor 47°F DB, 25 ft pipe length)
FXZQ05TAVJU	5,800	6,500
FXZQ07TAVJU	7,500	8,500
FXZQ09TAVJU	9,500	10,500
FXZQ12TAVJU	12,000	13,500
FXZQ15TAVJU	15,000	17,000
FXZQ18TAVJU	18,000	20,000

C. Indoor Unit:

1. The Daikin indoor unit FXZQ-TAVJU shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be fully insulated from the outdoor unit or nearest branch connection into the refrigerant network.
4. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
5. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
6. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 24-13/16" of lift, measured from the drain outlet, and has a built in safety shutoff and alarm.
7. The indoor units shall be equipped with a return air thermistor.
8. The indoor unit will be powered with 208~230V/1-phase/60Hz.
9. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose from via field setting.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Decoration Panel:

The FXZQ-TAVJU series shall be compatible with three optional decoration panels:

1. VISTA Decoration panel – white (BYFQ60C3W1W).
 - i. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
 - ii. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
 - iii. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
 - iv. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
 - v. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.
 - vi. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2W.
 - vii. The decoration panel color shall be fresh white (Munsell N9.5).
2. VISTA Decoration panel – silver and white (BYFQ60C3W1S).
 - i. The decoration panel shall be a four-way air distribution type and constructed of impact resistant polymer.
 - ii. The decoration panel dimensions shall measure 24-7/16" x 24-7/16" and shall fit into a standard 2x2 ceiling grid with no overlap of adjacent tiles.
 - iii. The four air discharge outlet louvers shall be independently motorized and controllable. Each louver shall have a visual indicator to easily identify the louver and simplify the airflow configuration.
 - iv. The louver outlets shall be capable of closure to allow for 3-way and 2-way air distribution.
 - v. The decoration panel shall be a low profile design, extending 5/16" below the ceiling.
 - vi. The decoration panel shall be compatible with the optional space and presence sensor kit, model BRYQ60A2S.
 - vii. The decoration panel color shall be fresh white (Munsell N9.5) and a specialty Daikin Silver color.
3. Legacy FXZQ-MVJU9 decoration panel (BYFQ60B3W1).
 - i. The FXZQ-TAVJU cassette body shall be compatible with the legacy 2x2 decoration panel BYFQ60B3W1.
- F. Optional Space and Presence sensor kit:
 1. The space and presence sensor shall be color matched to the decoration panel.
 2. The sensor kit shall be capable of sensing occupancy within the space and automatically controlling the indoor unit set point in response to the detection of occupancy.
 3. The sensor kit shall be capable of automatically adjusting the direction of individual air discharge outlet louvers in response to the detection of occupants in the vicinity of the unit.
 4. The sensor kit shall be capable of automatically adjusting the direction of individual air discharge outlet louvers in response to the sensed floor temperature.
- G. Fan:
 1. The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low.
 2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 50W.
 3. The airflow rate shall be available in high, medium, and low settings.
 4. When FXZQ-TAVJU is connected with either the BRC1E73 Navigation Remote Controller or the DCM601A71 I-Touch Manager, the Auto fan mode shall be selectable.

H. Filter:

1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

I. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 22 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 24-13/16" lift, measured from the drain outlet, shall be located below the coil in the condensate pan with a built in safety alarm.
7. A thermistor will be located on the liquid and gas line.

Model Number	Cooling	Heating
	(Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	(Indoor 70°F DB Outdoor 47F / 43F, 25 ft pipe length)

J. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

K. Control:

1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
2. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.06 FXMQ_M – CONCEALED CEILING DUCTED UNIT (Med. Static)

- A. General: Daikin indoor unit FXMQ_M shall be a built-in ceiling concealed fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation into the ceiling cavity. It is constructed of a galvanized steel casing. It shall be available in capacities from 72,000 Btu/h to 96,000 Btu/h. Model numbers are FXMQ72MVJU and FXMQ96MVJU to be connected to outdoor unit model RXYQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. It shall be a horizontal discharge air with horizontal return air configuration. All models feature a low height cabinet making them applicable to ceiling pockets that tend to be shallow. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72, BRC1E73 and BRC2A71. The indoor units sound pressure shall be 48 dB(A) at low speed measured 5 feet below the ducted unit.

- B. Performance: Each unit's performance is based on nominal operating conditions:

FXMQ72MVJU	72,000	96,000
FXMQ96MVJU	96,000	108,000

C. Indoor Unit:

1. The Daikin indoor unit FXMQ_M shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an adjustable external static pressure switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. The indoor units shall be equipped with a return air thermistor.
5. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
6. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be located into the ceiling and ducted to the supply and return openings.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Fan:

1. The fan shall be direct-drive Sirocco type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz, with a motor output of 0.51 HP.
3. The airflow rate shall be available in high and low settings.
4. The fan motor shall be thermally protected.
5. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings.
6. Fan motor external static pressure for nominal airflow:

Model Number	Fan ESP (in. WG)
FXMQ72MVJU	0.95 – 0.72
FXMQ96MVJU	0.95 – 0.8

F. Coil:

1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 3 row cross fin copper evaporator coil with 13 fpi design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1-5/16 inch outside diameter PVC.
5. A thermistor will be located on the liquid and gas line.

G. Electrical:

1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
- H. Control:
1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
 2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
 3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.07 FXAQ – WALL MOUNTED UNIT

- A. General: Daikin indoor unit FXAQ shall be a wall mounted fan coil unit, operable with refrigerant R-410A, equipped with an electronic expansion valve, for installation onto a wall within a conditioned space. This compact design with finished white casing shall be available in capacities from 7,500 Btu/h to 24,000 Btu/h. Model numbers are FXAQ07PVJU, FXAQ09PVJU, FXAQ12PVJU, FXAQ18PVJU and FXAQ24PVJU to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E72, BRC1E73 and BRC2A71. A mildew-proof, polystyrene condensate drain pan and resin net mold resistant filter shall be included as standard equipment. The indoor units sound pressure shall range from 31 dB(A) to 41 dB(A) at low speed measured at 3.3 feet below and from the unit.
- B. Performance: Each unit's performance is based on nominal operating conditions:

Model Number	Cooling (Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	Heating (Indoor 70°F DB Outdoor 47F / 43F, 25 ft pipe length)
FXAQ07PVJU	7,500	8,500
FXAQ09PVJU	9,500	10,500
FXAQ12PVJU	12,000	13,500
FXAQ18PVJU	18,000	20,000
FXAQ24PVJU	24,000	26,500

- C. Indoor Unit:
1. The Daikin indoor unit FXAQ shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion

- valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The drain pipe can be fitted to from either left or right sides.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 3. Both refrigerant lines shall be insulated from the outdoor unit.
 4. Return air shall be through a resin net mold resistant filter.
 5. The indoor units shall be equipped with a condensate pan.
 6. The indoor units shall be equipped with a return air thermistor.
 7. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
 8. The voltage range will be 253 volts maximum and 187 volts minimum.
- D. Unit Cabinet:
1. The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
 2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
- E. Fan:
1. The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high and low fan speeds available.
 2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.054 to 0.058 HP.
 3. The airflow rate shall be available in high and low settings.
 4. The fan motor shall be thermally protected.
- F. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 3. The coil shall be a 2-row cross fin copper evaporator coil with 14 fpi design completely factory tested.
 4. The refrigerant connections shall be flare connections and the condensate will be 11/16 inch outside diameter PVC.
 5. A thermistor will be located on the liquid and gas line.
 6. A condensate pan shall be located in the unit.
- G. Electrical:
1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
- H. Control:
1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
 2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
 3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.08 FXTQ_TA – MULTI-POSITION AIR HANDLING UNIT

- A. General: Daikin indoor unit FXTQ_TA shall be a floor mounted vertical, horizontal left, horizontal right, or downflow air handling unit, operable with refrigerant R-410A, equipped with an electronic expansion valve and direct-drive ECM type fan with constant CFM programming, for installation within a conditioned space. When installed in a vertical configuration it shall have top discharge air and bottom return air. When installed in a horizontal right or horizontal left configuration, it shall have a horizontal discharge air and horizontal return air. When installed in a downflow configuration it shall have bottom discharge and top return air. This compact design with pre-painted heavy-gauge steel casing shall be available in capacities from 9,500 Btu/h to 60,000 Btu/h. Model numbers are FXTQ09TAVJUA, FXTQ12TAVJUA, FXTQ18TAVJUA, FXTQ24TAVJUA, FXTQ30TAVJUA, FXTQ36TAVJUA, FXTQ42TAVJUA, FXTQ48TAVJUA, FXTQ54TAVJUA, and FXTQ60TAVJUA to be connected to outdoor unit model RXYQ / RXYMQ / RWEYQ heat pump and REYQ / RWEYQ heat recovery model. The FXTQ_TA series may also
- B. be specified to utilize a factory integral disconnect switch. Model numbers including the factory disconnect are FXTQ09TAVJUD, FXTQ12TAVJUD, FXTQ18TAVJUD, FXTQ24TAVJUD, FXTQ30TAVJUD, FXTQ36TAVJUD, FXTQ42TAVJUD, FXTQ48TAVJUD, FXTQ54TAVJUD, and FXTQ60TAVJUD. A KRCS01-2UA remote temperature sensor kit shall be required for all FXTQ indoor units not utilizing the thermistor in the Daikin remote controller BRC1E73. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature when used with Daikin remote control BRC1E73 and BRC2A71.
- C. Performance: Each unit's performance is based on nominal operating conditions:

Model Number	Cooling	Heating
	(Indoor 80°F DB / 67°F WB, Outdoor 95°F DB, 25 ft pipe length)	(Indoor 70°F DB Outdoor 47F / 43F, 25 ft pipe length)
FXTQ09TAVJUA(D)	9,500	10,500
FXTQ12TAVJUA(D)	12,000	13,500
FXTQ18TAVJUA(D)	18,000	20,000
FXTQ24TAVJUA(D)	24,000	27,000
FXTQ30TAVJUA(D)	30,000	34,000
FXTQ36TAVJUA(D)	36,000	40,000
FXTQ42TAVJUA(D)	42,000	47,500
FXTQ48TAVJUA(D)	48,000	54,000
FXTQ54TAVJUA(D)	54,000	61,000
FXTQ60TAVJUA(D)	60,000	68,000

C. Indoor Unit:

1. The Daikin indoor unit FXTQ_TA components shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, brazed connections, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through an optional or field supplied filter.
5. Condensate draining shall be made via gravity or external condensate pump.
6. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:

1. The cabinet shall be constructed with sound absorbing, foil-faced insulation to control air leakage.
2. Select an installation location with adequate structural support, space for service access and clearance for air return and supply duct connections.
3. A field supplied secondary drain pan shall be installed where required by national, state, or local code.

E. Fan:

1. The fan shall be a direct-drive Sirocco type fan, statically and dynamically balanced impeller with high and low fan speeds available.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range 0.2 to 1.0. HP.
3. The airflow rate shall be available in high setting.
4. The fan motor shall be thermally protected.
5. Fan motor external static pressure for nominal airflow:

Model Number	Fan ESP (in. WG)
FXTQ09TAVJUA(D)	Up to 0.9
FXTQ12TAVJUA(D)	Up to 0.9
FXTQ18TAVJUA(D)	Up to 0.9
FXTQ24TAVJUA(D)	Up to 0.9
FXTQ30TAVJUA(D)	Up to 0.9
FXTQ36TAVJUA(D)	Up to 0.9
FXTQ42TAVJUA(D)	Up to 0.9
FXTQ48TAVJUA(D)	Up to 0.9
FXTQ54TAVJUA(D)	Up to 0.9
FXTQ60TAVJUA(D)	Up to 0.9

F. Filter:

1. The return air shall be filtered by means of an optional or field supplied filter.

G. Coil:

1. Coils shall be of the direct expansion type constructed from aluminum tubes expanded into aluminum fins to form a mechanical bond.
 2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 3. The coils shall be a 2- to 4-row cross fin copper evaporator coil with 14 to 16 fpi design completely factory tested.
 4. The refrigerant connections shall be brazed connections and the condensate will be 3/4 inch outside diameter PVC.
 5. A thermistor will be located on the liquid and gas line.
- H. Electrical:
1. A separate power supply will be required of 208/230 volts, 1 phase, 60 hertz. The acceptable voltage range shall be 187 to 253 volts.
 2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.
- I. Control:
1. The unit shall have controls provided by Daikin to perform input functions necessary to operate the system.
 2. The unit shall be compatible with interfacing with a BMS system via optional LonWorks or BACnet gateways.
 3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.
- 2.09 FXSQ_TA – MSP Concealed Ducted Unit (Medium Static)
1. General: Daikin indoor unit FXSQ-TA shall be a built-in ceiling concealed fan coil unit. The unit shall be available in (11) capacities from 5,800 Btu/h to 54,000 Btu/h.
 2. Performance: Each unit's performance is based on nominal operating conditions:

Model Number	Cooling (Btu/h)	Heating (Btu/h)
	(Indoor 80°FDB / 67°FWB, Outdoor 95°FDB, 25 ft pipe length)	(Indoor 70°FDB, Outdoor 47°FDB / 43°FWB, 25 ft pipe length)
FXSQ05TAVJU	5,800	6,500
FXSQ07TAVJU	7,500	8,500
FXSQ09TAVJU	9,500	10,500
FXSQ12TAVJU	12,000	13,500
FXSQ15TAVJU	15,000	16,500
FXSQ18TAVJU	18,000	20,000
FXSQ24TAVJU	24,000	27,000
FXSQ30TAVJU	30,000	34,000
FXSQ36TAVJU	36,000	40,000

FXSQ48TAVJU	48,000	54,000
FXSQ54TAVJU	54,000	60,000

3. Unit Cabinet
 1. The unit cabinet shall be constructed of heavy gauge galvanized steel.
 2. The unit shall be internally insulated and shall be capable of installation in indoor environments up to 80% relative humidity without requiring additional field installed insulation.
 3. The unit shall ship from the factory in a rear-return configuration, and shall be field-convertible to a bottom-return configuration.
 4. The unit shall be equipped with a return air thermistor.
4. Fan Motor
 1. The fan shall be a direct-drive, brushless DC fan motor with (3) user-selectable fan speeds (H, M, L).
 2. The fan motor shall be capable of delivering nominal CFM for the follow ranges:

Model Number	Fan ESP (in. w.g.)
FXSQ05TAVJU	0.12 – 0.60
FXSQ07TAVJU	0.12 – 0.60
FXSQ09TAVJU	0.12 – 0.60
FXSQ12TAVJU	0.12 – 0.60
FXSQ15TAVJU	0.12 – 0.60
FXSQ18TAVJU	0.20 – 0.60
FXSQ24TAVJU	0.20 – 0.60
FXSQ30TAVJU	0.20 – 0.60
FXSQ36TAVJU	0.20 – 0.60
FXSQ48TAVJU	0.20 – 0.60
FXSQ54TAVJU	0.20 – 0.54

3. The unit shall be equipped with internal controls to allow the fan motor to be manually adjusted, via field setting, to deliver nominal airflow CFM at a variety of external static pressures. Models FXSQ05TAVJU through FXSQ15TAVJU shall have (13) available fan curves. Models FXSQ18TAVJU through FXSQ54TAVJU shall have (11) available fan curves.
4. The unit shall be equipped with internal controls to allow the fan to automatically select the operating fan curve to deliver nominal airflow CFM (within +/- 10%) when the connect ductwork has been designed with a total external static within the range

- of the FXSQ_TAVJU. This setting shall be accessible as a setting to be used during startup and commissioning of the system.
5. The fan motor shall be capable of Auto fan speed control when the unit is connected to the BRC1E73 Navigation Remote Control or the DCM601A71 Intelligent Touch Manager centralized control. The Auto fan speed control shall automatically adjust the unit's fan speed in response to the difference between the indoor unit's current set point and the current room temperature measurement. The Auto fan speed control shall utilize (5) fan speeds.
 6. The fan motor shall be thermally protected.
 7. The fan motor shall be internally isolated using rubber grommets to reduce transmission of vibrations to the unit.
5. Fan Blade
1. The fan blade shall be constructed of lightweight polymer.
 2. The fan blade shall be statically and dynamically balanced to minimize vibration.
6. Coil
1. Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 3. The coil shall be 2 or 3 row cross fin copper evaporator coil with 18 fpi design, completely factory tested.
 4. The refrigerant connections shall be flare connections.
 5. Factory mounted thermistors shall be installed on the liquid and gas lines.
7. Condensate Drainage
1. The unit shall be equipped with a condensate drain pan under the coil.
 2. The condensate drain outlet shall be of PVC construction and VP25 (1" ID, 1-1/4" OD).
 3. The unit shall be equipped with a factory-integral condensate pump capable of 25-5/16" lift from the condensate drain outlet. The condensate pump shall be equipped with a float switch to automatically stop unit operation and provide a system error code in the event drain pan water level rises too high.
8. Electrical and Wiring
1. Provide a separate power supply connection of 208/230V, 1 phase, 60 hertz. The allowable voltage range shall be 187 to 253 volts.
 2. Refer to the engineering data book for all other electrical data including MCA, MOCP, and FLA values.
 3. The transmission (control) wiring distance between the indoor unit and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
 4. The transmission (control) wiring between the indoor unit and the remote controller shall be a maximum distance of 1,640 feet.
9. Control
1. The unit shall be controlled with a Daikin remote controller to perform input functions necessary to operate the system.
 2. The unit shall be compatible with interfacing with a building management system (BMS) via optional BACnet or LonWorks gateways.
 3. The unit shall be compatible with a Daikin Intelligent Touch Manager advanced multi-zone controller.

2.08 DCM601A71: intelligent Touch Manager (iTM)

- A. Refer to Section 23 81 30 Variable Refrigerant Volume Control System FOR Additional Control systems for Variable Refrigerant Volume Systems.

PART 3 EXECUTION

3.01 INSTALLATION

- A. The VRF system shall be installed by a licensed mechanical contractor trained by the VRF equipment manufacturer.
- B. Commissioning shall be performed by the manufacturer as to ensure all aspects of the systems are being installed per manufacturer recommended installation guidelines. Provide inspection & report at all milestone construction periods prior to closing up work.

PART 4 HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)

- 4.1 The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package.
 - a) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.
 - b) The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.
 - c) The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.
 - d) All equipment must have visible and permanent label clearly identifying the original manufacturer of the equipment. These labels shall have original manufacturer's name and contact information and be located both inside and outside the equipment and on all equipment-related literature. Submittals shall include the above statement as confirmation by supplier that all conditions are agreed to and complied to. Failure to comply with these requirements shall be sufficient cause for rejection of the submittal and product with no further consideration.
- 2) The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation.
 - a) The drawing format shall be .dxf or equivalent, on 30"x42" sheets.
 - b) The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings.
 - c) The alternate equipment supplier shall prepare the following drawings:
 - i) XXX HVAC Floor Plan
 - ii) XXX HVAC Refrigerant Piping Plan
 - iii) XXX HVAC Refrigerant Piping/Controls Details
 - iv) XXX HVAC Details
 - v) XXX HVAC Schedules
 - d) The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment suppliers system.
 - e) Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.
 - f) The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.
- 3) The equipment supplier shall submit, as part of the equipment data package, condensing unit data sheets. Data sheets to include the following:
 - a) COOLING capacities at project design conditions:

- i) Cooling (Btu/h)
- ii) Cooling Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
- iii) Part Load IEER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
- iv) SCHE
- v) Full Load EER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
- b) HEATING capacities at project design conditions:
 - i) Heating (Btu/h)
 - ii) Heating Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
 - iii) Full Load COP @ 47°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - iv) Full Load COP @ 17°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
- c) The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.
 - i) OPERATING TEMPERATURE RANGE:
 - (1) Cooling
 - (2) Heating
 - ii) POWER SUPPLY:
 - (1) Maximum Circuit Amps (MCA)
 - (2) Maximum Overcurrent Protection Amps (MOP)
 - (3) Maximum Starting Current (MSC)
 - (4) Condenser Fan Motor
 - iii) REFRIGERANT:
 - (1) Refrigerant type and charge details including field charge for piping to ensure code compliance.
 - (2) Control of refrigerant temperature based on weather and load or alternative function.
 - iv) UNIT DATA:
 - (1) Max. number of indoor units
 - (2) Sound pressure level at 3ft (dBA)
 - (3) Weight (lbs)
 - (4) Dimensions

- (5) Demand limit function description
 - (6) Details on sequential start functionality
 - (7) Coil anticorrosion data
- 4) The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.
- a) Room Temperature (Cooling)
 - b) Room Temperature (Heating)
 - c) Ambient Temperature (Summer)
 - d) Ambient Temperature (Winter)
 - e) Defrost De-rate Factor
 - f) Refrigerant Piping Loss
- 5) The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:
- a) Capacities at project design conditions:
 - i) Cooling (Btu/h)
 - ii) Cooling Input Power (kW)
 - iii) Part Load IEER
 - iv) SCHE
 - v) Full Load EER
 - vi) Heating (Btu/h)
 - vii) Heating Input Power (kW)
 - viii) Full Load COP@47°F
 - ix) Full Load COP@17°F
 - x) Air Flow (CFM)
 - b) External Static Pressure (ESP)
 - c) Electrical Data (MAC, MOP, MSC, RLA)
 - d) Weight (lbs)
 - e) Dimensions
- 6) The equipment supplier shall provide a certificate which states that the equipment has a minimum salt spray resistance of 1000 hours.
- 7) The equipment supplier shall submit the warranty certificate to the mechanical contractor.

END OF SECTION

12-10-25

SECTION 23 81 30 - VARIABLE REFRIGERANT VOLUME CONTROL SYSTEM

Part 1 - General

1.01. Physical characteristics

A. General:

The advanced multi-zone controller shall be made from plastic materials with a neutral color. Each control shall have a LCD (Liquid Crystal Display) that shows On/Off, setpoint, room temperature, mode of operation (Cool/Heat/Dry/Fan/Auto), louver position, and fan speed.

1.02. Electrical characteristics

A. General:

The advanced multi-zone controller will require 24 VAC to power the controller. The advanced multi-zone controller shall supply 16 VDC to the communication bus on the F1F2 (out-out) terminal of the outdoor unit. The voltage may rise or fall in relation to the transmission packets that are sent and received.

B. Wiring:

The advanced multi-zone controller communication wiring shall be terminated in a daisy chain design at the outdoor unit, which is then daisy chained to branch selector (Heat Recovery system), then daisy chained to each indoor unit in the system and terminating at the farthest indoor unit. The termination of the wiring shall be non-polar. The remote control wiring shall run from the indoor unit control terminal block to the remote controller connected with that indoor unit.

C. Wiring size:

Wiring shall be non-shielded, 2-conductor sheathed vinyl cord or cable, and 18 AWG stranded copper wire.

1.03. VRV Controls Network

The VRV Controls Network is made up of local remote controllers, multi-zone controllers, advanced multi-zone controllers, and open protocol network devices that transmit information via the communication bus. The VRV Controls Network shall also have the ability to be accessed via a networked PC. The VRV Controls Network supports operation monitoring, scheduling, error e-mail distribution, general user software, tenant billing, maintenance support, and integration with Building Management Systems (BMS) using open protocol via BACnet® interface, Lonworks® interface or Modbus® adapter; all of which blend to provide the optimal control strategy for the best HVAC comfort solution.

Part 2 - Products

2.01. Advanced Multi-zone Controllers

The Daikin AC VRV advanced multi-zone controllers are compatible with all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. The advanced multi-zone controller wiring consist of a non-polar two-wire connection to the outdoor unit. The advanced multi-zone controllers may be wall-mounted and can be adjusted to maintain the optimal operation of up to 64 connected indoor unit groups and 128 indoor units. Set temperatures can be adjusted in increments of 1°F. In the cases where a system or unit error may occur, the VRV controllers will display a two-digit error code and the unit address.

A. DCM601A71: intelligent Touch Manager (iTM) V2.XX.XX

The intelligent Touch Manager (version 2.06) shall provide control for all VRV, SkyAir, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It

shall be capable of controlling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The intelligent Touch Manager shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

The controller wiring shall consist of a non-polar two-wire connection to the indoor unit at terminals F1F2 (out-out) of the outdoor unit. The intelligent Touch Manager is wall mounted and can be adjusted to maintain the optimal operation of the connected indoor unit(s).

The intelligent Touch Manager can be used in conjunction with the BRC1E73 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet interface, Lonworks interface, and Modbus adapter to control the same indoor unit groups. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each remote controller group associated with the intelligent Touch Manager. DIII-NET address can be set for one (1) indoor unit or each indoor unit in the remote controller group. No more than 2 remote controllers can be placed in the same group.

The intelligent Touch Manager shall be equipped with two RJ-45 Ethernet ports for 100 Mbps network communication to support interconnection with a network PC via the Internet, Local Area Network (LAN), or connection with a non-networked PC after completed installation.

Web access functions shall be available so that facility staff can securely log into each Intelligent Touch Manager via the PC's web browser to support monitoring, scheduling, error recognition, and general user functions. Error emails are also sent to designated email addresses. Provide additional software function Power Proportional Distribution (PPD) tenant billing shall also be available. The software shall require advanced purchase and can only be activated upon receipt of a license activation key from Daikin AC.

1. Mounting:

The intelligent Touch Manager shall be mounted on the wall or into the mounting fixtures included with the intelligent Touch Manager.

2. Display Features:

- a. The intelligent Touch Manager shall be approximately 11.42" x 9.57" x 1.97" in size with a backlit 10.4" LCD display.
- b. Display information shall be selectable from English, French, Italian, Korean, Dutch, Portuguese, Chinese, Japanese, German, or Spanish.
- c. Featured backlit LCD with auto off after 30 minutes (default) is adjustable between 1 to 60 minutes, or the choice of 3 different screen savers.
- d. Area and Group configuration
 - 1) Area contains one (1) or more Area(s) or Group(s)
 - 2) A Group may be an indoor unit, Di, Dio point that has a DIII-Net address
 - 3) A Group may be an external management point such as a Di, Do, Bi, Bo, Bv, Ai, Ao, Av, Mi, Mo, Mv that does not have a DIII-Net address
- e. An Area is a tiered group where management points (indoor unit, digital input/output, and analog input/output groups) can be monitored and controlled by global settings. Up to 650 Areas can be created. Area hierarchy can have up to 10 tiered levels (ex. top level: 1st floor West, 2nd level: offices, hallways, 3rd level: Office 101, 102, and 103, etc.). Area configuration shall classify levels of monitoring and control for each management point

- 1) Areas and Groups may be assigned names (ex. Office 101, Lobby, North Hallway, etc.)
 - f. The Controller shall display On/Off, Operation Mode, Setpoint, Space Temperature, Louver Position, Fan Speed for each Area or Group.
 - g. The Controller shall display Date (mm/dd/yyyy, yyyy/mm/dd, or dd/mm/yyyy format selectable) and day of the week along with the time of day (12hr or 24hr display selectable).
 - h. The Controller shall adjust for daylight savings time (DST) automatically.
 - i. Display information shall be updated every 3 seconds to show the latest status of the indoor unit groups.
 - j. System status icons shall display On/Off (color coded), Malfunction/Error (color coded), Forced Stop, Setback, Filter, Maintenance, and Screen Lock.
 - k. The controller shall display the temperature setpoint in one degree increments with a range of 60°F – 90°F, 1°F basis (16°C – 32°C, 0.1°C basis).
 - 1) Display of temperature setpoint information shall be configurable for Fahrenheit or Celsius
 - l. Display shall reflect room temperature in one tenth degree increments with a range of -58°F – 248°F, 0.1°F basis (-50°C – 120°C, 0.1°C basis) with 0.1°C accuracy.
 - 1) Display of room temperature information shall be configurable for Fahrenheit or Celsius
 - m. The Menu List shall be used to configure options and display information for each Area or Group.
 - n. Error status shall be displayed in the event of system abnormality/error with one of three color coded icons placed over the indoor unit icon or lower task bar.
 - 1) System errors are generated when the intelligent Touch Manager system with other VRV controls systems are combined incorrectly or power proportional distribution calculation errors occur. The intelligent Touch Manager shall display the error with a red triangle placed on the lower task bar.
 - 2) Unit errors occurring within the VRV system shall be displayed with a yellow triangle placed over the indoor unit icon
 - 3) Limit errors are based upon preconfigured analog input upper and lower limit settings and are generated when the limits have been met. When limit error is generated a yellow triangle will be placed over the unit icon.
 - 4) Communication errors between the intelligent Touch Manager and the indoor units shall be displayed with a blue triangle placed over the indoor unit icon
 - 5) Error history shall be available for viewing for up to 500,000 errors/abnormality events with operation events.
 - o. Layout View
 - 1) Capable of displaying site floor plan or graphical user interface (GUI) as the background for visual navigation. Indoor unit, DIII-Net Di and Dio, and External Di, Do, Ai, Ao, Av, Mi, Mo, Mv icons with operational status can be placed on the floor layout or GUI
 - i) Up to 4 status points can be assigned to the indoor unit icon (room name, room temperature, setpoint, and mode)
 - ii) Digital input and output icons will display On/Off status
 - iii) Analog icons will display Ai, Ao and Av.
 - iv) Multistate icons will display Mi, Mo and Mv.
 - 2) Up to 60 floor layout sections can be created
3. Basic Operation:
- a. Capable of controlling by Area(s) or Group(s)
 - b. Controller shall control the following group operations:
 - 1) On/Off
 - 2) Operation Mode (Cool, Heat, Fan, Dry, and Auto)

- 3) Independent Cool and Heat dual Setpoints or single Setpoint for current mode in the occupied period
- 4) Controller shall be able to limit the user adjustable setpoint ranges individually for cooling and heating based upon the Area or Group configurations
- 5) Independent Setup (Cooling) and Setback (Heating) setpoints in the unoccupied mode adjustable to 50 - 95°F
 - i) Setup and Setback setpoints can only be set outside of the occupied setpoint range
 - ii) The Setup and Setback setpoints will automatically maintain a 2°F fixed differential from the highest possible occupied setpoints
 - iii) The recovery differential shall be 4°F (default) and adjustable between 2 – 10°F
 - iv) Settings shall be applied based upon the Area or Group configurations
- 6) Fan Speed
 - i) Up to 3 speeds (dependent upon indoor unit type)
- 7) Airflow direction (dependent upon indoor unit type)
 - i) 5 fixed positions or oscillating
- 8) Remote controller permit/prohibit of On/Off, Mode, and Setpoint
- 9) Lock out setting for Intelligent Touch Manager display
- 10) Indoor unit Group/Area assignment
- c. Capable of providing battery backup power for the clock at least 1 year when no AC power is applied.
 - 1) The battery can last at least 13 years when AC power is applied
 - 2) Settings stored in non-volatile memory

4. Programmability:

- a. Controller shall support weekly schedule settings.
 - 1) 7 day weekly pattern (7)
 - 2) Weekday + Weekend (5 + 2)
 - 3) Weekday + Saturday + Sunday (5 + 1 + 1)
 - 4) Everyday (1)
 - 5) The schedule shall have the capabilities of being enabled or disabled
 - 6) 100 independent schedules configurable with up to 20 events settable for each days schedule
 - i) Each scheduled event shall specify time and target Area or Group
 - ii) Each scheduled event shall include On/Off, Optimum Start, Operation Mode, Occupied Setpoints, Setback Setpoints, Remote Controller On/Off Prohibit, Remote Controller Mode Prohibit, Remote Controller Setpoint Prohibit, Timer Extension Setting, Fan Speed, and Setpoint Range Limit
 - Setpoint when unit is On (occupied)
 - Configurable Setup (Cooling) and Setback (Heating) setpoints when unit is Off (unoccupied)
 - iii) Time setting in 1-minute increments
 - iv) Timer Extension shall be used for a timed override (settable from 30 – 180 minutes) to allow indoor unit operation during the unoccupied period
 - 7) A maximum of 40 exception days can be schedule on the yearly schedule (repeats yearly)
 - i) Exception days shall be used to override specified days on the weekly schedule based upon irregular occupied/unoccupied conditions
 - ii) Exception days can be configured on a set date (Jan 1) or floating date (1st Monday in September)
- b. Controller shall support auto-changeover.
 - 1) Auto-change shall provide Fixed (default), Individual, Averaging, and Vote changeover methods for both Heat Pump and Heat Recovery systems based upon the changeover group configuration. This will allow for the optimal room temperature to be maintained by automatically switching the indoor unit's mode

between Cool and Heat in accordance with the room temperature and setpoint. The following changeover scheme shall be applicable to the Fixed, Individual, and Averaging methods.

- i) Changeover to cooling mode shall occur at cooling setpoint + 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
 - Configurable from 1 – 4°F (0.5 – 2°C)
 - ii) Changeover to cooling mode shall occur at the primary changeover deadband to cooling + 1°F (0.5°C) as the secondary changeover deadband.
 - Configurable from 1 – 4°F (0.5 – 2°C)
 - iii) Changeover to heating mode shall occur at heating setpoint - 1°F (0.5°C) as the primary changeover deadband and takes the guard timer into consideration
 - Configurable from 1 – 4°F (0.5 – 2°C)
 - iv) Changeover to heating mode shall occur at the primary changeover deadband to heating - 1°F (0.5°C) as the secondary changeover deadband.
 - Configurable from 1 – 4°F (0.5 – 2°C)
 - v) A weighted demand shall be configurable for the Averaging and Vote methods.
- 2) Fixed Method
- i) Changeover evaluated by room temperature and setpoint of the representative indoor unit (first registered indoor unit in changeover group) in the changeover group even when it is not operating (must be in Cool, Heat, or Auto mode)
 - ii) Changeover affects all indoor unit groups in the changeover group.
- 3) Individual method (recommended for Heat Recovery Systems)
- i) Changeover evaluated by room temperature and setpoints of the individual indoor unit group in the changeover group
 - ii) Changeover affects individual indoor unit group in the changeover group
- 4) Average method
- i) Changeover evaluated by the average of all indoor unit group's room temperatures and setpoints operating in Cool, Heat, or Auto mode in the changeover group list
 - ii) If none of the indoor units in the group meet the above requirements the Fixed method of changeover will be applied
 - iii) A weighted demand (0 – 3) can be configured for each indoor unit in the changeover group.
 - iv) Changeover affects all indoor unit groups in the changeover group.
- 5) Vote Method
- i) In each indoor unit, the cooling demand is calculated based upon the difference between the room temperature and cooling setpoint. If the room temperature falls below the primary cool changeover point (cool setpoint plus the primary changeover deadband) the cooling demand is considered as 0 (zero). Then the total cooling demand is calculated as the sum of each indoor unit's cooling demand
 - ii) The opposite is true for the total heating demand
 - iii) A weight (0-3) can be added to each indoor unit's demand in the changeover group. The default setting is 1
 - iv) The weight 0 (zero) means the indoor unit's demand is not added in the total demand, so the indoor unit's demand is considered to be 0 (zero)
 - v) The weight 2 or 3 means the indoor unit's demand is added 2 or 3 times in the total demand, respectively
 - vi) Changeover to cooling mode shall occur when the total cooling demand is greater than the total heating demand.
 - vii) The opposite is true for changeover to heating
 - viii) Vote supports a Heating Override option, which prioritizes switching to the heating mode if at least one room temperature falls below the secondary

heat changeover point (heat setpoint minus the secondary changeover deadband) even if the total cooling demand is greater than the total heating demand.

ix) Changeover affects all indoor unit groups in the changeover group.

6) Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained to the same outdoor unit in the Heat Pump system or branch selector box in the Heat Recovery system.

7) Guard timer

i) Upon changeover, guard timer will prevent another changeover during the guard timer activation period (15, 30, 60 (default) min).

ii) Guard timer is ignored by a change of setpoint manually from either intelligent Touch Manger or Remote Controller, by schedule, or the room temperature meets or exceeds the secondary changeover deadband of the mode opposite of the current mode setting

c. Controller shall support Interlock

1) Interlock feature for use with 3rd party equipment (DOAS, dampers, occupancy sensing, etc...) to automatically control Groups or Areas corresponding to the change of the operation states or the On/Off states of any Group.

2) WAGO I/O unit – Di, Do, Ai, Ao

i) On/Off based monitoring and control of equipment

ii) Manual or scheduled operation of equipment

iii) Operation based upon interlock with management points (group(s))

iv) Monitor equipment error/alarm status

3) Digital Input/Output (DEC102A51-US2) unit or Digital Input (DEC101A51-US2) unit

i) On/Off based monitoring and control of equipment

ii) Manual or scheduled operation of equipment

iii) Operation based upon interlock with management points (group(s))

iv) Monitor equipment error/alarm status

d. Controller shall support force shutdown of associated indoor unit groups.

5. Web/Email Function

a. Each intelligent Touch Manager shall be capable of monitoring, operating, and scheduling a maximum of 64 indoor unit groups (up to 512 indoor unit groups with the addition of the iTM Plus Adapter) from a networked PC's web browser. It shall also be capable of creating general user access and sending detailed error emails to a customized distribution list (up to 10 email addresses).

b. All PCs shall be field supplied.

c. The following operation data stored in iTM every minute for the last 5 days can be accessed and downloaded through iTM web function (or USB output with a user specified time period):

a. Indoor and outdoor unit (applied model only) operation data.

b. BACNet Client management data points (AI, AO, AV, BI, BO, BV, MI, MO and MV).

c. WAGO IO system data points (External DI, DIO, PI, AI, and AO).

d. Airnet addressing required for both indoor units and outdoor units to enable the operation data on the iTM.

6. Software

Licensed, per intelligent Touch Manager shall be required.

a. DCM014A51: BACnet Server Gateway Option

1) The iTM BACnet Server Gateway Option shall be capable of making the intelligent Touch Manager work as a BACnet gateway using the BACnet/IP

protocol. The iTM BACnet Server Gateway Option shall be capable of exposing indoor unit management points and indoor/outdoor unit operation data as BACnet objects to the BMS. The iTM BACnet Server/Gateway Option shall be capable of allowing the BMS to monitor and/or control indoor units and outdoor units via BACnet objects.

- 2) The iTM BACnet Server Gateway Option shall support VRV, SkyAir, Outdoor Air Processing Unit, Mini-Split system with use of KRP928, and FFQ indoor unit for Multi-split system.
- 3) The iTM BACnet Server Gateway Option shall support operation data for VRV IDUs only (requires Airnet addressing)
- 4) The iTM BACnet Server Gateway Option shall support operation data for the following VRV IV outdoor units: RXYQ_TATJU, RXYQ_TAYDU, REYQ_TATJU, REYQ_TAYDU (requires Airnet addressing).
- 5) Functions:
 - i. The iTM BACnet Server Gateway Option shall be capable of supporting Change of Value (COV) notification.
 - ii. The iTM BACnet Server Gateway Option shall communicate to BMS using port number 47808 (configurable).
 - iii. The iTM BACnet Server Gateway Option shall function as BACnet router to provide unique virtual BACnet device identification number (ID) for every indoor unit group address and every outdoor unit device.
 - iv. The iTM BACnet Server Gateway Option shall provide configurable BACnet Network number.
 - v. The iTM BACnet Server Gateway Option shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.
 - vi. The iTM BACnet Server Gateway Option shall be run in environments with BACnet communication traffic up to 100 packets/second.
 - vii. The iTM BACnet Server Gateway Option functions shall be configurable through CSV file which shall be downloaded from iTM and configured by trained personnel.
- 6) System Capacity
 - i. A maximum of 128 device IDs (including indoor units groups outdoor units) and a maximum of 4000 BACnet objects can be monitored and/or controlled from a BMS
 - ii. Max of 8 DIII-Net ports shall be connected to iTM.
- 7) The Building Management System shall monitor and control the following BACnet objects for indoor units
 - i. Indoor unit ON/OFF status.
 - ii. Alarm status with error description
 - iii. Room temperature.
 - iv. Indoor Unit ON details
 - Off
 - Normal [ON]
 - Override
 - Setback

- v. Filter sign status.
- vi. Fan status.
- vii. Communication status.
- viii. Thermo-on status.
- ix. Compressor status
 - On
 - Off
 - Defrost
- x. Aux heater status.
- xi. Occupancy Mode
 - Unoccupied,
 - Occupied
 - Standby
- xii. Operation Mode (Cool, Heat, Fan, and Dry)
- xiii. Cooling and Heating setpoints during occupied mode.
- xiv. Cooling and Heating setpoints during unoccupied mode.
- xv. Maximum and minimum cooling setpoint.
- xvi. Maximum and Minimum heating setpoint
- xvii. Minimum cooling and heating setpoint differential.
- xviii. Fan Speed
 - Up to 3 speeds (dependent upon indoor unit type)
- xix. Vane direction (dependent upon indoor unit type)
 - 5 fixed positions or swing position
- xx. Remote controller permit/prohibit
 - On/Off
 - Mode,
 - Setpoint
- xxi. Filter sign reset for indoor units
- xxii. Forced indoor units off.
- xxiii. Return air temperature
- xxiv. Discharge air temperature
- xxv. Liquid pipe temperature
- xxvi. Gas pipe temperature
- xxvii. EV position
- xxviii. Freeze protection (For FXEQ_P, FXFQ_T, FXTQ_TA, FXUQ_P, FXZQ_TA, FXSQ_TA, CXTQ_TA indoor unit only).

8) The Building Management System shall monitor the following BACnet objects (if available) for outdoor unit devices:

Point Name	Point Description
Communication Status	Monitors and displays the communication status (General)
Operation Mode	Monitors and displays the operation mode (Cool, Heat, Fan or Heat &Cool) (General)
Outdoor Unit Alarm Status	Monitors whether or not the outdoor unit is operating normally. (General)

Defrost Mode	Monitors if the defrost mode is active. (General)
Oil Return Mode	Monitors whether or not the outdoor unit is in oil return operation. (General)
Electric Power	Monitors and displays the electric power (calculated). (General)
Electric Current	Monitors and displays the electric current (calculated). (General)
System Capacity Code	Monitors and displays the system capacity code. (General)
Outdoor Air Temperature	Monitors and displays the outdoor air temperature. (General)
M_Condensing Pressure	Monitors and displays the condensing pressure (Master Module)
M_Evaporating Pressure	Monitors and displays the evaporating pressure (Master Module)
M_Condensing Temperature	Monitors and displays the condensing temperature (Master Module)
M_Evaporating Temperature	Monitors and displays the evaporating temperature (Master Module)
M_Inverter Compressor 1 Speed	Monitors and displays the speed of the inverter compressor1 (Master Module)
M_Inverter Compressor 2 Speed	Monitors and displays the speed of the inverter compressor2 (Master Module)
M_Fan Step	Monitors and displays the fan step (Master Module)
M_EV Position 1	Monitors and displays the position of the expansion valve1 (Master Module)
M_EV position 2	Monitors and displays the position of the expansion valve2 (Master Module)
M_Hot Gas Temperature (Compressor 1)	Monitors and displays the hot gas temperature of the compressor1 (Master Module)
M_Hot Gas Temperature (Compressor 2)	Monitors and displays the hot gas temperature of the compressor2 (Master Module)
M_Liquid Pipe	Monitors and displays the liquid pipe temperature

Temperature	(Master Module)
M_Liquid Pipe Temperature (HX Upper)	Monitors and displays the liquid pipe temperature for the upper HX (Master Module)
M_Liquid Pipe Temperature (HX Lower)	Monitors and displays the liquid pipe temperature for the lower HX (Master Module)
M_Liquid Pipe Temperature (De-Icer)	Monitors and displays the liquid pipe temperature for the de-icer (Master Module)
M_Gas Pipe Temperature (HX Upper)	Monitors and displays the gas pipe temperature for the upper HX (Master Module)
M_Gas Pipe Temperature (HX Lower)	Monitors and displays the gas pipe temperature for the lower HX (Master Module)
M_Suction Temperature	Monitors and displays the suction temperature (Master Module)
M_Compressor Suction Temperature	Monitors and displays the compressor's suction temperature (Master Module)
M_Subcool Inlet Temperature	Monitors and displays the subcool inlet temperature (Master Module)
M_Subcool Outlet temperature	Monitors and displays the subcool outlet temperature (Master Module)
M_Subcool EV Position	Monitors and displays the subcool expansion valve position (Master Module)
S1_Condensing Pressure	Monitors and displays the condensing pressure (Sub Module1)
S1_Evaporating Pressure	Monitors and displays the evaporating pressure (Sub Module1)
S1_Condensing Temperature	Monitors and displays the condensing temperature (Sub Module1)
S1_Evaporating Temperature	Monitors and displays the evaporating temperature (Sub Module1)
S1_Inverter Compressor 1 Speed	Monitors and displays the speed of the inverter compressor1 (Sub Module1)
S1_Inverter	Monitors and displays the speed of the inverter

Compressor 2 Speed	compressor2 (Sub Module1)
S1_Fan Step	Monitors and displays the fan step (Sub Module1)
S1_EV Position 1	Monitors and displays the position of the expansion valve1 (Sub Module1)
S1_EV position 2	Monitors and displays the position of the expansion valve2 (Sub Module1)
S1_Hot Gas Temperature (Compressor 1)	Monitors and displays the hot gas temperature of the compressor1 (Sub Module1)
S1_Hot Gas Temperature (Compressor 2)	Monitors and displays the hot gas temperature of the compressor2 (Sub Module1)
S1_Liquid Pipe Temperature	Monitors and displays the liquid pipe temperature (Sub Module1)
S1_Liquid Pipe Temperature (HX Upper)	Monitors and displays the liquid pipe temperature for the upper HX (Sub Module1)
S1_Liquid Pipe Temperature (HX Lower)	Monitors and displays the liquid pipe temperature for the lower HX (Sub Module1)
S1_Liquid Pipe Temperature (De-Icer)	Monitors and displays the liquid pipe temperature for the de-icer (Sub Module1)
S1_Gas Pipe Temperature (HX Upper)	Monitors and displays the gas pipe temperature for the upper HX (Sub Module1)
S1_Gas Pipe Temperature (HX Lower)	Monitors and displays the gas pipe temperature for the lower HX (Sub Module1)
S1_Suction Temperature	Monitors and displays the suction temperature (Sub Module1)
S1_Compressor Suction Temperature	Monitors and displays the compressor's suction temperature (Sub Module1)
S1_Subcool Inlet Temperature	Monitors and displays the subcool inlet temperature (Sub Module1)
S1_Subcool Outlet temperature	Monitors and displays the subcool outlet temperature (Sub Module1)

S1_Subcool EV Position	Monitors and displays the subcool expansion valve position (Sub Module1)
S2_Condensing Pressure	Monitors and displays the condensing pressure (Sub Module2)
S2_Evaporating Pressure	Monitors and displays the evaporating pressure (Sub Module2)
S2_Condensing Temperature	Monitors and displays the condensing temperature (Sub Module2)
S2_Evaporating Temperature	Monitors and displays the evaporating temperature (Sub Module2)
S2_Inverter Compressor 1 Speed	Monitors and displays the speed of the inverter compressor1 (Sub Module2)
S2_Inverter Compressor 2 Speed	Monitors and displays the speed of the inverter compressor2 (Sub Module2)
S2_Fan Step	Monitors and displays the fan step (Sub Module2)
S2_EV Position 1	Monitors and displays the position of the expansion valve1 (Sub Module2)
S2_EV position 2	Monitors and displays the position of the expansion valve2 (Sub Module2)
S2_Hot Gas Temperature (Compressor 1)	Monitors and displays the hot gas temperature of the compressor1 (Sub Module2)
S2_Hot Gas Temperature (Compressor 2)	Monitors and displays the hot gas temperature of the compressor2 (Sub Module2)
S2_Liquid Pipe Temperature	Monitors and displays the liquid pipe temperature (Sub Module2)
S2_Liquid Pipe Temperature (HX Upper)	Monitors and displays the liquid pipe temperature for the upper HX (Sub Module2)
S2_Liquid Pipe Temperature (HX Lower)	Monitors and displays the liquid pipe temperature for the lower HX (Sub Module2)
S2_Liquid Pipe Temperature (De-Icer)	Monitors and displays the liquid pipe temperature for the de-icer (Sub Module2)
S2_Gas Pipe Temperature (HX	Monitors and displays the gas pipe temperature for

Upper)	the upper HX (Sub Module2)
S2_Gas Pipe Temperature (HX Lower)	Monitors and displays the gas pipe temperature for the lower HX(Sub Module2)
S2_Suction Temperature	Monitors and displays the suction temperature (Sub Module2)
S2_Compressor Suction Temperature	Monitors and displays the compressor's suction temperature (Sub Module2)
S2_Subcool Inlet Temperature	Monitors and displays the subcool inlet temperature (Sub Module2)
S2_Subcool Outlet temperature	Monitors and displays the subcool outlet temperature (Sub Module2)
S2_Subcool EV Position	Monitors and displays the subcool expansion valve position (Sub Module2)

9) The Building Management System may choose to monitor and control the following BACnet objects linked to iTM control logic:

- i. Enable/Disable iTM Schedule operation.
- ii. Enable/Disable iTM Auto Changeover Operation.
- iii. Set Timed Override Minutes.
 - Monitor and configure timer extension on iTM (30, 60, 90, 120, 150, 180 minutes)
- iv. System forced off
 - Enable/Disable all emergency stop programs that are registered on the iTM.

10) Schedule

The BMS shall utilize iTM schedule function or support weekly schedule settings through its programming.

- i. BMS schedule shall support the indoor unit:
 - Each scheduled event shall specify time and target group address.
 - Each scheduled event shall include Occupancy Mode, Operation Mode, Occupied Cooling Setpoint, Occupied Heating Setpoint, and Unoccupied cooling setpoint, Unoccupied heating setpoint, Remote Controller On/Off Permit/Prohibit, Remote Controller Mode Permit/Prohibit, Remote Controller Setpoint Permit/Prohibit, and Timed Override Enable.
 - An override shall be provided for use enabling indoor unit operation during the unoccupied period by the BMS programming.

11) Auto Changeover

The BMS shall utilize iTM Auto changeover function or support auto-changeover through its programming.

- i. Auto-change shall provide changeover for both Heat Pump and Heat Recovery systems based upon the group configurations. This will allow the optimal room temperature to be maintained by automatically switching the indoor unit's mode between Cool and Heat in accordance with the room temperature and setpoint temperature.
- ii. Changeover shall change the operation mode of the indoor unit that is set as the Changeover Master. The Changeover Master indoor unit shall then change the operation mode of all indoor unit groups daisy chained on the same DIII-Net communication bus to the same outdoor unit in the Heat Pump system or the same branch selector box in the Heat Recovery system.
- iii. Changeover to cooling mode shall occur when the room temperature is great than or equal to the cooling setpoint
 - Differential to be determined by BACnet building management system programming
- iv. Changeover to heating mode shall occur when room temperature is less than or equal to the heating setpoint.
 - Differential to be determined by BACnet building management system programming
- v. Guard timer
 - Upon changeover, guard timer will prevent another changeover during this period.
 - Guard timer should be ignored by a change of setpoint manually from the BMS, Intelligent Touch Controller, Remote Controller, or by schedule.Guard timer to be configured by BMS programming (30 minute minimum recommended)

12) Setpoint limitation

The BMS shall utilize maximum and minimum cooling and heating setpoint to configure upper and lower setpoints range.

13) System shutdown:

BMS should utilize System forced off point to execute emergency stop program registered on the iTM.

14) Restricted functions:

The following iTM functions shall be prohibited when the BACnet Server Gateway option enabled:

- i. Interlocking Control.
- ii. Emergency Stop (Emergency stop manual release).
- iii. Power Proportional Distribution (PPD) option.
- iv. BACnet Client option.
- v. D-Net Service.
- vi. External Management Point Registration

B. DCM601A72: iTM Plus Adapter

The iTM Plus Adapter shall provide control for all VRV, SkyAir indoor units, and Daikin RA and FTXS indoor units with the use of the KRP928BB2S RA Adapter. It shall be

capable of handling a maximum of 64 indoor unit groups and 128 indoor units connected to a maximum of 10 outdoor units. The iTM Plus Adapter is to be used in conjunction with intelligent Touch Manager. Up to 7 iTM Plus Adapters can be connected to a single intelligent Touch Manager. This combination will provide intelligent Touch Manager monitoring and control of up to 512 indoor unit groups, 1024 indoor units, and 80 outdoor units. The iTM Plus Adapter shall support operations superseding that of the local remote controller, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring.

The controller wiring shall consist of a non-polar two-wire connection to the outdoor unit at terminals F1F2 (out-out). The iTM Plus Adapter is wall mounted and is used in conjunction with the intelligent Touch Manager to maintain the optimal operation of the connected indoor unit(s). The iTM Plus Adapter is connected to the intelligent Touch Manager via a polarity sensitive 18-2 AWG stranded non-shielded wire (field supplied).

The iTM Plus Adapter can be used in conjunction with the BRC1E73 (Navigation Remote Controller), the BRC2A71 (Simplified Remote Controller), or the BRC4C82/7E83/7C812/7E818 (Wireless Remote Controller), BACnet interface, Lonworks interface and Modbus Adapter to control the same indoor unit groups. No more than 2 remote controllers can be placed in the same group. The remote controller shall require daisy chain wiring for grouping multiple indoor units (up to 16) together. Manual addressing is required of each indoor unit group associated with the iTM Plus Adapter.

1. Mounting:
The iTM Plus Adapter can be mounted on the wall or in a standard enclosure (field supplied).
2. Features:
 - a. The iTM Plus Adapter shall be approximately 6.30" x 5.87" x 2.41" in size.
3. Basic Operation:
 - a. Control of all associated indoor unit groups shall be done via the connected intelligent Touch Manager.
4. Programmability:
 - a. Programming of all associated indoor unit groups shall be done via the connected intelligent Touch Manager.

END OF SECTION

12-10-25

SECTION 23 82 39 - ELECTRIC HEATING EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Work Included:
 - 1. Electric Unit Heaters

1.03 SUBMITTALS

- A. General: All submittals shall comply with the requirements of Division 1 - GENERAL REQUIREMENTS and Section 20 01 00 - GENERAL PROVISIONS.
- B. Product Data: data shall be submitted on the following items:
 - 1. Unit Heaters
- C. Operation and Maintenance Data: Data shall be provided on the following items:
 - 1. Unit Heaters

1.04 QUALITY ASSURANCE

- A. Standards:
 - 1. National Electrical Code (NEC)
 - 2. Underwriter's Laboratories (UL)

PART 2 PRODUCTS

2.01 UNIT HEATERS

- A. Unit heaters shall be UL labeled vertical or horizontal discharge type as indicated on the drawings. Heaters shall have steel housing with baked enamel finish, resistance heating elements, integral fan and motor, discharge louvers, mounting bracket and fan/heater controls.
- B. Elements shall be the finned tubular sheathed type and wired to terminal block.
- C. Fan shall be propeller type with permanently lubricated motor.
- D. Discharge louvers on horizontal units shall be individually adjustable. Discharge louvers on vertical units shall be type indicated on the drawings.
- E. Unit heater controls shall include power contactor(s) automatic reset high limit switch, fan delay relay, control power transformer (24 volts), and built-in thermostat.
- F. Mounting bracket, unless indicated otherwise on the drawings, shall be manufacturer's standard bracket.
- G. Manufacturer and Capacity: refer to drawings.

PART 3 EXECUTION

3.01 STORAGE

- A. Electric heating equipment shall be stored in shipping cartons on wooden pallets or rails. Cartons shall be covered with 6 mil (minimum) polyethylene, taped in place.

3.02 INSTALLATION

- A. Unit Heaters:
 - 1. Unit heaters shall be suspended from structure using hanger rods. Where indicated on the drawings to be wall mounted, bracket shall be bolted to hollow masonry wall with spring wing toggle bolts or to solid masonry wall with self tapping anchors.

END OF SECTION

12-10-25

DIVISION 26 0000 - ELECTRICAL

1.01 BASIC ELECTRICAL REQUIREMENTS

- A. The specifications for the project electrical work are included in Divisions 26 0000, 27 0000, and 28 0000. The separation of the project electrical specifications into such divisions is for the sole purpose of convenience. The specifications of any of these divisions shall hold for all such divisions the same as if they were stated in each division.
- B. All references made on the drawings and in these specifications to "owner" shall be interpreted to mean "project owner".
- C. The word "shall", where used, is to characterize mandatory requirements, and the word "should", where used, is to characterize advisories. The word "may" is used in the permissive sense.
- D. Unless noted otherwise, the word "provide" shall be interpreted to mean "furnish, install, and connect as required to be complete and ready for the intended use" when referencing connectible items, equipment, and/or materials which are associated with the electrical work; shall be interpreted to mean "furnish and install as required to be complete and ready for the intended use" when referencing unconnectible items, equipment, and/or materials which are associated with the electrical work; and shall be interpreted to mean "furnish as required to be complete and ready for the intended use" when referencing electrical work which is neither installable nor connectible.
- E. In each instance where there is a conflict between the requirements of these electrical specifications, the electrical drawings, the architectural specifications, the architectural drawings, the specifications of any other project division, the drawings of any other project division, etc., the more stringent requirements shall govern; however, if such conflict is not a matter of stringency, bring such conflict to the immediate attention of the architect for resolution.
- F. Consult the General Conditions and the supplementary conditions, and all other sections of the project drawings and specifications, in detail for instructions pertaining to this work.
- G. Give written notice to the architect of all materials and/or apparatuses which are believed to be inadequate or unsuitable, and/or believed to be in violation of codes, laws, ordinances, and/or rules, and of all required items of work which are omitted. In the absence of such written notice, provide all such materials and apparatuses, and be responsible for the approved satisfactory functioning of the entire electrical system, without additional compensation.
- H. The locations of the existing utilities at the site which are involved with the scope of this work, where and as indicated on the drawings and/or referenced herein, are offered only as a general guide, with no guarantee as to accuracy. Examine the site and verify the locations of all existing utilities, and the relationship of such utilities to the project work, and base the contract proposal on all conditions

which will be encountered during the progress of the work. Verify all parameters and requirements in advance.

- I. Cooperate fully with all other trades, where and as required, so as not adversely to impact the project construction schedule or the work of such other trades. Verify all parameters and requirements in advance.
- J. Unless explicitly indicated otherwise, provide all materials, devices, equipment, equipment supports, controls, labor, services, appurtenances, etc. which are referenced in these specifications, shown on the drawings, and/or required to make complete and satisfactory installations, in working order.
- K. Before submitting the project proposal, ask the architect for a decision concerning all places where drawings, specifications, standards, and/or codes conflict, or are not clearly understood. In the absence of obtaining such decisions, abide by the decisions of the architect if the necessity for such decisions arises after the signing of the project construction contract.
- L. Visit the project site, determine the existing conditions, and allow for such conditions in the project proposal.
- M. Coordinate the locations of the electrical work with the work of all other trades.
- N. The general arrangement of the work is indicated on the drawings. Due to the small scale of the drawings, not all required offsets, fittings, conduit bodies, boxes, etc. are indicated. Provide offsets, fittings, conduit bodies, boxes, etc. where and as needed, in accordance with codes and accepted practices.
- O. Verify measurements for accuracy before ordering any materials or doing any work.
- P. Provide all flashing which is required for the electrical work. Flashing shall meet the architect's approval; verify in advance.
- Q. Establish and record the locations and grades of all underground conduit. In the event unforeseen obstructions occur in the work, obtain written consent from the architect before undertaking any deviations from the drawings.
- R. Provide and maintain a complete grounding system.
- S. Connect all electrical equipment, including that which is furnished by others.
- T. Connect all electrical equipment in strict accordance with the instructions of the respective manufacturers; verify in advance.
- U. Perform all electrical work in strict accordance with state ordinances governing this class of work, and with the National Electrical Code.
- V. The specifications are intended to describe complete and workable systems of various sorts. Report all discrepancies and/or omissions preventing such utility prior to making the contract proposal.

- W. Due to the equipment which will be installed for this project by other trades, coordination is required. Reference the architectural and mechanical drawings and specifications for layouts and descriptions of equipment which shall be connected.
- X. Note carefully that the electrical drawings are intended to indicate, only diagrammatically, the extent, the general character, and the respective locations of the work which is included. Provide all work which is obviously intended, but for which minor details are not shown, so as to be complete where and as required to perform the functions that are intended. Follow the architectural and/or structural drawings and specifications for building details and fit the work of the electrical drawings and specifications thereto.
- Y. Furnished materials shall be new and listed by UNDERWRITERS' LABORATORIES as conforming to their standards for the respective applications. All work shall be installed in a well-executed manner and shall present a neat appearance when completed.
- Z. Base the project proposal on the equipment and materials which are specified herein and/or on the drawings. Reference to a specific manufacturer or trade name is not intended to indicate a preference for a specific manufacturer but to indicate a standard of quality. Substitute equipment which meets the architect's approval as being "equivalent" for the respective application, may be provided.
- AA. Provide proper grounding of the construction power system, and provide proper lighting if, where, and as required during construction. Provide adequate construction power and lighting where and as required by all trades.
- BB. Keep the work as installed in repair and perfect working order for one (1) year from the date of notice of final acceptance. Such guarantee shall be based on defective materials, installation, and connection. Provide, free of additional cost to the owner, all materials and labor which are required to comply with such guarantee. In all cases where equipment has a factory warranty exceeding one (1) year, such full warranty shall apply.
- CC. Comply with all state building and safety laws, ordinances, and regulations relating to building and public health and safety, and with the National Electrical Code.
- DD. Notify the architect well in advance of permanently concealing any of the project work.
- EE. Coordinate fully with Entergy, the local power company, and give Entergy all required information. Provide the required reinforced-concrete slab for the Entergy-provided, main, power transformer; project all required concrete-filled-pipe, protection bollards; provide all required grounding apparatuses; and provide all required power-metering and service-entrance equipment, etc., where and as required by Entergy, and make the complete installation conform to Entergy's recommendations, standards, and other requirements.

- FF. Ascertain, from Entergy, the exact total amount of the connection, service, and/or metering-equipment charges (if any) which Entergy is required to be paid for their permanent-power facilities, well in advance of the date on which such total amount must be paid to Entergy (verify), and then so advise the architect. As a clarification, the payment of such total amount of the connection, service, and/or metering-equipment charges (if any) which Entergy is required to be paid for their permanent-power facilities will be paid directly to Entergy by the owner. As a further clarification, the connection, service, and/or metering-equipment charges which are required to be paid to Entergy for the project temporary (i.e., construction) power connection shall be paid directly to Entergy by this (the project) contractor, and shall not be included in the above-referenced, total amount of the connection, service, and/or metering-equipment charges (if any) for the permanent-power facilities which will be paid directly to Entergy by the owner.
- GG. For the purpose of coordination with Entergy, contact Entergy directly; call 1-800-ENTERGY.
- HH. As soon as possible following the execution of the construction contract, obtain in writing on an Entergy letterhead, and directly from Entergy, all information which is required by the state fire marshal's office for submittal (through the professional of record) to the state fire marshal's office, including, but not limited to, the proposed main-power-transformer primary and secondary voltage ratings, and KVA rating; the available short-circuit current at the primary terminals, and at the secondary terminals, of the proposed main power transformer; and the available short-circuit current at the location of the connection of Entergy's facilities to the project electrical system. Submit all such information, as soon as possible, to the project electrical engineer for subsequent submittal to the fire marshal's office. This contractor is hereby advised that the state fire marshal's office will not allow occupancy of the project until such information is submitted to them, and until all corrective measures which are determined by them, and based thereon, to be necessary have been performed. This contractor shall be responsible for all delays which are caused by the untimely obtainment and submission of such information.
- II. The work shall be inspected before being permanently concealed.
- JJ. Follow, as minimum project standards, the established standards of the following organizations, and the individual standards which are named, the same as if they were fully written herein, except where otherwise explicitly specified (in all places in the project construction/bid documents where standards and codes are referenced, the reference is to the respective latest editions of such standards and codes; provide higher grades of materials and workmanship which are specified herein or indicated on the drawings):
1. The Institute of Electrical and Electronic Engineers (IEEE);
 2. The National Fire Protection Association "National Electrical Code" (NFPA No. 70) and "Life Safety Code" (NFPA No. 101);
 3. The National Fire Protection Association "Standard for Electrical Safety in the Workplace" (NFPA 70E);
 4. The International Building Code;
 5. The International Fire Code;

6. The International Energy Conservation Code (IECC)
 7. The National Electrical Manufacturers Association (NEMA);
 8. The Edison Electric Institute (EEI);
 9. The Insulated Power Cable Engineers Association (IPCEA);
 10. The American National Standards Institute (ANSI);
 11. The American Society for Testing Materials (ASTM);
 12. The National Electrical Safety Code (Handbook H30);
 13. The Safety Rules for the Installation and Maintenance of Electrical Supply and Communications Lines (Handbook 81) of the National Bureau of Standards, Washington, D.C.;
 14. All National Fire Protection Association related standards; and
 15. The applicable Entergy mandates, recommendations, details, guidelines, instructions, etc.
- KK. INTERNATIONAL ENERGY CONSERVATION CODE (IECC) NOTE: At and for all project facility areas where detainees have access (with or without supervision), Exception No. 1 of IECC Section C405.2, which states "Lighting controls are not required for...areas designated as security... areas...", is being invoked.
- LL. Submit to the architect for review an electronic copy of detailed drawings showing construction details and dimensions, and in the case of lighting fixtures photometric data, of all items, equipment, and/or materials which are being provided, before they are ordered. Drawings for motor starters and safety switches which do not designate the respective motors and/or equipment, will not be reviewed and will be considered informal.
- MM. With the first set of such detailed drawings (i.e., the project electrical-equipment shop drawings) which are submitted for review, submit for review a scaled drawing of each project, interior-and-exterior, electrical-equipment space illustrating the exact proposed equipment layout using the dimensions of the actual equipment which is being provided, and obtain the approval for such layouts from the architect before ordering the project equipment. In laying out such spaces, strictly conform to the requirements of all applicable codes and governing authorities, particularly to the requirements for working space, clearances, guarding, and warning signs of Article 110 of the National Electrical Code. It shall be this contractor's responsibility to produce and submit such accurate, scaled drawings to the architect in a timely manner, i.e., with the project electrical-equipment shop drawings. If this contractor does not submit such accurate, scaled drawings in a timely manner, i.e., with the project electrical-equipment shop drawings, this contractor shall accept all responsibility for all lack of adequate physical space and clearances, and shall bear the cost for all remedies, no matter how extensive and/or costly.
- NN. Deliver to the architect an electronic copy, and three (3) hard copies, of maintenance manuals, which shall include printed instructions relating to the operation, proper maintenance, and repair, and parts lists indicating the various parts by name, number, and diagram, for each piece of equipment that is being provided. Neatly bind such documentation in hard-covered binders and deliver it to the architect before the acceptance of the project.

- OO. Request and obtain from the architect one (1) set of the project electrical drawings and keep such set of drawings on the project site. Show on such drawings all changes in the project work which are caused by any factors whatsoever. At the end of the project, submit such corrected set of drawings to the architect prior to receiving the final project payment.

- PP. Advise the general contractor, both before the contract proposal is made and during construction, which electrical items, equipment, and materials shall be painted in strict accordance with the architectural painting specifications.

- QQ. Remove all debris and clean all electrical work prior to project completion.

- RR. As part of the electrical portion (i.e., Division 26 0000) of the project, prepare project drawings, in an electronic format and in a version which are approved by the architect (verify in advance), which depict all portions of the above-ceiling project construction (including architectural, structural, mechanical, electrical, etc.) in complete coordination (without any conflicts), as proposed to be constructed, and submit such electronic version of such drawings to the architect for acceptance and approval in advance of the commencement of any project construction.

- SS. For the project Medical Areas, the project electrical work shall be in strict accordance with the requirements of the latest editions of all applicable codes (including, but not limited to, NFPA 70: National Electrical Code [NEC], NFPA 99: Health Care Facilities Code, NFPA 101: Life Safety Code, all other applicable NFPA codes, the International Building Code, the International Fire Code, the International Energy Conservation Code [IECC], etc.), standards, and acts (including the Americans with Disabilities Act and the Architectural Barriers Act Accessibility Guidelines [ADA-ABA]), and with the requirements of all applicable governing authorities, particularly as noted for a health care facility, and as a business occupancy and an ambulatory health care occupancy, and as relevant for the respectively-assigned, individual, project spaces. As a clarification, the "patient care spaces" at and in the project Medical Areas are classified as "Basic Care (Category 3) Spaces".

- TT. For the project Medical Areas, the project medical-equipment manual, which has been furnished by the owner and/or by the architects, all associated equipment information (including the equipment schedules, details, elevations, sections, etc.), and all medical-equipment information which is included on the architectural drawings and in the architectural specifications, form an integral part of these project construction documents (drawings and specifications), particularly Division 26 0000, and contain project requirements which shall be followed the same as if such information was bound with the remainder of the project Division 26 0000 construction documents (drawings and specifications). Request and obtain, in advance, copies of such equipment information and such equipment-requirement information, and copies of all applicable architectural drawings, schedules, details, elevations, sections, etc.; thoroughly review, and take into consideration, all information which is contained therein and thereon including, but not limited to, all required power connections and circuiting, rough-in requirements, outlet boxes, junction boxes, raceways (conduits), interconnecting wiring, etc.; figure the project proposal accordingly; and construct

the project in strict accordance with the information, parameters, and requirements which are contained therein and thereon. All references in such documents to work being "provided by customer" shall be interpreted to mean "provided by this (the project) contractor". In each instance where there is a conflict between the requirements of such documents and the requirements of the other portions of the Division 26 0000 documents (drawings and/or specifications), the more stringent requirements shall govern; however, if such conflict is not a matter of stringency, the requirements of such documents shall govern.

UU. The project food-service-equipment drawings (i.e., the "FS" sheets), which were prepared by Futch Design Associates, Inc.; 7948 Goodwood Boulevard; Baton Rouge, Louisiana 70806; phone: 225-923-1289; Attention: Mr. Greg Futch, email: greg@futchdesign.com or Mr. Chad Tate, email: chad@futchdesign.com, and all associated equipment information (including the equipment schedules, details, elevations, sections, etc.), and all food-service-equipment information which is included on the architectural drawings and in the architectural specifications, form an integral part of these project construction documents (drawings and specifications), particularly Division 26 0000, and contain project requirements which shall be followed the same as if such information was bound with the remainder of the project Division 26 0000 construction documents (drawings and specifications). Request and obtain, in advance, copies of such equipment and equipment-requirement information, and copies of all applicable architectural drawings, schedules, details, elevations, sections, etc.; thoroughly review, and take into consideration, all information which is contained therein and thereon including, but not limited to, all required power connections and circuiting, rough-in requirements, outlet boxes, junction boxes, raceways (conduits), interconnecting wiring, etc.; figure the project proposal accordingly; and construct the project in strict accordance with the information, parameters, and requirements which are contained therein and thereon. All references in such documents to work being "provided by customer" shall be interpreted to mean "provided by this (the project) contractor". In each instance where there is a conflict between the requirements of such documents and the requirements of the other portions of the Division 26 0000 documents (drawings and/or specifications), the more stringent requirements shall govern; however, if such conflict is not a matter of stringency, the requirements of such documents shall govern.

1.02 MOTOR STARTERS, VARIABLE-FREQUENCY DRIVES (VFD'S), EQUIPMENT CONTACTORS, AND PUSHBUTTONS

- A. Install and connect starters and/or VFD's (as applicable) for all motors, and contactors for all equipment, except for motors and equipment having integral, factory-mounted starters, VFD's, and/or contactors (as applicable). In such case, connect the starters, VFD's, and/or contactors.
- B. Furnish starters and/or VFD's (where and as applicable) for all motors, and contactors for all equipment, except for motor starters, VFD's, and/or equipment contactors (where and as applicable) which are expressly specified as being furnished by others.

- C. For all motor starters, VFD's, and/or equipment contactors (where and as applicable) which are required to be furnished, obtain from the mechanical contractor, the control contractor, and/or any other entity that is furnishing the respective motors and/or equipment, the exact electrical characteristics of, and the exact electrical requirements for, such motors and/or equipment, and provide starters, VFD's, and/or contactors (where and as applicable) therefor which are completely compatible with the respective motors and/or equipment, and which are approved for the respective applications. Furnish starters, VFD's, and/or contactors (where and as applicable) having respectively, among other characteristics, the proper NEMA sizes; the proper NEMA-enclosure types; the proper voltage-and-current ratings; the proper numbers of poles; the proper coil arrangements and coil-voltage ratings; the proper numbers and types of auxiliary contacts; the proper control devices for the control schemes that are designed and intended; the proper pilot devices; and the properly-sized overload devices.
- D. Magnetic motor starters and VFD's for motors which are rated 10HP and above shall have undervoltage, overvoltage, and phase-failure protection.
- E. Install and connect pushbuttons and pushbutton stations where and as shown on the drawings, and where and as required (verify in advance).
- F. Furnish all required pushbuttons and pushbutton stations, except for pushbuttons and pushbutton stations which are expressly specified as being furnished by others. Pushbuttons and pushbutton stations shall be completely compatible with the respective devices which they control, and shall be approved for the respective applications. Pushbuttons and pushbutton stations shall have the numbers of contacts of the proper ratings and configurations, and shall have the proper enclosures, as required for the respective applications.

1.03 MOTOR WIRING

- A. Provide electrical connections to all motors, pushbutton stations, starters, contactors, and starting switches.
- B. Provide conduit connections to motors using flexible (liquidtight where installed outdoors and/or where exposed to moisture) metallic conduit which is not less than 12" long nor more than 36" long.
- C. Provide a safety switch adjacent to, and within sight from, each motor, unless the respective branch-circuit protective device is within fifty (50) feet of, and within sight from, a particular motor and the respective motor starter contains correctly-sized and correctly-rated overload devices protecting all phase conductors. Each such safety switch shall be fused, unless the respective motor starter has correctly-sized and correctly-rated overload devices protecting all phase conductors; in such case the respective safety switch may be the "non-fusible" type.
- D. Provide all wiring to and for all motors, including the feeders to the line side of all starters and contactors, and from the load side of all starters and contactors to the respective motors.

- E. Do not test equipment motors for rotation except in the presence, and under the direction, of qualified representatives of the respective equipment suppliers and/or installers.

1.04 CIRCUITING AND GROUPING OF CIRCUITS

- A. The electrical cables for a maximum of four (4) 20-amp, single-pole circuits which are dedicated to feeding modular furniture workstations for power and which emanate from a common three-phase, four-wire panelboard may be grouped into common raceways, boxes, etc. Otherwise, the electrical cables for two (2) or three (3) 15-amp and/or 20-amp, single-pole circuits which emanate from a common three-phase, four-wire panelboard may be grouped into common raceways, boxes, etc.
- B. Except for the electrical cables for 15-amp, single-pole circuits and for 20-amp, single-pole circuits, group, as a maximum, into common raceways, boxes, etc. the electrical cables for individual circuits as indicated on the drawings.
- C. Unless approved in writing and in advance by the architect, do not install the electrical cables for additional circuits (power, lighting, control, or otherwise) into the above-mentioned, common raceways, boxes, etc.
- D. Where, for any reason, the inclusion of additional electrical cables into such common raceways, boxes, etc. is unavoidable, submit in writing to the architect for review a request indicating exactly which raceways, boxes, electrical cables, circuits, etc. would be involved, and the exact proposed sizes and ratings of all items which would be involved.
- E. Except where the number of electrical cables is indicated on the drawings (e.g., for feeders), determine and provide the number of electrical cables which is required for each individual circuit according to all applicable codes and governing authorities, according to the instructions of the manufacturers of the respective electrical equipment that is being fed, and according to good practice.
- F. Provide a separate-and-distinct neutral conductor for each project circuit which requires a neutral conductor, whether such circuit is a "single-pole" circuit or a "multi-wire" circuit. As a clarification, do not provide any "common neutrals" for this project (a "common neutral" conductor is defined as a neutral conductor which is associated with more than one [1] circuit).
- G. Provide an insulated equipment-grounding conductor in each raceway, box, wireway, etc., whether so indicated on the drawings and/or elsewhere in these specifications or not. Such equipment-grounding conductors shall be sized respectively in accordance with Section 250-122 of the National Electrical Code.

1.05 BALANCING THE SYSTEM

- A. Balance the electrical loads to +/- 10% across the incoming phase conductors at each panelboard and switchboard, and submit to the architect a tabulation of such balancing.

1.06 TORQUING

- A. Torque all project lugs in strict accordance with the respective manufacturers' instructions, with all UNDERWRITERS' LABORATORIES' standards, and with the National Electrical Code, once at connection, and again just prior to project completion.

1.07 TESTING

- A. After the electrical work is complete and at the time that the architect directs, conduct an operating test of each electrical item, equipment, and material for approval. Provide all instruments and personnel which are required for such tests.

1.08 EXCAVATING

- A. Provide all required excavations and backfilling for the proper execution of the work, and remove all dirt and debris. Tamp (utilizing a mechanical compactor where and as practicable) the backfill in 9" layers and water the finished fill. At the completion of the project, fill all low spots.

1.09 CUTTING AND PATCHING

- A. Cut, patch, and paint where required. Obtain the approval of the architect for the cutting of any structural beams or joists. Patching and painting shall be done by the various crafts whose work is respectively involved.

1.10 SAFETY PRECAUTIONS

- A. Provide proper guards for the prevention of accidents. Provide and maintain all other construction which is required to secure safety of life and property, including maintaining sufficient lights where and as required to secure such protection.

1.11 SUPERVISION

- A. Constantly supervise the project work from beginning to completion. Furnish all information and personnel which are required to assist the architect in inspecting the work.

1.12 SLEEVES, INSERTS, CLAMPS, HANGERS, AND OPENINGS

- A. Provide all sleeves and openings through floors and/or walls which are required for the passage of raceways.
- B. Sleeves shall be constructed of Schedule 40 galvanized-steel pipe which is rigidly supported and suitably packed. After the installation of the raceways and/or cables through such sleeves and/or openings, thoroughly and completely seal such sleeves and/or openings so as to be watertight and firestopped. Seal all unused sleeves, thimbles, and/or openings so as to be watertight and firestopped.

- C. Provide inserts, clamps, and hangers where and as required to support all electrical items, equipment, and/or materials. Fasten hangers and clamps to joists and/or beams and not directly to slabs, roof decks, duct work, piping, or conduit.
- D. Provide all required roof penetrations in strict accordance with architectural details and instructions from the architect. Verify all parameters and requirements in advance, and provide accordingly.

1.13 SPECIAL NOTE--CONTRACTOR'S ATTENTION

- A. The horsepowers of motors and the load ratings of equipment which are indicated on the drawings or in the specifications are the estimated horsepowers and load-rating requirements of equipment which is being furnished under other project divisions. Provide raceways, electrical cables, circuit breakers, safety switches, and fuses (also contactors, motor starters, VFD's, etc., where and as applicable) of the respective sizes, ratings, and capacities which are required to suit the horsepowers of the motors and the load ratings of the equipment that are actually being furnished under such various project divisions. However, in no case provide raceways, electrical cables, and safety switches (also contactors, motor starters, VFD's, etc., where and as applicable) having smaller capacities or sizes than those which are respectively indicated on the drawings or in the specifications. Coordinate the requirements of the various divisions of the project drawings and specifications, and provide suitable equipment and electrical facilities therefor, in order that the above requirements will be met, without additional cost to the owner. Note carefully all other divisions of the project drawings and specifications which describe electrical work which shall be provided in order to fully understand the total extent of the required electrical work.

1.14 UNDERGROUND POWER, CONTROL, FIRE-ALARM, COMMUNICATION, AND SECURITY-SYSTEM, PULL BOXES

- A. Provide all underground power, control, fire-alarm, communication, and security-system, pull boxes which are required for the project, whether shown on the drawings or not.
- B. Unless required by any applicable code or by any respective governing authority otherwise, each such pull box which is associated in any way with a public utility shall be in strict accordance with all applicable standards, details, recommendations, requirements, etc. of the respective utility company (request and obtain all relevant information in advance), and shall have a watertight, traffic-duty cover which is inscribed to say "POWER" or "COMMUNICATIONS", as applicable.
- C. Unless shown on the drawings, or required by any applicable code or by any respective governing authority otherwise, each such pull box which is involved with project work that is not associated with a public utility shall be approved for, and shall be completely compatible with, the respective application, and shall have a watertight, traffic-duty cover which is inscribed to say "POWER",

"CONTROL", "FIRE ALARM", "COMMUNICATIONS", or "SECURITY", as applicable.

- D. Each underground power pull box shall meet all requirements of the National Electrical Code, particularly Article 314.

1.15 TEMPORARY ELECTRICAL SERVICE

- A. Provide temporary electrical service for construction power, in strict accordance with the National Electrical Code, all local codes, and all Entergy requirements and recommendations, and disconnect and remove same before the completion of the project.
- B. Make all required arrangements with Entergy, including arrangements for metering and billing.

1.16 SAFETY SWITCHES

- A. Safety switches shall be heavy-duty, fusible (except as specified otherwise herein above), quick-make, quick-break, with cover interlock and, where installed outdoors, shall be U.L.-listed as raintight. The handle for each safety switch shall be lockable in the "open" position and in the "closed" position with up to three (3) padlocks. Fusible safety switches shall include rejection clips which will accept current-limiting fuses and reject all others.
- B. Safety switches shall be manufactured by SCHNEIDER, ABB, SIEMENS, or EATON, or shall be approved equivalent.

1.17 FUSES

- A. Each fuse shall be Class "RK1" (for a 600-amp-or-less application) or Class "L" (for a 601-amp-or-greater application), shall have a minimum U.L.-listed interrupting rating of 200,000 amps, shall provide fast-acting protection against short-circuit currents but time-delayed protection against motor overloads, and shall have a barrel which are yellow in color.
- B. Unless indicated otherwise, the continuous-current rating of each fuse which is provided for a distribution circuit shall be in accordance with the National Electrical Code current-carrying capacity of the conductors of the respective circuit.
- C. Unless indicated otherwise, the continuous-current rating of each fuse which is provided for a motor circuit shall be in accordance with the nameplate of the respective equipment. The exact fuse which is provided for each application involving a motor circuit shall be as determined by the manufacturer of the motor that is being protected, and by the manufacturer of the fuse that is being provided, so that no possibility for a single-phasing condition will exist.
- D. Install each fuse so that its continuous-current rating is readily visible without the need to be removed. As a clarification, on each project punch list, a monetary value will be assigned to each fuse which is not so installed.

- E. Deliver to the owner six (6) spare fuses of each different type and size fuse which is being furnished for the project, and obtain a signed receipt from the owner.

1.18 PROJECT CONDUCTOR AND LUG/TERMINATION TEMPERATURE RATINGS

- A. Ensure that all project conductors and all project lugs/terminations are compatible, as per NEC 110-14(C) and 110-40, as applicable.

1.19 IDENTIFICATION AND DIRECTORIES

- A. Provide at and for each enclosed circuit breaker, panelboard, switchboard, transformer, automatic transfer switch, contactor, unit motor starter, safety switch, pushbutton station, and motor starter switch a laminated plastic nameplate which is engraved with the appropriate device designation. Provide at and for each switchboard and distribution panelboard an engraved laminated plastic nameplate which respectively identifies each branch/feeder circuit.
- B. Provide at and for each panelboard, other than distribution panelboards, a typewritten directory which accurately identifies all respective branch circuits.
- C. Provide at and for the electrical-service-entrance equipment a sign which indicates the types and locations of all on-site "emergency" power sources.
- D. At and for the remote (i.e., remote from the on-site "emergency" power sources) location where the grounded circuit conductor which is connected to the on-site "emergency" power sources are connected to a grounding-electrode conductor, provide a sign which identifies all "emergency" and "normal" power sources that are connected at such location.

1.20 RACEWAYS AND ELECTRICAL CABLES

- A. At, in, and for the Medical Areas, wiring in patient-care spaces shall comply with NFPA70:517.13(A) and (B), as well as with the requirements of all other applicable codes and governing authorities. As a clarification, patient-care spaces also include (but are not limited to) examining rooms, treatment rooms, therapy areas, recovery rooms, procedure rooms, patient corridors, etc.
- B. Electrical cables shall be installed in raceways which are concealed to the full extent which is practicable (verify in advance).
- C. Raceways which are installed below grade and beneath building floor slabs shall be Schedule 40 PVC conduit, with long-radius, rigid, galvanized-steel, conduit elbows where rising to above grade or concrete.
- D. Raceways which are installed below grade, but not beneath building floor slabs, and which are either for the Entergy-provided, main-transformer-primary, incoming-service, power cables or for the contractor-provided, main-transformer-secondary, underground, service-lateral-feeder, electrical cables, shall be Schedule 40 PVC conduit, with long-radius, rigid, Schedule 80 PVC, conduit elbows where rising to above finished grade or concrete. Such raceways shall

be 4'-0" minimum below finished grade. Provide the proper warning tape, at 1'-0" below finished grade, immediately above, and running parallel with, each underground raceway, for the entire length of such raceway.

- E. Raceways which are installed below grade, but not beneath building floor slabs, and which are neither for the Entergy-provided, main-transformer-primary, incoming-service, power cables nor for the contractor-provided, main-transformer-secondary, underground, service-lateral-feeder, electrical cables, shall be Schedule 40 PVC conduit, with long-radius, rigid, Schedule 40, galvanized-steel, conduit elbows where rising to above finished grade or concrete. Such raceways shall be 3'-0" minimum below finished grade. Provide the proper warning tape, at 1'-0" below finished grade, immediately above, and running parallel with, each underground raceway, for the entire length of such raceway.
- F. Raceways which are installed below grade, but not beneath building floor slabs, shall be encased in red-tinted-concrete envelopes, 3" minimum all around.
- G. Raceways which are completely concealed within walls or above ceilings shall be electrical metallic tubing (EMT), except in locations where any governing authority or the National Electrical Code does not permit its use. In such locations, rigid metallic conduit shall be provided.
- H. Exposed raceways in unfinished interior areas shall be EMT, unless prohibited by any governing authority or the National Electrical Code, or unless subject to mechanical abuse. In such cases, rigid metallic conduit shall be provided.
- I. At, in, and for the Medical Areas, branch circuits serving patient-care spaces shall be provided with an effective ground-fault current path by installation in a metal raceway system. Such metal raceway system shall be listed and identified for grounding, and shall itself qualify as an equipment-grounding conductor, independent of the second component of this grounding method required by NFPA70:517.13(B), in strict accordance with NFPA70:250.118. Submit to the state fire marshal's office, and to all other applicable governing authorities, for approval, complete information, as required by the state fire marshal's office, and as required by all other applicable governing authorities, verifying such listing and such identification. However, as a clarification, metal-clad and metal-sheathed cables are not allowed for this project, and shall not be provided, except that listed, flexible raceways and metal-sheathed-cable assemblies are allowed, and may be provided, for limited application only where used in listed fabricated medical headwalls or in listed office furnishings, and only where not subject to physical damage.
- J. As per NFPA101:7.1.3.2(10), electrical conduits shall not penetrate (including penetrations into, and openings through) the enclosure walls of any exit enclosure assembly unless each such conduit is directly serving devices within the respective exit enclosure.
- K. Exposed raceways in finished interior areas shall be WIREMOLD, WALKERDUCT, or PORTER surface-type, metallic raceways. Notify the architect before installing any exposed raceways in finished interior areas so that

possible alternate routings using concealed raceways might be found. As a clarification, the architect and the owner will not entertain the provision of exposed raceways in finished areas unless such provision is justified (as determined by the architect) as a result of unusual conditions. Be advised of the owner's strong desire for no exposed raceways to be provided in finished areas.

- L. Above-grade, exterior raceways shall be rigid metallic conduit.
- M. Install exposed raceways so as to be parallel or perpendicular to building or structural lines.
- N. EMT and metallic conduit shall be galvanized steel.
- O. EMT connectors and couplings shall be the "compression-type". "Set-screw-type" connectors and couplings are unacceptable and shall not be provided.
- P. Support raceways by pipe straps, conduit clamps, hangers, or other approved fastening devices. Do not provide tie wires for such application.
- Q. Provide an approved expansion fitting wherever a raceway crosses an expansion joint.
- R. Keep raceways at least 12" from parallel runs, and at least 6" from perpendicular runs, of hot-water pipes.
- S. In runs of flexible metallic conduit, where 90-degree bends of less than 6" radius are unavoidable, use 90-degree fittings or connectors, as required. Do not install flexible metallic conduit for 90-degree bends of less than 6" radius.
- T. Raceways serving roof-mounted equipment shall penetrate the roof inside of the respective equipment curbs, to the full extent which is practicable (verify in advance); otherwise the penetrations shall be within 18" of the respective equipment. External penetrations shall be sheathed through the roof allowing conduits to have free movement. Each conduit shall have a weathercone. The sleeve shall be sealed with a watertight compound.
- U. Provide pull boxes where and as required. Each pull box shall be of code-gauge steel, and shall have a removable access panel in its side, top, or bottom, as required.
- V. Do not install horizontal runs of raceways in slabs, unless special permission for each such run is obtained from the architect in advance.
- W. Where vertical raceway runs interrupt more than 12" of structural concrete in any direction, reinforce the concrete in accordance with typical reinforcing details.
- X. Provide an insulated equipment-grounding conductor in each raceway system, wireway, etc., whether so indicated on the drawings and/or elsewhere in these specifications or not. Such grounding conductors shall be sized respectively in accordance with Section 250-122 of the National Electrical Code (verify in advance and provide accordingly).

- Y. Conductors shall be of soft-drawn copper having the ampacity of at least ninety-eight percent (98%) of that of pure copper.
- Z. Unless noted otherwise, the minimum conductor size shall be No. 12 AWG. 15-amp and 20-amp, 120-volt or 208-volt, circuit runs of from 75 feet to 199 feet in length, and 15-amp and 20-amp, 277-volt or 480-volt, circuit runs of from 175 feet to 449 feet in length, to the ends of the respective loads shall have conductors which are sized no smaller than No. 10 AWG; 15-amp and 20-amp, 120-volt or 208-volt, circuit runs of from 200 feet to 349 feet in length, and 15-amp and 20-amp, 277-volt or 480-volt, circuit runs of from 450 feet to 799 feet in length, to the ends of the respective loads shall have conductors which are sized no smaller than No. 8 AWG; and 15-amp and 20-amp, 120-volt or 208-volt, circuit runs that are longer than 349 feet in length, and 15-amp and 20-amp, 277-volt or 480-volt, circuit runs that are longer than 799 feet in length, to the ends of the respective loads shall have conductors which are sized no smaller than No. 6 AWG. The conductor size shall be the same throughout each circuit.
- AA. Unless noted otherwise, size all conductors in accordance with the ratings of the respective protective devices and in accordance with the requirements of Article 240-OVERCURRENT PROTECTION of the National Electrical Code.
- BB. Provide variable-frequency-drive (VFD) electrical cables from each project VFD to the respective motor. Provide termination kits which are designed, manufactured, installed, and connected specifically for the exact, helical, copper-tape shields that are provided (verify in advance). Each VFD cable:
 - 1. Shall consist of three (3) conductors;
 - 2. Shall be rated 90 degrees C., wet or dry;
 - 3. Shall have stranded conductors which are insulated with heat-and moisture-resistant, cross-linked polyethylene
 - 4. Shall have phase-identified conductors;
 - 5. Shall have such insulated conductors cables together with suitable fillers and with three (3) symmetrical, bare-copper, equipment-grounding conductors;
 - 6. Shall have a 5-mil thick, helical, copper-tape shield and an overall, flame-and-sunlight-resistant, black, PVC jacket;
 - 7. Shall be code-approved and UL-listed specifically for VFD application; and
 - 8. Shall be in strict accordance with UL 1227, IEEE 383, IEEE 1202, ICEA T-29-520, and ICEA S-95-658/NEMA WC-70.
- CC. Unless noted otherwise, electrical cables shall be the single-conductor type.
- DD. Unless noted otherwise, electrical cables shall be Type "THHN/THWN" (75-degree C. rating) or Type "XHHW" (75-degree C. rating).
- EE. Conductors which are sized No. 8 AWG or larger shall be stranded; conductors which are sized smaller than No. 8 AWG shall be solid, except that conductors which are provided purely for control work may be stranded.

- FF. Wiring which is installed in spaces that are being used, or will be used, as air plenums or for environmental air shall be in accordance with Section 300-22 of the National Electrical Code.
- GG. Color code electrical cables in strict accordance with the National Electrical Code. Unless required otherwise by any applicable code or governing authority, the insulation on electrical cables shall be color coded as follows:
1. 277/480-Volt, Three-Phase, Four-Wire, Wye-Connected System:
 - a. Phase A - brown
 - b. Phase B - orange
 - c. Phase C - yellow
 - d. Neutral - white or grey
 - e. Equipment ground - green
 2. 120/208-Volt, Three-Phase, Four-Wire, Wye-Connected System:
 - a. Phase A - black
 - b. Phase B - red
 - c. Phase C - blue
 - d. Neutral - white
 - e. Equipment ground - green
- HH. On each phase-conductor cable and on each neutral-conductor cable (not on equipment-grounding-conductor cables) in each outlet and junction box, provide a permanent cable marker which indicates from which panelboard or switchboard, and from which pole number in such panelboard or switchboard, it is fed.

1.21 OUTLET BOXES

- A. Provide all outlet boxes which are required for electrical devices and connections, whether so indicated on the drawings or not. Each outlet box shall be U.L. listed, and shall be suitable and approved for the exact applications for which it is provided.
- B. As per NFPA101:8.3.5.6.3, electrical outlet boxes which are located on opposite sides of any fire-rated wall shall be separated by not less than 24" horizontally, and the required openings shall not exceed a total of 100 square inches per 100 square feet of wall area.
- C. Each outlet box for a lighting fixture or for another type of ceiling outlet shall be galvanized steel. Each such outlet box which is provided for a lighting fixture shall have a 3/8" fixture stud protruding through, and fastened to, the back of the box.
- D. Each floor-mounted, outlet box shall be cast iron or PVC; shall be fully adjustable before and after the respective floor installation; shall be the flush type; shall be watertight; shall be appropriate for the depth of the respective floor; shall have a carpet flange, if required; and shall have the appropriate screw-type cover. The cover for each such outlet box shall be brass or aluminum, as respectively selected by the architect (verify in advance and provide accordingly). Where practicable, each such outlet box which is provided in a location that requires both (a) power connection(s) and communication wiring shall be the combination

type with (a) divider(s) where and as necessary to separate the "electrical-power" section(s) from the "communication" section(s). "Pedestal-type" and "tombstone-type" floor outlet boxes are unacceptable and shall not be provided.

- E. Surface-mounted outlet boxes which are provided for weatherproof switches and receptacles shall be corrosion-resistant; cast iron; and Type "FS" or "FD", as required for the respective application; verify in advance and provide accordingly.
- F. Covers for switches and receptacles in damp or wet locations shall be metallic, and shall be U.L. listed and code approved as being weatherproof. Weatherproof covers which are provided for receptacles in wet locations shall be weatherproof while the respective receptacles are in use.
- G. Each outlet box which is provided for exposed work in an unfinished interior area shall be corrosion-resistant; cast iron; Type "FS" or "FD", as required for the respective application (verify in advance and provide accordingly); and of the proper number of gangs, with surface-wiring-type cover plates. "Flush-type" boxes (e.g., sheet metal boxes with knockouts, etc.) for such application are unacceptable, as are plaster rings with standard receptacle or switch plates.
- H. Each outlet box which is provided for exposed work in a finished interior area shall be the surface-type and metallic, of the proper number of gangs, with a surface-wiring-type cover plate. "Flush-type" boxes (e.g., sheet metal boxes with knockouts, etc.) for such application are unacceptable, as are plaster rings with standard receptacle or switch plates. Notify the architect before installing any surface-mounted outlet/junction boxes in finished interior areas so that possible alternate installations utilizing recessed outlet/junction boxes might be found. As a clarification, the architect and the owner will not entertain the provision of exposed outlet/junction boxes in finished interior areas unless such provision is justified (as determined in advance by the architect and the owner) as a result of unusual conditions, etc. Be advised of the owner's strong desire for no surface-mounted outlet/junction boxes to be provided in finished interior areas.

1.22 SWITCHES

- A. Switches shall be U.L. listed and approved for the respective applications for which they are provided and shall have minimum ratings which are equal to the ratings of the respective loads that they control.
- B. Switches shall have a minimum continuous-current rating of 20 amps.
- C. Switches which are provided in dormitory areas and day rooms of housing units, and all other receptacles which are designated on the drawings as "security-type" devices, shall be equipped with "security wall plates" (with tamperproof screws). Reference the project-specification paragraph which is entitled "Interior Wiring-Device Cover Plates", and the associated subparagraphs, for more information.
- D. Each switch which is provided in and for other project areas shall be industrial-specification grade with a nylon or urea housing and a steel mounting strap; switches which are equipped with plastic or nylon mounting straps are unacceptable and shall not be provided. Switches may be back wired and/or

side wired (this contractor's option), but each back-wired switch shall utilize pressure connections which require the side screws to be tightened; wires that are held with "clip-type" mechanisms are unacceptable and shall not be provided. This contractor shall tighten the screws on all unused switch terminations so as to reduce the possibility of protruding screws faulting (shorting) to the respective outlet boxes.

- E. Switches which control motor circuits shall be motor-rated, shall have "on" pilot lights, and shall have minimum ratings that are equal to the ratings of the respective loads which they control.
- F. Install switches in suitable metallic boxes and, where they are installed adjacent to doors, locate them on the strike side of the respective doors, whether so indicated on the drawings or not. Install each switch, except for three-way and four-way switches, so that its "up" position closes, and its "down" position opens, the respective circuit.
- G. The colors of switches shall be as respectively selected by the architect.
- H. Switches which are installed adjacent to lighting dimmers shall match the appearance of such adjacent lighting dimmers (as approved in advance by the architect).

1.23 RECEPTACLES

- A. Rigidly fasten receptacles to their respective outlet boxes so that they do not depend on their respective cover plates for support.
- B. Install each vertically-mounted receptacle so that its "equipment-ground hole" is oriented downward (i.e., its blades are oriented upward) and install each horizontally-mounted receptacle so that its "equipment-ground hole" is oriented to the left (i.e., its blades are oriented to the right).
- C. Receptacles which are connected to 20-amp circuits shall be rated 20 amps.
- D. In, at, and for the Medical Areas, receptacles which are provided in and for patient-care spaces, and all other receptacles which are so indicated on the drawings, shall be "hospital grade". The grounding terminal of each such receptacle shall be connected to an insulated, copper, equipment-grounding conductor which is sized in accordance with NFPA70:Table 250.122.
- E. Receptacles which are provided in dormitory areas and day rooms of housing units, and all other receptacles which are designated on the drawings as "security-type" devices, shall be equipped with "security wall plates" (with tamperproof screws). Reference the project-specification paragraph which is entitled "Interior Wiring-Device Cover Plates", and the associated subparagraphs, for more information.
- F. Each receptacle which is provided in and for other project areas shall be "industrial-specification" ("high-commercial") grade with a nylon housing and a steel mounting strap; receptacles which are equipped with plastic or nylon

mounting straps are unacceptable and shall not be provided. Receptacles may be back wired and/or side wired (this contractor's option), but each back-wired receptacle shall utilize pressure connections which require the side screws to be tightened; wires held with "clip-type" mechanisms are unacceptable and shall not be provided.

- G. All receptacles which are located in patient rooms of the Medical Areas, bathrooms, activity rooms, etc. of pediatric areas, or spaces with similar risk as determined by the governing body of the facility (verify in advance), shall be listed as being tamper-resistant, or shall be equipped with listed tamper-resistant covers.
- H. Each wall-mounted and/or floor-mounted receptacle which is indicated on the drawings as a USB-charging, duplex receptacle shall be a 20-amp, 125-volt, 3-wire-grounding-type, duplex receptacle which is equipped with two (2) 3-amp. 5-volt DC, charging ports.
- I. Tighten the screws on all unused receptacle terminations so as to reduce the possibility of protruding screws faulting (shorting) to the respective outlet boxes.
- J. Provide receptacles with integral ground-fault protection (or provide ground-fault-interrupting-type, circuit breakers for the respective branch circuits, where and as indicated. and where and as applicable) for outdoor receptacles, for receptacles which are installed in wet locations, and for all other receptacles which are required by code to render "ground-fault" protection.
- K. Receptacles shall be in strict accordance with the requirements of all applicable articles, sections, and figures of the National Electrical Code Handbook, and in strict accordance with the applicable, ANSI/NEMA, receptacle-configuration standards.
- L. Receptacles shall be marked as required to indicate the respective panelboards and circuit numbers which supply them.
- M. The colors of receptacles shall be as respectively selected by the architect.

1.24 INTERIOR WIRING-DEVICE COVER PLATES

- A. Wiring devices (e.g., receptacles, switches, communication outlets, etc.) which are provided in dormitory areas and day rooms of housing units, and all other wiring devices which are designated on the drawings as "security-type" devices, shall be vandalproof, and shall be provided with cast-metal outlet boxes and with "security wall plates" (with tamperproof screws). Such wiring devices, outlet boxes, and cover plates shall be approved by the architect before the preparation of the respective shop drawings, and before being ordered.
- B. Each such "security wall plate":
 - 1. Shall be of one-piece, injection-molded, high-strength, polycarbonate/nylon-blend construction which has a high-impact and high-abuse resistance and is virtually unbreakable;
 - 2. Shall be smudge resistant, 100% rust proof, and extremely durable;

3. Shall be able to be attached to any surface when installed with its included hardware;
 4. Shall be oversized so as to accommodate its mounting directly to any wall type, and to allow for J-box-opening and mounting-surface imperfections;
 5. Shall be equipped with protective side-impact lips;
 6. Shall include a tamperproof fastening system;
 7. Shall have smooth, rounded corners;
 8. Shall be manufactured in the USA to the ISO Quality Standard; and
 9. Shall be CORTECH "Tiger Plate" Series "TP", or approved equivalent.
- C. Interior wiring-device (e.g., receptacle, switch, communication-outlet, etc.) cover plates for other project areas (i.e., non-secure areas) shall be super stainless steel, Type 302. Figure the project proposal with the assumption that the project wiring-device cover plates will indeed be super stainless steel, Type 302 but, before preparing the project shop drawings and before ordering the project wiring-device cover plates, verify with the architect whether or not super stainless steel, Type 302, cover plates are indeed desired for the project. If so, provide super stainless steel, Type 302, cover plates; if not, provide flexible nylon or polycarbonate (and expressly not phenolic plastic) cover plates.
- D. The colors of interior, wiring-device, cover plates, if not stainless-steel, Type 302, shall be as respectively selected by the architect.
- E. The cover plates for all project receptacles shall be adequately and substantially marked (utilizing a method which is approved by the owner in advance; verify) as required to indicate the respective panelboards and circuit numbers which supply them.

1.25 OUTLETS

- A. Provide outlets where and as shown on the drawings, and where and as required, and provide wiring for the controls which are respectively indicated and required. Accurately locate outlets. Unless specified herein or indicated on the drawings otherwise, locate outlets as follows (each dimension which is given is from finished floor to the centerline of the respective outlet, unless noted otherwise):
1. Wall-mounted, all-communication outlets (ACO's), switch outlets, dimmer outlets, and receptacle outlets which are located above counter tops: 6" above the respective counter-top back splashes;
 2. Wall-mounted ACO's, switch outlets, dimmer outlets, and receptacle outlets which are located above work tables: 6" above the respective working surfaces;
 3. ACO's for wall telephones: 4'-0";
 4. ACO's and receptacle outlets in modular furniture: shall be located in the appropriate, integral, modular-furniture raceways, as per the modular-furniture manufacturer's instructions (verify in advance);
 5. All other wall-mounted, switch outlets and dimmer outlets: 4'-0";
 6. All other wall-mounted, ACO's, and receptacle outlets: 1'-6";
 7. Pushbutton and fire-alarm-pull-station outlets: 4'-0"; and
 8. Access-control-card-reader outlets, keypad outlets, and other security-system outlets: the respective heights which are stipulated in the security-

system specifications and/or indicated on the project security-system drawings (verify in advance).

- B. The face of each recessed outlet box shall not be more than 1/8" from the respective finished face. Install each recessed outlet box at such a height so as to require the cutting of only one (1) course of brick, block, or tile. Have a mechanic at the project site at such times as necessary to locate outlet boxes in order to comply with such requirement.

1.26 CONCRETE

- A. Concrete for electrical work shall be ready-mix and, except for concrete for underground electrical duct banks, shall develop a compressive strength of 4000 p.s.i. (minimum) within twenty-eight (28) days.
- B. Concrete which is provided for underground electrical duct banks shall develop a compressive strength of 1500 p.s.i. (minimum) within twenty-eight (28) days and shall have an approved, red coloring agent added to the concrete mixture in sufficient quantity as required to provide an apparent red color to the concrete after setting.
- C. Thoroughly compact concrete during and immediately after pouring, and thoroughly work concrete into the corners of the respective forms.
- D. Provide a 4" high, reinforced-concrete, housekeeping pad for each piece of floor-mounted, indoor, electrical equipment and provide a 6" high, reinforced-concrete, housekeeping pad for each piece of ground-mounted, outdoor, electrical equipment.

1.27 SEALING AND FIRESTOPPING

- A. Seal with an approved sealing compound all raceways which are required to be sealed.
- B. Provide firestopping in strict accordance with details which are furnished by an approved testing agency (U.L.) for all penetrations of vertical and horizontal fire-rated assemblies, as per Section 713 of the IBC. Request and obtain all such details in advance.
- C. Inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems and perimeter fire-barrier systems shall be in strict accordance with Section 1705.16 of the IBC. Employ and pay an approved inspection agency to inspect penetration firestop systems which are tested and listed in accordance with Sections 714.3.1.2 and 714.4.1.2 of the IBC, in accordance with ASTM E 2174, and to document all such compliance. Employ and pay an approved inspection agency to inspect fire-resistant joint systems which are tested and listed in accordance with Sections 715.3 and 715.4 of the IBC, in accordance with ASTM E 2393, and to document all such compliance. Submit compliance documentation, as well as the certification of such inspection agency's approval status, to the architect.

- D. As per NFPA101:8.3.5, penetrations through rated construction shall be sealed by approved firestop systems or devices which are tested in accordance with ASTM E-814 or ANSI/UL 1479, or by assemblies or firestopping materials that are capable of preventing the passage of flames and hot gasses when tested and rated in accordance with NFPA 251 (such requirement shall apply to electrical outlets, light switches, etc.). Detailed, instructive, cut sheets of the fire-penetration-sealing system which is being provided shall be furnished to the inspector at the time of the inspection. Random selective sampling shall be furnished by the contractor for observation by the inspector, upon the inspector's command.

1.28 GROUND RODS

- A. Ground rods shall be 3/4" diameter x 10'-0" long, copper-clad steel with braze, irreversible-crimp, or thermal-weld connectors for the connection of grounding cables.
- B. Bond all electrical-system-grounding and equipment-grounding means to the project underground ground ring, to all telecommunication-system equipment-grounding means, to all metallic water piping (e.g., the incoming and outgoing water piping to water heaters, as well as the water heaters themselves, etc.), to all natural-gas piping, to all metallic building structures, to the required concrete-encased electrodes [as per NFPA70:250.52(A)(3)]; and to the facility lightning protection system(s). The electrical cables which are provided for all such bonding shall be sized the same as the project grounding-electrode cable.

1.29 CONNECTION OF COMPUTER (DATA) EQUIPMENT

- A. Connect all computer (data) equipment.
- B. The connection for power shall be in the form of a grounded receptacle. Provide matching plugs on equipment cords if, where, and as required.
- C. Each piece of equipment shall be fed from a circuit which includes an equipment-grounding cable.
- D. For each piece of equipment, provide an all-communication outlet (ACO), and provide the appropriate, computer (data)/telephone (voice) jacks and station cables and associated raceways. For more information, specifications, and requirements which are relative hereto, reference DIVISION 27 0000 - COMMUNICATIONS.

1.30 DIMMERS

- A. Provide LED lighting dimmers where and as shown on the drawings, and where and as required, for the respective light control which is indicated.
- B. Dimmer installations shall include the appropriate outlet boxes and cover plates.

- C. Dimmers which are installed in gangs shall be installed, in strict accordance with instructions from the dimmer manufacturer, so that derating of the dimmers is not required.
- D. The colors of the handles of the dimmers, and the respective cover plates (faceplates), shall be as respectively selected by the architect; verify in advance and provide accordingly.
- E. LED dimmers shall be completely compatible with the corresponding dimming LED drivers in and for the respective lighting fixtures. Whether specifically stipulated in the lighting-fixture descriptions (or catalogue numbers) or not, provide the proper dimming LED drivers (of the proper manufacture) so that such compatibility is realized.
- F. Each LED dimmer which is provided for 0-10V dimming application:
 - 1. Shall be UL-listed for the exact application for which it is provided;
 - 2. Shall be equipped with a large paddle switch with a captive, linear-slide control, and shall be compatible with a standard, designer-opening, wall plate;
 - 3. Shall be completely compatible with all third-party, LED lighting fixtures (verify in advance);
 - 4. Shall be able to be connected for single-pole, 3-way, or 4-way application (as selected in the field, at the project site), and shall be connected for single-pole, 3-wire, or 4-way operation as required for the application for which it is provided, in strict accordance with the appropriate wiring diagrams which are furnished by the dimmer manufacturer directly to this contractor (request and obtain all required wiring diagrams in advance);
 - 5. Shall have a rated operating voltage of from 120VAC to 277VAC;
 - 6. Shall be equipped with power-failure memory;
 - 7. Shall be able to be furnished with accompanying Claro switches and coordinating wall plates;
 - 8. Shall be equipped with field-adjustable, high-end and low-end, trim settings, for optimal performance;
 - 9. Shall be rated as required to control up to fifteen (15) LED drivers; and
 - 10. Shall be LUTRON Model Number DVSTV-XX or Model Number DVSTV-453PH-WH, or shall be LUTRON Model Number DVTV-XX with the required LUTRON Model Number PP-DV power pack (so as to render it applicable for 120VAC to 277VAC driver/ballast-switching operation), as required for the exact application for which it is provided, and for the amount of electrical load that is respectively being controlled (verify in advance and provide accordingly), or shall approved equivalent by ACUITY, ETC, or WATT-STOPPER.
- G. Switches which are installed adjacent to lighting dimmers shall match the appearance of such adjacent lighting dimmers (as approved in advance by the architect).

1.31 SYSTEMS OF WIRING

- A. The systems of wiring shall be 120/208 and 277/480 volts, three phase, four wire, wye connected.

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1.32 SERVICE ENTRANCE

- A. The service entrance shall be from underground.

1.33 MEDIUM-VOLTAGE, TRANSFORMER-PRIMARY, UNDERGROUND CONDUITS

- A. Provide the empty, underground conduits, with pull wires, for the Entergy-provided, medium-voltage, main-power-transformer, primary cables, and provide an additional, "spare", underground conduit, with pull wire, according to all Entergy requirements. Such conduits shall have a 4'-0" minimum soil cover (more if so directed by Entergy; verify in advance). Provide the required warning tape at the proper depth directly above each such underground raceway, for its entire length. Extend such conduits underground to the location which is designated by Entergy and cap them, or terminate them as service risers with weatherheads on an Entergy power pole, as directed by Entergy. Verify all parameters and requirements in advance, and provide accordingly.
- B. For the purpose of making the project proposal, assume that the required size of such conduits will be as indicated on the drawings; that one (1) Entergy-approved, underground pull box will be required; and that the Entergy-designated, power-supply-connection location will be as indicated on the drawings, and include all related costs in the project proposal, except include in the project proposal the cost for an additional 100'-0" distance for each such conduit. The actual amount which will be paid to this contractor for such project work will be adjusted upward (in the form of an additive change order) or downward (in the form of a credit change order) from such figure when the actual size of such conduits, the actual number of pull boxes, and the actual power-supply connection location are established.
- C. Conduit bends shall be the "long-radius" type.

1.34 LOW-VOLTAGE, TRANSFORMER-SECONDARY, SERVICE-LATERAL, UNDERGROUND CONDUITS AND ELECTRICAL CABLES

- A. Provide the main, incoming-power, transformer-secondary, low-voltage, service-lateral, underground conduits, spare conduits with pull wires, and electrical cables, where and as indicated on the drawings, and where and as required, in strict accordance with all Entergy requirements. Such conduits shall have a 4'-0" minimum soil cover (more if so directed by Entergy; verify in advance). Verify all parameters and requirements in advance, and provide accordingly.
- B. Conduit bends shall be the "long-radius" type..

1.35 TRANSFORMER SLAB AND GROUnding

- A. Provide the reinforced-concrete slab and the concrete-filled-pipe, protection bollards for the pad-mounted, main, power transformer.
- B. The size of the slab and the total installation shall be in strict accordance with drawings, details, and/or directions which are furnished directly to this contractor

by Entergy (request and obtain all relevant information directly from Entergy in advance).

- C. The concrete-filled-pipe, protection bollards and the total installation shall be in strict accordance with drawings, details, and/or directions which are furnished directly to this contractor by Entergy (request and obtain all relevant information directly from Entergy in advance).
- D. Provide the grounding system for such transformer installation.
- E. The grounding system for such transformer installation shall conform fully to Entergy's requirements, and shall be in strict accordance with all drawings, details, and/or directions which are furnished directly by Entergy to this contractor (request and obtain all relevant information directly from Entergy in advance). Such grounding system shall include grounding rods, conductors, connectors, clamps, and all other required apparatuses.
- F. Coordinate fully the power requirements of this project with Entergy, and conform fully to Entergy's requirements.
- G. Pay all expenses which are incurred in meeting these requirements and include such costs in the project proposal.

1.36 DISCONNECTION, RELOCATION, AND RECONNECTION OF THE EXISTING, ENTERGY, TIMBER, POWER POLES; THE ASSOCIATED, EXISTING, OVERHEAD, PRIMARY, POWER LINES; ETC., WHICH ARE LOCATED ON THE PROJECT SITE AND WHICH ARE IN CONFLICT WITH THE PLANNED PROJECT CONSTRUCTION

- A. As soon as possible following the execution of the project construction contract, contact directly, and coordinate directly and fully with, Entergy as required:
 - 1. To determine all of the existing Entergy facilities which are in conflict with the planned project construction; and
 - 2. To have Entergy completely disconnect, relocate, and reconnect all of the existing Entergy facilities which are in conflict with the planned project construction including, but not limited to, the existing, timber, power poles; the associated, existing, overhead, primary, power lines; etc.
- B. In doing so, arrange the scheduling for such work with Entergy so that all such work will be completed before the commencement of the project construction, so as to accommodate such project construction.
- C. Ascertain, from Entergy, the exact total amount of the charges (if any) which Entergy is required to be paid for such work, well in advance of the date on which such charges need to be paid to Entergy (verify), and then so advise the architect. As a clarification, the payment of such charges (if any) which Entergy is required to be paid for such work will be paid directly to Entergy by the owner.

1.37 GROUND-FAULT PROTECTION OF EQUIPMENT, AND GROUND-FAULT MONITORING, INDICATION, AND ALARM

- A. Provide ground-fault protection of equipment at all locations where and as required by the National Electrical Code or any other applicable code (whether so indicated on the drawings or specified elsewhere herein, or not), at all locations where and as required by any governing authority (whether so indicated on the drawings or specified elsewhere herein, or not), and at all locations where and as otherwise stipulated elsewhere herein and/or indicated on the drawings, particularly for solidly-grounded-wye, electrical services of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, for each service disconnecting means which is rated 1000 amperes or more, and for each other service, main, and feeder (branch) disconnecting means which is so stipulated herein or on the drawings, including the Service-Entrance-Rated, Main ("Normal-Power"), Enclosed, Circuit Breaker ("MECB"), and all feeder protective devices of Main ("Normal-Power") Switchboard "MSB".
- B. Where "circuit breakers" are indicated on the drawings, or specified elsewhere herein, to be provided in locations where such ground-fault protection of equipment is required, provide "shunt-trip" type, or other U.L.-listed and code-approved-type, circuit breakers having "electrically-operated tripping", having the proper U.L.-listed and code-approved ground-fault-sensing and ground-fault-tripping devices, and having all other devices which are necessary to render the required ground-fault protection of equipment.
- C. Factory set the ground-fault protection at and for all protective devices in strict accordance with the requirements of all applicable codes and governing authorities, and as required to render 100%, full, tripping-and/or-indication (as applicable) selectivity between and among all upstream and downstream protective devices; verify all parameters in advance and provide the proper settings accordingly. Each such ground-fault-protection system shall operate to cause the respective service, main, or feeder disconnecting means to open all ungrounded conductors of the respective faulted circuit, and each such ground-fault-indication system shall operate to render the proper visual and audible alarms.
- D. Provide ground-fault monitoring, indication, and alarm (but not protective-device-tripping protection) at and for all locations where and as required by the National Electrical Code or any other applicable code (whether so indicated on the drawings or specified elsewhere herein, or not), at and for all locations where and as required by any governing authority (whether so indicated on the drawings or specified elsewhere herein, or not), and at and for all locations where and as otherwise stipulated elsewhere herein and/or indicated on the drawings, e.g., at and for the mainline, output, circuit breaker of each genset.
- E. Unless indicated otherwise on the drawings, or specified elsewhere herein, factory set the ground-fault protection for the MECB, and factory set the ground-fault monitoring, indication, and alarm for the mainline, output, circuit breaker of each of the gensets, at 1100 amperes, and factory set, for each, the time delay at 0.75 second for ground-fault currents which are equal to, or greater than, 3000 amperes. Factory set the ground-fault protection for each of the Main

Switchboard "MSB", feeder, circuit breakers at lower levels, as compared to such levels for the MECB, so that the required circuit-breaker-tripping selectivity is realized, but so that proper protection is rendered. Each such ground-fault-protection system shall operate to cause the respective, service or feeder, disconnecting means to open all ungrounded conductors of the faulted circuit.

1.38 FAULT-CURRENT STUDY, OVERCURRENT-PROTECTIVE-DEVICE COORDINATION STUDY, AND ARC-FLASH STUDY

- A. Scope:
1. Provide a fault-current study, overcurrent-protective-device-coordination study, and an arc-flash study, which are referenced herein below collectively as "the study", and which are relevant to all portions of the project, electrical, power-generation-and-distribution systems;
 2. The engineering analyses of the study shall include a short-circuit analysis, with protective-device evaluations; a protective-device coordination study; and an arc-flash study with labels; and
 3. Such analyses shall begin at the point of Entergy's service, and at the outputs of the project gensets, for the project and shall continue down through all new portions of the project, electrical, power-generation-and-distribution systems.
- B. Related Documents:
1. The project electrical drawings; and
 2. The project electrical specifications.
- C. Submittals:
1. Unless stipulated otherwise below, make all submittals in strict accordance with all submittal requirements which are stipulated elsewhere in these specifications;
 2. Submit an electronic copy of the study report before the submittal of the shop drawings for the affected project equipment, or no later than at the same time as the submittal of the project, electrical equipment, shop drawings;
 3. Shop drawings for equipment which is relevant to the study will not be reviewed until the study report has been submitted, reviewed, and accepted;
 4. Such study shall include qualification data indicating the qualifications of the firm and the person(s) who are responsible for the study, as required to demonstrate their capabilities and experience, including a list of completed projects with the respective project names and addresses, the name of the engineer, and the name of the respective project owners, as well as other qualifying information;
 5. Such study shall include a one-line diagram of all portions of the system on which the study is based;
 6. An electronic copy of the final report shall be submitted; and
 7. The hard copies (three [3] copies are required) of the final report shall be bound in three-ring binders, and submitted
- D. Related Standards: The study shall be performed in accordance with the latest applicable IEEE and ANSI standards.

- E. Quality Assurance:
1. The firm who is performing the study shall have experience in the analysis, evaluation, and coordination of electrical, power-generation-and-distribution systems which are similar to the electrical, power-generation-and-distribution systems for this project. Such firm shall have, at a minimum, a 4-year record of successful in-service performance; and
 2. The study shall be prepared in accordance with the latest edition of NETA Std. ATS, NFPA 70B, the "National Electrical Code", ANSI C2, the "National Electrical Safety Code", and ANSI/IEEE Guidelines, as well as in accordance with the recommendations of the affected equipment manufacturers.
- F. Manufacturer: The study shall be performed by the manufacturer who is furnishing the majority of the project, electrical, power-distribution equipment.
- G. Short-Circuit Analysis with Protective-Device Evaluations:
1. Fault currents shall be systematically calculated based on the available fault current at the project, electrical, service entrance. The study preparer shall obtain the available fault current information, and all other required information, directly from Entergy;
 2. Short-circuit calculations shall be prepared by means of a digital computer, utilizing a commercially available, software package. The results of the short-circuit calculations shall be presented in tabular form, and shall include momentary and interrupting, fault values for three-phase and phase-to-ground faults;
 3. The short-circuit currents shall be analyzed while preparing a tabulation that compares the fault-current levels to the respective, device, interrupting ratings. Areas in which integrated/series ratings are utilized shall be indicated. The following information shall be included in the tabulation:
 - a. Bus identification numbers;
 - b. Location identifications;
 - c. Voltages;
 - d. Manufacturers and types of equipment;
 - e. Device ratings; and
 - f. Calculated short-circuit currents.
- H. Protective-Device, Coordination Study:
1. Coordination, time-current, characteristic curves, as necessary to determine the required settings/sizes of the protective devices, and so as to maximize selectivity, shall be prepared. The utility, upstream, protective device which is feeding the project shall be maintained as the upper limit for coordination. Such settings shall be obtained by the preparer, along with all other protective-device setting requirements. The coordination curves shall be prepared on log-log paper and shall illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but shall reflect the actual, protective devices which are provided. Adequate time-current curves shall be generated so as to depict coordination. In addition, the

- protective-device characteristics shall be suitably determined, as required to reflect the calculated short-circuit levels at the respective locations;
2. A narrative analysis shall accompany each coordination-curve sheet and shall describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted, and the reasons for allowing such condition to remain shall be stated, or the proper solution for resolving the situation shall be identified. Such system coordination, recommended ratings, and settings for protective devices shall be accomplished by a registered (in the State of Louisiana) professional electrical engineer having a minimum of eight (8) years of current experience in the coordination of electrical, power-generation-and-distribution systems; and
 3. The following information shall be provided on all curve sheets;
 - a. Device identifications and associated settings/sizes;
 - b. Voltages at which the curves are plotted;
 - c. Current multipliers;
 - d. ANSI frequent-fault, damage curves;
 - e. Cable-insulation damage curves;
 - f. Transformer-inrush points;
 - g. A single-line diagram for the entire, project, power-distribution system; and
 - h. Motor starting profiles (where applicable; verify).
- I. Arc-Flash Analysis:
1. An arc-flash analysis shall be performed in conjunction with the short-circuit study;
 2. The results from the short-circuit study shall be used to determine arc-energy levels at each defined location of the project, electrical, power-generation-and-distribution systems, for a specified working distance;
 3. Based on the arc energy at each such defined point, the proper PPE shall be determined and, if the arc energy level exceeds the available PPE ratings, such locations shall be noted;
 4. Labels, which list the respective hazard levels, along with the required PPE while working in the respective areas, shall be provided for each evaluated location; and
 5. An analysis, which determines if any changes can be made in the protection system so as to reduce arc-energy levels, shall be performed, and the results shall be reported.
- J. Single-Line Diagram:
1. The final report shall include a multi-color, single-line diagram of the entire, project, electrical, power-generation-and-distribution systems. Such single-line diagram shall include:
 - a. Genset ratings;
 - b. Transformer ratings, voltage ratios, impedances, and winding connections;
 - c. Feeder-cable phase, neutral, and equipment-ground sizes, lengths of cable, conductor materials, and conduit size and types;
 - d. Continuous-current ratings of all project switchboards, panelboards, fuses, circuit breakers, and switches;
 - e. Protective devices, with appropriate device numbers; and

- f. A detailed legend indicating device-type identifications, and other significant details.
- K. Summary:
 - 1. The results of the study shall be summarized in a final report; and
 - 2. If required by Entergy (verify in advance), copies of the final report shall be submitted to Entergy for their review and approval. In such case, approved copies of the report shall be submitted to the engineer.
- L. Field Settings:
 - 1. This contractor shall engage the equipment manufacturer's service group or, alternately, a qualified independent testing firm, to perform field adjustments of the protective devices, where and as required for placing the equipment in final operating condition. Such settings shall be in accordance with the approved short-circuit study, and protective-device evaluation and coordination study; and
 - 2. All necessary field settings of devices, and adjustments and minor modifications to equipment, which are required to accomplish conformity to the approved, short-circuit and protective-device, coordination study, shall be performed by such manufacturer's service group, or by such qualified independent testing firm.

1.39 ARC ENERGY REDUCTION

- A. Where the highest, continuous-current, trip rating for which the actual overcurrent device that is installed in a circuit breaker is rated, or to which it can be adjusted, is 1200 amps or higher (including being equipped with interchangeable trip modules/plugs that can be replaced with 1200-amp, or larger, trip modules/plugs), all requirements of Section 240.87 of NFPA 70 (NEC) shall be met.
- B. All such project circuit breakers shall be equipped with a U.L.-listed, code-compliant, "energy-reducing, active, arc-flash, mitigation system", which is in strict accordance with the requirements of all applicable codes and governing authorities. Verify all parameters and requirements in advance, and provide accordingly.
- C. Each such "energy-reducing, active, arc-flash, mitigation system" shall include the following, or shall be a pre-approved equivalent system:
 - 1. A dynamic, arc-flash sentry (i.e., a dual protective setting), which is factory installed and connected into the respective circuit breaker, and which renders two (2) trip curve-setting modes, one (1) setting for normal conditions, and the other setting for protection during maintenance;
 - 2. A keyed, maintenance, selector switch, which is factory-installed and connected at the respective gear (e.g., service-entrance-rated, main, enclosed, circuit breaker; switchgear; switchboard; panelboard; emergency, engine-generator set [genset], output, circuit breaker; etc.), with positions for "standard operating mode" (i.e., for "normal operation"), and for "arc-flash mode" with instantaneous protection (i.e., for "maintenance" operation), and with permanent labeling that indicates the respective switch positions;

3. A "blue" indication light which renders a visual indication of the proper activation and operation of the system;
4. For each such circuit breaker which is an equipment, main, circuit breaker, the capability of allowing the project installer to set, in the field, either of two (2) different, short-time and instantaneous settings at and for such circuit breaker; and
5. All required, factory-installed and factory-connected, power supplies, controllers, and annunciator panels with flashing lights, and all other required appurtenances.

1.40 Dry-TYPE TRANSFORMERS

- A. Each dry-type transformer shall have the KVA, voltage, phase, and wire ratings which are respectively indicated on the drawings.
- B. Each dry-type transformer shall have all-copper windings.
- C. Each dry-type transformer which is indicated on the drawings as "NON-LINEAR" shall be "UL K-13"-rated and shall be equipped with an electrostatic shield for non-linear (high-harmonic) load service, and shall have double-size, neutral terminals that are sized and rated as required for the additional neutral cables which are indicated on the drawings and required. Verify all parameters in advance and provide accordingly.
- D. Each dry-type transformer shall be self-cooled and shall be capable of carrying a continuous full load at normal voltage and frequency, without exceeding 115 degrees C. above an ambient of 40 degrees C. and without shortening its expected lifetime. Each transformer shall have a sound rating which is equal to, or less than, the respective NEMA standard rating.
- E. Each dry-type transformer shall be equipped with NEMA standard taps below and above normal voltage on the primary side. Such taps shall be the external type.
- F. Each dry-type transformer shall have Class 155, or higher, insulation systems and shall be completely enclosed, except for ventilating openings.
- G. Each dry-type transformer which is installed indoors shall have a NEMA 1 (general-purpose, indoor) enclosure and each dry-type transformer which is installed outdoors shall have a NEMA 3R (raintight, outdoor) enclosure with a weathershield. Each dry-type transformer shall have built-in junction boxes for primary and secondary connections.
- H. Install each dry-type transformer on 2" vibration isolators and make flexible conduit connections. Floor mount or ground mount (as applicable) each dry-type transformer unless it is respectively indicated on the drawings to be wall-mounted or to be hung from the overhead building structure. Provide a 4" high, reinforced-concrete, housekeeping pad for each floor-mounted (indoor), dry-type transformer and provide a 6" high, reinforced-concrete, housekeeping pad for each ground-mounted (outdoor), dry-type transformer. The weight loading rating of each supporting means which is provided for hanging a dry-type transformer

from the overhead building structure, or for wall mounted a dry-type transformer, shall be at least thrice the total weight of the respective transformer and supporting means.

- I. Replace at no additional cost to the owner, all dry-type transformers which are considered by the architect or by the owner to be excessively hot and/or noisy.
- J. Each dry-type transformer shall be provided with a warning nameplate which is permanently affixed to the top of the transformer and which is engraved to say "WARNING - HOT SURFACE - DO NOT PLACE OR STORE ANYTHING ON TOP OF, OR DIRECTLY ABOVE, THIS TRANSFORMER."
- K. Dry-type transformers shall be manufactured by SCHNEIDER, ABB, SIEMENS, or EATON, or shall be approved equivalent.

1.41 PANELBOARDS

- A. Provide panelboards where and as shown on the drawings, and where and as required. The top of each panelboard cabinet shall be at 6'-6" above finished floor.
- B. Each panelboard shall have the current rating, the voltage rating, the phase and wire ratings, the number and type of branch circuit breakers and branch-circuit-breaker spaces, and a main circuit breaker or main lugs, as respectively shown on the drawings, and as required for the respective application. Verify all parameters and requirements in advance, and provide accordingly.
- C. Whether so indicated on the drawings and/or specified herein, or not, the number of panelboard sections for each panelboard shall be as required to accommodate the number of circuit breakers of the respective ratings and the number of branch-circuit-breaker-pole spaces/provisions which are indicated in the respective panelboard schedule and which are required for the respective applications, and as required for such panelboard physically to fit in the respectively-designated location while accommodating all code-required clearances, etc.; verify all parameters and requirements in advance, and provide accordingly. In order to accomplish such, and to the extent which is practicable, provide panelboard sections which accommodate more than the classical forty-two (42) branch-circuit-breaker poles (and pole spaces/provisions), where and as required.
- D. "Load-center" type panelboards are unacceptable and shall not be provided.
- E. Panelboards shall have all-copper buses.
- F. Each 120/208-volt panelboard which is indicated on the drawings as "NON-LINEAR" shall be UL-rated for non-linear (high-harmonic) load service, and shall be equipped for a 200%-rated neutral capacity, and with double-size neutral terminals, as required for (a) double-size neutral cable(s), and as respectively indicated on the drawings.

- G. Branch circuit breakers shall be bolt-on, quick-make, quick-break, over-center toggle devices with trip indication, and with common-trip for multi-pole breakers. Trip indication for each circuit breaker shall be clearly shown by the circuit-breaker handle taking a position between the "OFF" position and the "ON" position. No tandem-type circuit breakers shall be provided.
- H. Whether so indicated on the drawings and/or specified elsewhere herein, or not, all 15-amp and 20-amp, 1-pole, 120-volt, branch circuit breakers which are provided at and for dwelling units shall be UL-listed and code-approved as being "combination-type, arc-fault circuit interrupters".
- I. Whether so indicated on the drawings and/or specified elsewhere herein, or not, all circuit breakers which are provided for circuits that are involved with air-conditioning equipment shall be UL-listed and code-approved as being the "listed HACR type".
- J. Branch circuit breakers feeding unswitched lighting loads shall be U.L.-listed as being "switching-duty" rated.
- K. Panelboards shall have distributed phase bussing throughout. Any two (2) adjacent, 1-pole, branch circuit breakers shall be replaceable by a 2-pole, branch circuit breaker and any three (3) adjacent, 1-pole, branch circuit breakers shall be replaceable by a 3-pole, branch circuit breaker.
- L. All branch-circuit-breaker spaces shall contain complete provisions (including, but not limited to, bussing, mounting apparatuses, access holes, access hole covers, etc.) which are required for accommodating future branch circuit breakers.
- M. The minimum bus-bracing rating and the minimum circuit-breaker-interrupting rating for each panelboard shall be the value of the available short-circuit current which is indicated in the respective panelboard schedule. In order to achieve such ratings, "U.L. series-connected ratings" may be utilized if, and only if, all documentation which is required to prove such ratings is a part of, and submitted with, the respective, service-entrance-rated-main-enclosed-circuit-breaker (MECB), panelboard, and switchboard review submittals (shop drawings). The review submittals (shop drawings) for the MECB, for all panelboards, and for all switchboards shall be submitted simultaneously.
- N. Number branch-circuit-breaker poles from top to bottom beginning at the top of the left-hand column, with odd numbers occurring on the left and even numbers occurring on the right, as required to conform to the circuit numbers which are respectively shown on the drawings. In multiple-section panelboards, number the branch-circuit-breaker poles consecutively. Do not repeat numbers in the same panelboard. Each successive odd-numbered pole and each successive even-numbered pole shall be connected to an alternate incoming line, i.e., the poles shall be connected alternately to Incoming Line 1, Incoming Line 2, Incoming Line 3, Incoming Line 1, Incoming Line 2, Incoming Line 3, etc.
- O. Each panelboard, for which such feature is available, shall be equipped with door-in-door trim as required to allow hinged access to its interior panelboard

wiring without removing the panelboard-door assembly (i.e., one [1] lockable door over the interior and one [1] which exposes the gutter).

- P. Unless indicated otherwise, panelboards which are installed indoors shall have NEMA 1 enclosures and panelboards which are installed outdoors shall have NEMA 3R enclosures.
- Q. Provide lock-on and lock-off devices for branch circuit breakers where and as indicated, and where and as required.
- R. At each panelboard, provide a "bushing-type" raceway connector at and for each raceway which contains electrical cables that are sized No. 6 AWG or larger.
- S. Panelboards shall be manufactured by SCHNEIDER, SIEMENS, ABB, or EATON, or shall be approved equivalent.

1.42 SERVICE-ENTRANCE-RATED, MAIN, ENCLOSED, CIRCUIT BREAKER ("MECB")

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the service-entrance-rated, main, enclosed circuit breaker (which is referenced herein and on the drawings as "MECB"), as specified herein and/or on the drawings, shall include adequate verbiage and/or other information as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each such specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting and labeling, will not be reviewed and will be considered informal.
- B. Provide the MECB. The MECB shall be as specified herein, as indicated on the drawings, as intended, and as required for the exact application for which it is provided (including all applicable project parameters; verify all relevant parameters and requirements in advance of preparing the respective equipment shop drawings and in advance of ordering the respective equipment; and prepare the respective shop drawings and provide the MECB accordingly).
- C. Provide a 6" high (above finished grade or concrete), reinforced-concrete, housekeeping pad for the MECB.
- D. Provide complete, coordinated, "tripping selectivity" for all project protective devices, including the MECB, all protective devices which are associated with Main Switchboard "MSB," the output circuit breakers of all of the gensets, and all other project protective devices. Such "tripping selectivity" shall be relevant to all ground-fault protection (of equipment), and to all long-time, short-time, and instantaneous tripping functions. Furnish, as part of the project electrical-equipment shop drawings, complete documentation which indicates all parameters which are associated with such complete, coordinated, "tripping selectivity", including all trip settings and all corresponding (and accurate) tripping curves that are based thereon. Electrical-equipment shop drawings which do not contain such complete documentation will not be reviewed, and will be rejected.

- E. ME CB:
1. Shall meet all applicable requirements of UNDERWRITERS' LABORATORIES;
 2. Shall be totally enclosed, dead front, and free standing, with complete, front-only accessibility and connectivity. Such free-standing enclosure shall have a maximum height of 91.5";
 3. Shall have a NEMA Type 3R (raintight, outdoor) enclosure;
 4. Shall have structural framework which is fabricated of UL gauge steel and which is secured together as required to support all cover plates, bussing, and the protective device during shipment and installation. Formed, removable, closure plates shall be provided on the front, rear, and sides. Such closure plates shall be single-tool, screw removable. Ventilation shall be furnished where and as required. Each section shall include a single-piece, removable, top plate;
 5. Shall have all of its painted parts pre-treated and furnished with a corrosion-resistant, UL-listed, baked, acrylic paint finish. The paint color shall be ANSI #49 medium grey per ANSI Standard Z55.1-1967;
 6. Shall be service-entrance rated;
 7. Shall be equipped with a 320kA/phase surge-protective device (SPD4), as specified elsewhere in the specifications;
 8. Shall be suitable for operation at the available fault-current level which is respectively indicated on the drawings. ME CB shall be labeled so as to indicate the maximum fault-current rating, taking into account the structure, the bussing, and the protective device. The ME CB equipment shop drawings, the Main-Switchboard-"MSB" equipment shop drawings, and all project panelboard equipment shop drawings shall be submitted simultaneously for review;
 9. Shall be equipped with main busses which are tin-plated or silver-plated copper. Such bussing shall be of sufficient cross-sectional area so as to meet all requirements of UL Standard 891 for temperature rise. The main busses shall have a continuous-current rating which is equal to, or greater than, the continuous-current rating of the protective device which is respectively indicated on the drawings. Such busses shall be 100% rated. The neutral bus shall be 100% rated. The neutral and equipment-ground busses shall be sized in strict accordance with UL Standard 891, and shall be of the same material as the main busses;
 10. Shall be rated for 277/480V, 3-phase, 4-wire operation, and as required for the exact application;
 11. Shall be equipped with main lugs having a continuous-current rating which is equal to, or greater than, the continuous-current rating of respective protective device. The protective device shall be a solid-state-trip, circuit breaker, and shall be the molded-case or insulated-case (as applicable) type;
 12. Shall, in conjunction with the protective device, be provided with ground-fault protection (of equipment), and long-time, short-time, and instantaneous trip (with "flags" or "targets"), as well as phase-failure protection and (adjustable) phase-voltage-imbalance protection;
 13. Shall have its ground-fault protection factory set at 1100 amperes, and shall have its time delay for ground-fault currents which are equal to, or greater than, 3000 amperes factory set 0.75 seconds. Such ground-fault-

- protection system shall operate so as to cause the protective device to open all ungrounded conductors of the faulted circuit;
14. Shall have a circuit-breaker-type, protective device which is totally front accessible and front connectible. The circuit-breaker connections to the main busses shall be of the "blow-on" design, such that the connections will grip the bus bars firmly under high-fault conditions;
 15. Shall have provisions which allow it to be padlocked in the "open" and/or "closed" positions (when the protective device is padlocked in the "closed" position, its normal tripping shall still be allowed and accommodated);
 16. Shall be equipped with incoming and outgoing cable lugs which are sized and rated for the respective incoming and outgoing electrical cables that are indicated on the drawings and required for the applications. This contractor is advised that, for reasons of voltage-drop mitigation, and for other reasons, such lugs sizes and ratings might be greater than what would normally be expected (if based solely on continuous-current ratings); in such case, "upsized" and/or "uprated" lugs will be required; provide such "upsized" and/or "uprated" lugs, where and as required, and provide all additional physical space which is required within the enclosure, accordingly;
 17. Shall be capable of being handled with the use of removable lifting bars (where practicable) or rollers, and shall be clearly labeled with the proper handling instructions (procedures); and
 18. Shall be manufactured by SCHNEIDER, ABB, SIEMENS, or EATON, or shall be approved equivalent.

1.43 MAIN ("NORMAL-POWER") SWITCHBOARD "MSB"

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with Main ("Normal-Power") Switchboard "MSB", as specified herein and/or on the drawings, shall include adequate verbiage and/or other information as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting, will not be reviewed and will be considered informal.
- B. Provide Main ("Normal-Power") Switchboard "MSB" (which is referenced herein below as "the switchboard"). The switchboard shall be as specified herein, as indicated on the drawings, as intended, and as required for the exact application for which it is provided (including all applicable project parameters; verify all relevant parameters and requirements in advance of preparing the respective equipment shop drawings and in advance of ordering the respective equipment; and prepare the respective shop drawings and provide the switchboard accordingly).
- C. Provide a 6" high (above finished floor), reinforced-concrete, housekeeping pad for the switchboard.
- D. Provide complete, coordinated, "tripping selectivity" for all project protective devices, including the MECB; the output circuit breakers of the genset; all

protective devices which are associated with the switchboard; and all other project protective devices. Such "tripping selectivity" shall be relevant to all ground-fault protection (of equipment), and to all long-time, short-time, and instantaneous tripping functions. Furnish, as part of the project electrical-equipment shop drawings, complete documentation which indicates all parameters which are associated with such complete, coordinated, "tripping selectivity", including all trip settings and all corresponding (and accurate) tripping curves that are based thereon. Electrical-equipment shop drawings which do not contain such complete documentation will not be reviewed, and will be rejected.

- E. The switchboard:
1. Shall meet all applicable requirements of UNDERWRITERS' LABORATORIES (UL);
 2. Shall be totally enclosed, dead front, and free standing, with complete, front-only accessibility and connectivity. Such free-standing enclosure shall have a maximum height of 91.5";
 3. Shall have a NEMA Type 1 (general-purpose, indoor) enclosure;
 4. Shall have structural framework which is fabricated of UL gauge steel and which is secured together as required to support all cover plates, bussing, and component devices during shipment and installation. Formed, removable, closure plates shall be provided on the front, rear, and sides. Such closure plates shall be single-tool, screw removable. Ventilation shall be furnished where and as required. Each section shall include a single-piece, removable, top plate;
 5. Shall have all of its painted parts pre-treated and furnished with a corrosion-resistant, UL-listed, baked, acrylic paint finish. The paint color shall be ANSI #49 medium grey per ANSI Standard Z55.1-1967;
 6. Shall be suitable (the entire switchboard, including all components) for operation at the available fault-current level which is indicated in the switchboard schedule on the drawings. The switchboard shall be labeled so as to indicate the maximum fault-current rating, taking into account the structure, the bussing, and all switchboard protective devices. The switchboard protective devices shall be fully rated for short-circuit current, or may have their short-circuit-current rating determined by UL-labeled, "series-connected" ratings, but only if all documentation which is required to verify such ratings is submitted with the switchboard and the MECB equipment shop drawings, which shall be submitted simultaneously with the equipment shop drawings for all project switchboards and panelboards;
 7. Shall be equipped with through busses which are tin-plated or silver-plated copper. The switchboard bussing shall be of sufficient cross-sectional area so as to meet all requirements of UL Standard 891 for temperature rise. The through busses shall have a continuous-current rating which is equal to, or greater than, the continuous-current rating of the main lugs that is indicated in the switchboard schedule on the drawings. The through busses shall be 100% rated and shall extend the full length of the switchboard. Provisions shall be included for the future splicing of additional switchboard sections at either end of the switchboard. The neutral bus shall be 100% rated. The switchboard-distribution-section busses for each section shall be of the same material as the through busses, and shall have a continuous-current rating which

is equal to, or greater than, the sum of the continuous-current ratings of all feeder (branch) devices that are contained in the respective section, including representative continuous-current-rating contributions for spaces having provisions for "future" feeder (branch) devices. The distribution-section neutral plates shall be of copper and shall be equipped with Cu/Al lugs for the devices which are provided, and for "future" devices. The equipment-ground bus shall be sized in strict accordance with UL Standard 891, and shall be of the same material as the through busses;

8. Shall have all of its physical spaces which are available for future devices equipped with complete provisions for such future devices;
9. Shall be rated for 277/480V, 3-phase, 4-wire operation, and as required for the exact application;
10. Shall be equipped with a 240kA/phase surge-protective device (SPD3), as specified elsewhere in the specifications;
11. Shall be equipped with main lugs having the continuous-current rating which is indicated in the switchboard schedule on the drawings;
12. Shall be equipped with feeder (branch) protective devices, each of which is a solid-state, circuit breaker that is the molded-case or insulated-case (as applicable) type having the respective continuous-current rating which is indicated in the switchboard schedule on the drawings; and that is equipped with fully-adjustable, ground-fault protection (of equipment) and fully-adjustable, long-time, short-time, and instantaneous trip with "flags" or "targets";
13. Shall have the ground-fault protection (of equipment) for each of the feeder (branch) protective devices (circuit breakers), factory set so as to trip at a somewhat lower ampere rating and with somewhat less time delay, as compared to the settings of the MECB, for the purposes of proper, "100% tripping selectivity" (in accordance with the above-referenced, coordinated, "100% tripping selectivity" documentation). Each such ground-fault-protection system shall operate to cause the respective main or feeder (branch) protective device to open all ungrounded conductors of the faulted circuit;
14. Shall be equipped with customer metering for cumulative-kWH/kW-demand (with resettable peak-demand register), kVA-demand (with resettable peak-demand register), power-factor, volts, and amps, which is mounted in the unit door of the main-lug compartment, with the appropriate phase-selector switch, potential transformers, current transformers, etc.;
15. Shall be equipped with all current transformers, potential transformers, disconnecting devices, fuses, contacts, relays, terminal blocks, connections, and interconnecting wiring (raceways and electrical power and signal cables), and all other appurtenances, which are required for the project energy-management system that is being provided under the HVAC division of the project. Coordinate completely and directly with the project general contractor, with the project HVAC-division subcontractor, and with the owner; ascertain all parameters and requirements in advance; and provide accordingly;
16. Shall have group-mounted, feeder (branch) circuit breakers which are the molded-case type or the insulated-case type (as applicable), with the operating handles extending through the hinged front cover plates of the

respective sections. Each feeder (branch) circuit breaker shall be individually fed from the main busses of the switchboard. The load side of each feeder (branch) circuit breaker shall be bussed to cable lugs which are totally front accessible and front connectible (as shall be the entire switchboard). Each feeder (branch) circuit breaker shall have provisions which allow it to be padlocked in the "open" position with up to three (3) padlocks;

17. Shall have circuit-breaker connections to the distribution-section busses which are of the "blow-on" design, such that the connections will grip the bus bars firmly under high-fault conditions.
18. Shall be equipped with incoming and outgoing cable lugs which are sized and rated for the respective incoming and outgoing electrical cables that are respectively indicated on the drawings and respectively required for the applications. This contractor is advised that, in some cases, and for reasons of voltage-drop mitigation, and for other reasons, such lug sizes and ratings might be greater than what would normally be expected (if based solely on continuous-current ratings); in such case, "upsized" and/or "uprated" lugs will be required; provide such "upsized" and/or "uprated" lugs, where and as required, and provide all additional physical space which is required within the switchboard enclosure, accordingly;
19. Shall be separated into shipping blocks. Each switchboard section shall be capable of being handled individually with the use of removable lifting bars (where practicable) or rollers, and shall be clearly labeled with the proper handling instructions (procedures); and
20. Shall be manufactured by SCHNEIDER, ABB, SIEMENS, or EATON, or shall be approved equivalent.

1.44 SURGE PROTECTIVE DEVICES

- A. Provide surge protective devices (each of which is referenced herein below and on the drawings as "SPD") where and as indicated on the drawings, where and as specified herein, and where and as required for the project.
- B. Provide SPD's where and as required to conform to all applicable codes and standards. Before submitting the project electrical-equipment shop drawings, verify with the project lightning-protection-system vendor/subcontractor, and with UL, that all of the SPD's which are proposed to be provided for the project are in strict accordance with all UL requirements, standards, etc., as applicable to lightning protection systems, and that their provision will not, in any way, adversely affect the issuance of the lightning-protection-system, UL, Master Label. By submitting the project electrical-equipment shop drawings, including the required information which is relevant to the project SPD's, this contractor shall be certifying that they have indeed verified such facts with the project lightning-protection-system vendor/subcontractor, and with UL, so that no conflicts will ensue, and so that such UL Master Label will indeed be issued and erected. To the extent which is required, provide alternate SPD's which will meet all such UL requirements and all other project requirements (verify all parameters and requirements in advance, and provide accordingly), at no additional cost to the owner.

- C. Each SPD shall be complete in every respect, shall be modified and/or augmented as required for the exact application for which it is provided, and shall contain all appurtenances that are required for proper operation.
- D. Each SPD shall be listed and labeled in strict accordance with UL 1449-3rd Edition, and shall comply with all other UL standards, and with all applicable ANSI/IEEE standards and testing procedures.
- E. Each SPD shall be manufactured by a company that is normally engaged in the design, development, and manufacture of such equipment, and by the manufacturer of the main, enclosed, circuit breaker, the respective switchboard, or the respective panelboard into which it is provided.
- F. The SPD manufacturer shall provide unlimited free replacement of all inoperable SPD units during the warranty period.
- G. Each SPD shall be guaranteed by this project contractor and by the SPD manufacturer to be free of defects in materials and workmanship for a period of not less than ten (10) years from the date of the notice of acceptance of the project by the owner. Any SPD which shows evidence of failure, malfunction, or incorrect operation during such 10-year warranty period shall be replaced as a complete unit, not just modules, subassemblies, or components, by the manufacturer, at no cost to the owner.
- H. Each SPD shall have the phase rating (i.e., three-phase), the voltage rating (i.e., 120/208 volts or 277/480 volts), and the type of connection (i.e., wye) which are required to be completely compatible with the system to which it is connected (verify all parameters and requirements in advance, and provide accordingly).
- I. Each SPD shall be of a "parallel" design utilizing fast-acting, transient energy protection which will divert and dissipate the surge energy.
- J. Each SPD shall be self-restoring and fully automatic with a total response time not exceeding 1 nanosecond for any individual component.
- K. The maximum continuous-operating-voltage (MCOV) rating and threshold-voltage rating of all suppression components in each SPD unit shall be selected in accordance with ANCI C84.1, and shall provide ample "headroom" for C84.1 Voltage Range B, maximum utilization and service voltage per Table 1, as required to provide continuous operation without AC voltage sine-wave interaction.
- L. Each SPD shall use only solid-state clamping components to limit the surge voltage. SPD devices and SPD components which "crowbar" short circuit the AC power system (e.g., spark gaps, gas tubes, or SCR's) are unacceptable and shall not be provided.
- M. Each SPD shall have phase-to-phase, phase-to-ground, phase-to-neutral, and neutral-to-ground, independent, distinct, and dedicated, protective circuitry. Reduced-mode devices are unacceptable and shall not be provided.

- N. Each SPD shall have LED status monitors as required to indicate, at a minimum, the continuous, positive, operational status of each protected phase.
- O. Each SPD shall be labeled as a Type 1 surge arrester, or as a Type 2 surge arrester, as applicable for the respective exact application, and as stipulated herein below, and shall meet all requirements of the National Electrical Code, NFPA 70: Article 285.
- P. Each SPD shall be provided with, and shall be factory installed and connected within, the cabinet (enclosure) of, the main, enclosed, circuit breaker, or the respective switchboard or panelboard, which it is designed and specified to protect.
- Q. Each SPD shall be equipped with EMI/RFI filtration (54dB attenuation from 20kHz. to 100MHz., minimum performance), incorporating true, sine-wave tracking ("normal" and "common" mode).
- R. Each SPD which is designated on the drawings, in these specifications, and/or elsewhere (e.g., in a switchboard or panelboard schedule) as "SPD1" shall be a Type 2 surge arrester, and shall have a minimum peak surge current rating of 120kA per phase.
- S. Each SPD which is designated on the drawings, in these specifications, and/or elsewhere (e.g., in a switchboard or panelboard schedule) as "SPD2" shall be a Type 2 surge arrester, and shall have a minimum peak surge current rating of 160kA per phase.
- T. Each SPD which is designated on the drawings, in these specifications, and/or elsewhere (e.g., in a switchboard or panelboard schedule) as "SPD3" shall be a Type 2 surge arrester, and shall have a minimum peak surge current rating of 240kA per phase.
- U. Each SPD which is designated on the drawings, in these specifications, and/or elsewhere (e.g., in a switchboard or panelboard schedule) as "SPD4" shall be a Type 1 surge arrester, and shall have a minimum peak surge current rating of 320kA per phase.

1.45 ELECTRICAL POWER-AND-ENERGY-MONITORING SYSTEM

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the "electrical, power-and-energy-monitoring system", as specified herein below and/or on the drawings, shall include adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting, will not be reviewed and will be considered informal.
- B. Provide the project, electrical, power-and-energy-monitoring system which is required to meet all requirements of all applicable codes including, but not limited

to, the latest edition of the International Energy Conservation Code (IECC), particularly but not limited to, Section C405.12 of the IECC; which is required to meet all requirements of all applicable governing authorities; and which is required to meet all system requirements which are indicated on the drawings and/or specified herein. Verify all parameters and requirements in advance, and provide accordingly.

- C. Such electrical, power-and-energy-monitoring system is referenced herein as "the system".
- D. The system shall include all equipment, devices, materials, hardware, software, interconnections, certifications, commissioning, etc. which are generally and specifically required for such a system, for "single-source responsibility".
- E. Provide (completely under this division of the project), and be completely responsible for, the entire system as indicated on the drawings, as specified herein, as required, and as intended.
- F. The system shall be complete in every respect. Provide all equipment, materials, labor, supervision, inspections, testing, calibrations, certifications, commissioning, etc. which are required for a complete and functioning system, as per the owner's needs, whether so indicated on the drawings and/or specified herein or not.
- G. The system shall be installed and connected in strict accordance with installation and connection instructions, including connecting and/or interconnecting diagrams, from the system manufacturer. Request and obtain all required installation and connection instructions directly from such manufacturer in advance of the commencement of the system installation.
- H. The system shall be equipped as required to measure, monitor, record, and report energy-consumption data in compliance with Sections C405.12.1 through C405.12.5 of the IECC.
- I. For all electrical energy which is supplied to the facility, and its associated site, including but not limited to site lighting, parking areas, and all other areas that serve the facility and its occupants, meters or other measurement devices shall be provided as required to collect energy-consumption data for each end-use category which is stipulated in IECC Section C405.12.2, which are:
 - 1. HVAC systems (i.e., heating, cooling, and ventilation, including fans, pumps, boilers, chillers, and water heating); this end-use category is referenced on the project electrical drawings as "End-Use Category A";
 - 2. Interior lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category B";
 - 3. Exterior Lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category C";
 - 4. Power-receptacle (plug) loads; this end-use category is referenced on the project electrical drawings as "End-Use Category D";
 - 5. Process loads; this end-use category is referenced on the project electrical drawings as "End-Use Category E"; and

6. Facility operations and other miscellaneous loads (i.e., all other electrical loads); this end-use category is referenced on the project electrical drawings as "End-Use Category F".
-
- J. Meters, or other approved measuring devices, shall be provided to collect energy-use data for each such end-use category. Where multiple meters are provided to measure an end-use category, the data-acquisition system shall total all of the energy used by such category. Not more than 5% of the measured load for each of the end-use categories shall be permitted to be from a load that is not within that category.
 - K. Meters, and/or other measurement devices, shall be configured automatically to communicate energy-conservation data to the data-acquisition system which is required by IECC Section C405.12.4. Source meters may be any digital-type meter. Current sensors may be provided, as long as they have a tested accuracy of +/- 2%. The metering system and equipment shall have the capability to record and report, at least hourly, data that is fully integrated into the data-acquisition system and graphical energy report, in accordance with IECC Sections 405.12.4 and 405.12.5.
 - L. The data-acquisition system shall have the capability to store the data from the system meters, and other sensing devices, for a minimum of thirty-six (36) months. The data-acquisition system shall have the capability to store real-time energy-consumption data and to report hourly-, monthly-, and annually-logged data for each end-use category.
 - M. A permanent and readily-accessible reporting mechanism shall be provided at the facility which is accessible by the facility operation-and-management personnel. Such reporting mechanism shall have the capability graphically to report the energy consumption for each end-use category, at least every hour, day, month, and year for the previous thirty-six (36) months.
 - N. Documents:
 1. This section of the specifications forms part of the project contract documents, and shall be read, interpreted, and coordinated with all other parts of the project contract documents.
 - O. System Description:
 1. It is intended that the products which are specified herein shall render a complete sub-metering solution. This solution shall be utilized to measure and monitor the electrical power and electrical usage of the following systems (loads) separately:
 - a. HVAC systems (i.e., heating, cooling, and ventilation, including fans, pumps, boilers, chillers, and water heating); this end-use category is referenced on the project electrical drawings as "End-Use Category A";
 - b. Interior lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category B";
 - c. Exterior Lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category C";

- d. Power-receptacle (plug) loads; this end-use category is referenced on the project electrical drawings as "End-Use Category D";
 - e. Process loads; this end-use category is referenced on the project electrical drawings as "End-Use Category E"; and
 - f. Facility operations and other miscellaneous loads (i.e., all other electrical loads); this end-use category is referenced on the project electrical drawings as "End-Use Category F".; and
 - 2. The system shall comply with all requirements of all applicable, national and local, energy codes, and shall include all equipment and appurtenances which are required to meet the specific criteria of the latest edition of the International Energy Conservation Code (IECC).
- P. This Section Includes:
- 1. Electrical sub-metering equipment, data-collection systems, and data-management software systems including:
 - a. Standard, single-point, kWh, electrical sub-meters;
 - b. Advanced, single-point, kWh, electrical sub-meters;
 - c. Multi-point electrical sub-meters;
 - d. Data-collection hubs;
 - e. High-density pulse modules;
 - f. Open-protocol data-communication networks;
 - g. Wireless communication devices; and
 - h. Energy-monitoring software.
- Q. Standards:
- 1. Provide the equipment, and all required appurtenances, of this section in full compliance with the following applicable portions of the latest revisions of the following standards:
 - a. ANSI C12.1 & C12.20 at 0.5 Accuracy Class;
 - b. UL Certified to IEC/EN/UL/CSA 61010-1 2nd Edition;
 - c. UL916:
 - (1) These requirements cover energy-management equipment and associated sensing devices which are rated 600 volts, or less, and are intended for installation in accordance with the National Electrical Code, NFPA 70; and
 - d. NEMA -ESM-1.
- R. Shop Drawings:
- 1. The installation and shop drawings shall include the following:
 - a. The system manufacturer's literature and specifications;
 - b. The system-component-connection wiring diagrams; and
 - c. The communications system specifications.
- S. Installation, Operation, and Maintenance Manuals:
- 1. Submit installation, operation, and maintenance manuals for the system data-collection system, and data-management software.
- T. Technical Performance:

1. The minimum, measured, technical performance of each piece of installed system equipment shall meet the specifications published by the respective manufacturer;
2. Optimize the technical performance of all systems as required to produce the highest, achievable, technical performance, to the satisfaction of the architect, the electrical consultant, and the owner; and
3. Any deficiencies in the system, particularly information-communication errors, or operational deficiencies, shall be cause for rejection of the system. Rectify all such deficiencies prior to requesting the substantial-completion review.

U. Warranty:

1. The system manufacturer shall furnish a comprehensive warranty for all products;
2. All electrical sub-meters included in this specification shall be free from defects in materials and workmanship from the date of substantial completion for a period of five (5) years; and
3. All data-collection-system components included in this specification shall be free from defects in materials and workmanship from the date of substantial completion for a period of five (5) years.

V. Acceptable Manufacturers:

1. LEVITON Manufacturing;
2. ELECTRO-INDUSTRIES;
3. TBWC TECHNOLOGY/DENT;
4. PACKET POWER;
5. HONEYWELL E-MON;
6. The basis-of-design is LEVITON VerifEye Metering System; and
7. Requests for prior-approval substitutions shall be submitted in advance of project pricing, in accordance with the project submittal requirements which are stated elsewhere in the project specifications. Relative to such requests for substitution:
 - a. Identify all substitution equipment and components;
 - b. Submit a manufacturer's reference list;
 - c. Clearly delineate all proposed substitutions as such;
 - d. Prior to rough-in, submit to the engineer for review and approval complete, engineered, shop drawings, including power wiring, with all deviations from the original design highlighted in an alternate color; and
 - e. By using pre-approved substitutions, the contractor accepts the responsibility and associated costs for all required modifications to circuitry, devices, wiring, etc.

W. Meters and Current Transformers:

1. Standard, single-point, metering devices: LEVITON Mini-Meters, Series 1000, and Series 2000;
2. Advanced, single-point, metering devices: LEVITON Series 3500, Series 4000, and Series 4100;
3. Multi-point metering devices: LEVITON Series 7000, 7100, 8000;
4. LEVITON solid-core or split-core, current transformers, with a full-scale output of 0.1A or 0.333V;

5. LEVITON Rogowski-coil current transformers;
 6. Solid-Core current transformers which are available for 100A to 400A, and split-core current transformers which are available from 50A to 5,000A; and
 7. Current-transformer secondary-conductor wires can be extended:
 - a. 500 feet for 0.1A CT's;
 - b. 300 feet for 0.333V CT's; and
 - c. 20 feet for Rogowski-Coil CT's.
- X. System Description – Single-Point Metering Devices:
1. Provide single-point metering devices which are capable of metering 1PH/2W, 2PH/3W, 3PH/3W, and/or 3PH/4W loads;
 2. The meters shall be capable of directly metering North American 120/208/240V and 277/480V systems;
 3. The metering units shall be capable of metering loads between 50A and 5000A. Provide meters which are specific to the project, as indicated on project-construction drawings;
 4. The metering units may have the capability of paralleling up to three (3) sets of CT's per phase (such is not applicable to Rogowski-coil meters);
 5. Shall meet all ISO 9001 standards for quality control, where all meters test to a minimum of +/-0.2% or +/-0.5% accuracy, depending on the stated accuracy class;
 6. The system shall be as described below:
 - a. It shall consist of electronic meters with embedded communications capability, and solid-core, split-core, or Rogowski-coil, current-transformer technology. The current transformers shall have a full-scale output of 0.1A or 0.333V, and secondary voltage clamps for safety purposes;
 - b. The meters shall be used for energy-monitoring applications;
 - c. The meters shall be capable of remote communication from each metering device;
 - d. The Standard Meters shall have an isolated pulse output, with output ranges of from 10Wh to 1kWh;
 - e. The Advanced Meters shall transmit data via one of the following communication protocols:
 - (1) Isolated Pulse Output;
 - (2) Modbus TCP/IP;
 - (3) ACNet IP;
 - (4) Modbus RTU; or
 - (5) BACNet MS/TP;
 - f. Backup power shall be supplied by an on-board battery which maintains the real-time clock through power loss (Advanced Meters only). Power and energy data shall be stored in non-volatile memory, as required to maintain values through power losses, and such memory shall be capable of holding sixty-five (65) days of historical data in default settings (Advanced Meters only);
 - g. Failure of the facility, normal, electrical-power system shall not result in a loss of data, and shall not require manual restarting of the metering system; and

- h. The system shall be a fully automated, micro-processor-based, electrical-energy-measurement system for measurement and verification purposes. The system shall incorporate complete metering, communications, reporting functions; energy-monitoring, and threshold-limit capabilities.
- Y. System Measurements – Single-Point Metering Devices:
 - 1. The meters shall be complete with a Liquid Crystal Display (LCD), as required to access all power and energy measurements, and phase diagnostics when needed;
 - 2. Standard Meter Power and Energy Parameters:
 - a. kWh real consumption; and
 - b. kW peak-resettable kW peak;
 - 3. Advanced Meter Power and Energy Parameters:
 - a. Bi-directional energy measurements;
 - b. kWh real consumption;
 - c. kW peak resettable kW peak;
 - d. kW instantaneous real power;
 - e. kVAh apparent energy consumption;
 - f. kVA total apparent power;
 - g. kVARh reactive consumption;
 - h. kVAR total reactive power;
 - i. PF power-factor total;
 - j. Maximum kW peak demand, with time and date stamp; and
 - k. Hz line frequency;
 - 4. Advanced Meter Phase Diagnostics: Parameters which shall be displayed for each individual phase of each metered load:
 - a. Voltage Phase-to-neutral and phase-to-phase;
 - b. Amps Instantaneous amperage for each phase;
 - c. kW Instantaneous real power;
 - d. PF Real power factor;
 - e. kVA Instantaneous apparent power; and
 - f. kVAR Instantaneous reactive power.
- Z. System Description -- Multi-Point Metering Devices:
 - 1. The system shall be as described below:
 - a. It shall consist of electronic multiple-point meters with embedded communications capability, and with solid-core, split-core, or Rogowski-coil current-transformer technology. The current transformers shall have a full-scale output of 0.1A or 0.333V. N.C. outputs, and secondary-voltage clamps for safety purposes;
 - b. The meters shall be used for energy-monitoring applications;
 - c. The meters shall be capable of being externally mounted in a NEMA 1 enclosure, or of being internally mounted in electrical panels or switchgear;
 - d. The meters shall be capable of remote communication from each metering device. Each device shall have IP sockets and RS-485 terminals as required to accommodate data transmission via Modbus RTU, Modbus TCP/IP, BACNet MS/TP, BACNet IP, and standard Ethernet. Data shall be transmitted by one, or a combination of, the following

- (1) A standard Ethernet interface;
 - (2) An Ethernet connection to a PC or to a laptop via a crossover cable; and
 - (3) An RS-485 Network-Modbus RTU and BACNet MS/TP;
- e. The system shall have backup storage power for key components, so that no data is ever lost during power outages. The system shall continue to function after the resumption of power; and
- f. The failure of the facility, normal, electrical-power system shall not result in a loss of data, and shall not require manual restarting of the metering system;
2. The system shall be a fully-automated, microprocessor-based, electrical power-and-energy-measurement system for measurement and verification purposes. The system shall incorporate the following:
 - a. Complete metering;
 - b. Communications;
 - c. Reporting functions;
 - d. Energy monitoring; and
 - e. Threshold-limits capabilities;
3. The meters shall be capable of directly metering on board, North American 120/208/240V and 277/480V systems;
4. The meters may require potential transformers (PT's) for 480V and 240V delta applications;
5. The meters shall be capable of operating with two (2) distinct-and-independent, reference-voltage inputs as required to allow for monitoring two (2) separate electrical systems. Each meter shall allow any CT input to be referenced against either input voltage channel;
6. The metering units may have the capability of accommodating a wiring-harness, single, incoming cable containing twenty-five (25) pairs of 22 AWG wire with associated current transformers (CT's), or have optional terminal strips with screw-terminal connections for the CT's. The metering units may also be configured with individual input channels for secondary wires of the CT's;
7. The system shall meet all ISO 9001 standards for quality control, where all meters test to a minimum of +/-0.2% or +/-0.5% accuracy, depending on the accuracy class;
8. The metering units shall be configured as required to meter the respective number of circuits which are required to be measured (provide multiple metering units where a single metering unit does not have enough capacity for the number of circuits which are required to be measured; verify in advance, and provide accordingly), e.g., the metering units shall be configured for:
 - a. Twelve (12) single-pole circuits, six (6) two-pole circuits; or four (4) three-pole circuits;
 - b. Twenty-four (24) single-pole circuits, twelve (12) two-pole circuits, or eight (8) three-pole circuits;
 - c. Forty-eight (48) single-pole circuits, twenty-four (24) two-pole circuits, or sixteen (16) three-pole circuits; or
 - d. More circuits, where and as required for the respective applications.

AA. System Measurements – Multi-Point Metering Devices:

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1. Each meter shall be complete with a Liquid Crystal Display (LCD), as required to access the power-and-energy measurements and the phase diagnostics, when needed:
2. Energy/Power Parameters:
 - a. kWh real energy consumption;
 - b. kW instantaneous power;
 - c. kVAh apparent consumption;
 - d. kVA apparent power;
 - e. kVARh reactive consumption; and
 - f. kVAR reactive power;
3. Phase Diagnostics: Parameters which shall be displayed for each individual phase of each metered load:
 - a. Voltage Phase-to-neutral or phase-to-phase;
 - b. Amps Instantaneous amperage for each phase;
 - c. kW Instantaneous power;
 - d. PF Power factor;
 - e. PA Phase angle;
 - f. kVA Instantaneous apparent power;
 - g. KVAR Instantaneous reactive power; and
 - h. THD Total Harmonic Distortion - Theta.

BB. Meter-Data Collection and Communication:

1. Data-acquisition server: LEVITON Energy-Monitoring HUB;
2. Pulse-data collection: LEVITON High-Density Pulse Module; and
3. Wireless data transmission: LEVITON ModHopper or TBWC TECHNOLOGY/DENT CS-IPM.

CC. System Description – Meter Communications and Data Collection:

1. The system shall be as described below:
 - a. The system shall consist of energy-management hubs, pulse modules, wireless communication devices, and software which are used to transmit, collect, and display the data that is generated by the sub-metering equipment which is used to capture measurements from electrical utilities;
 - b. The system shall allow all data which is collected to be connected to IP-based applications, including ENTERPRISE Energy-Management Software, Demand Response, and Smart-Grid Collection, for use in power measurement; and
 - c. The data-collection system shall be all non-proprietary and compatible with industry-standard M&V software applications. Open protocols such as Modbus, pulse outputs, analog, resistive inputs, etc. shall be utilized. Proprietary or manufacturer-specific protocols between the meters and the data collectors are unacceptable, and shall not be provided.

DD. Product Requirements – Data-Acquisition Server:

1. Provide a data-acquisition server which measures and verifies data from the electrical meters, and other compatible sensors;
2. The server shall comply with the following codes and standards:
 - a. FCC CFR 47 Part 15, Class A;
 - b. EN 610000;

- c. EN 61326; and
 - d. CE;
- 3. The server shall be equipped with an ARM7 embedded CPU, an ARM7 I/O co-processor, 32MB of on-board RAM, 16MB of NOR flash memory, and a USB expansion port;
- 4. The server shall operate under the following conditions:
 - a. From 32 degrees F. to 122 degrees F. (0 degrees C. to 50 degrees C.), 0-90% RH, non-condensing; or
 - b. From 41 degrees F. to 104 degrees F. (5 degrees C. to 40 degrees C.), 0-90% RH, non-condensing;
- 5. The server shall have the capability to collect and log information at intervals from one (1) minute to sixty (60) minutes;
- 6. The server shall time stamp all acquired data and store such data in a non-volatile memory;
- 7. The server shall use modem connections and/or Ethernet connections for Internet access, thus allowing either static-IP (Internet-protocol) addressing or DHCP (Dynamic Host Control Protocol) addressing;
- 8. The server shall communicate with all metering data points via wired or wireless connections over the following protocols:
 - a. Wired communications:
 - (1) Pulse;
 - (2) Ethernet-Modbus TCP/IP; and
 - (3) RS-485-Modbus RTU;
 - (a) Modbus devices shall be connected via BELDEN 1120A, or approved equivalent, 18-gauge stranded bare copper, single-twisted-pair, shielded, instrumentation cables; or
 - b. Wireless communications:
 - (1) Wireless Modbus;
- 9. The server shall communicate with external devices via wired or wireless connections over the following protocols:
 - a. Wired communications:
 - (1) Ethernet LAN (Local Area Network) or WAN (Wide Area Network);
 - (2) TCP/IP;
 - (3) PPP;
 - (4) HTTP/HTML;
 - (5) FTP;
 - (6) NTP;
 - (7) XML;
 - (8) SNMP; and
 - (9) BACnet-Optional Downloaded Module;
 - b. Wireless Communications:
 - (1) GSM (Global System for Mobile Communications);
 - (2) GPRS (General Packet Radio Service); and
 - (3) PSTN (Public Switched Telephone Network);
 - c. The server shall upload data at user-selectable scheduled intervals via HTTP or FTP, and shall download data in XML or custom formats;
 - d. The server shall generate alarms for data points, including SNMP (Simple Network Management Protocol) traps; and

- e. The server shall be equipped with the following input and output connections:
 - (1) Input:
 - (a) RS485 Modbus serial input which is capable of supporting thirty-two (32) external devices. Such input shall be expandable at the owner's option;
 - (b) Eight (8) Flex I/O inputs which are configurable for the following modes:
 - i) 0-10VDC, 4-20mA, Resistive;
 - ii) Standard KYZ pulse modes for A or C, dry-contact relay outputs; and
 - iii) Status; and
 - (2) Output:
 - (a) Two (2) Opto-FET dry-contact relays which are rated at 30VDC and 150mA maximum.

EE. Product Requirements – High-density Pulse Modules:

- 1. Provide high-density pulse modules for the collection and distribution of all pulse-output data which are generated by all electric meters and sensors, and all other similar devices;
- 2. Each such module shall be equipped with on-board, adjustable, Modbus addressing, via dip switches with addresses from 1 to 128;
- 3. Each such module shall comply with the FCC CFR 47 Part 15, Class A, emissions standard;
- 4. Each such module shall be equipped with an ARM7 I/O processor having field-upgradable firmware;
- 5. Each such module shall communicate over a Modbus/RTU RS-485, two-wire network with the following network speeds:
 - a. 19200 Baud; and
 - b. 9600 Baud;
- 6. Each such module shall operate satisfactorily under the following conditions:
 - a. From 22 degrees F. to 158 degrees F. (-6 degrees C. to 70 degrees C.), 0-90% RH, non-condensing;
- 7. Each such module shall have a 32-bit pulse counter which rolls over at 4.295 billion pulses per channel, and stores pulse data in a non-volatile memory. The pulse rate shall be user-selectable;
- 8. Each such module shall have the following input and output connections:
 - a. Input:
 - (1) Non-isolated pulse and power inputs;
 - (2) Modbus RS485 connection;
 - (3) Twenty-three (23) independent pulse-count inputs which are designed for use with dry-contact outputs. The pulse rate shall be user-selectable among the following:
 - (a) 10Hz: The minimum pulse width shall be 50ms;
 - (b) 50Hz: The minimum pulse width shall be 10ms; and
 - (c) 100Hz: The minimum pulse width shall be 5ms.

FF. Product Requirements – Wireless Transceivers:

1. Provide the optional wireless transceivers for the collection and distribution of all pulse outputs which are generated by electrical meters, and all other energy meters and sensors;
2. Each transceiver shall comply with the following codes and standards:
 - a. FCC CFR 47 Part 15, Class A, emissions standard; and
 - b. FCC ID shall be OUR-9XTREAM;
3. Each transceiver shall be equipped with a 60 MHZ ARM7 embedded CPU;
4. Each transceiver's firmware shall be field upgradable;
5. Each transceiver shall communicate over a self-healing, self-optimizing, wireless, mesh network and shall utilize frequency hopping, spread-spectrum, radio transmission and reception over a 900MHz band;
6. Each transceiver shall have a line-of-sight range of 3000 feet indoors and 14 miles outdoors;
7. The Transceiver broadcast power shall be 1 watt;
8. Each transceiver shall operate under the following conditions:
 - a. From 32 degrees F. to 122 degrees F. (0 degrees C. to 50 degrees C.), 0-90% RH, non-condensing; and
 - b. 1.24 miles (2000m) maximum altitude, with Degree 2 pollution;
9. Each transceiver shall be equipped with a pulse counter, with the pulse data being stored in a non-volatile memory; and
10. Each transceiver shall have the following input and output connections, and the Modbus addresses shall be adjustable via DIP switches, with addresses between 1 and 247:
 - a. Input:
 - (1) Two (2) Pulse inputs with user-selectable pulse rates of 10, 50, 100, or 250 Hz.;
 - (2) Modbus RS485 input; and
 - (3) Connect a maximum of thirty-two (32) Modbus devices to the transceiver's input; and
 - b. Outputs shall be user-selectable between 100 Ohms and 2.5 kOhms;
 - (1) Two (2) Opto-FET dry-contact relays rated at 30VDC, 150mA max.

GG. Cloud-Based Energy-information Software:

1. The software package shall consist of one (1) or both of the following WEB-based system modules:
 - a. Basic Building Management Software: BMO Base Module; and/or
 - b. ENTERPRISE Energy-Management Software: BMO Advanced Reporting Module;

HH. Product Requirements – Basic Software-BMO Base Module:

1. The software shall be able to be integrated into the Building Energy Management System which is used for HVAC systems; and
2. Provide a web-hosted software platform which is fully functional without software other than standard web browsers including, but not limited to, MICROSOFT Internet Explorer, GOOGLE Chrome and FIREFOX Mozilla:
 - a. The software shall support an unlimited number of meter-data points based on the subscription level; and

- b. The software shall be able to be used for the collection, analysis, and reporting of the electrical power and energy data from the sub-metering equipment which is used to capture energy-power and energy-usage measurements that include, but are not limited to:
 - (1) HVAC systems (i.e., heating, cooling, and ventilation, including fans, pumps, boilers, chillers, and water heating); this end-use category is referenced on the project electrical drawings as "End-Use Category A";
 - (2) Interior lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category B";
 - (3) Exterior Lighting; this end-use category is referenced on the project electrical drawings as "End-Use Category C";
 - (4) Power-receptacle (plug) loads; this end-use category is referenced on the project electrical drawings as "End-Use Category D";
 - (5) Process loads; this end-use category is referenced on the project electrical drawings as "End-Use Category E"; and
 - (6) Facility operations and other miscellaneous loads (i.e., all other electrical loads); this end-use category is referenced on the project electrical drawings as "End-Use Category F".

II. Wiring and Connections:

1. All wiring and connections shall meet or exceed all of the requirements of all applicable codes and governing authorities (verify in advance, and provide accordingly);
2. Show on all submittals (shop drawings, etc.) all system metering points which will be furnished, installed, and connected, and only such metering points;
3. Install all wiring in conduit;
4. Provide a dedicated Ethernet drop as required to accommodate and report remote meter readings and diagnostics of the system;
5. Perform all necessary system calibrations, testing, commissioning, and demonstrations as required; and
6. Prepare and submit record drawings, and installation, operation, and maintenance manuals, for this electrical power monitoring system, as required.

JJ. Testing and Commissioning:

1. Perform all required final calibrations, testing, adjustment, commissioning, and demonstrations of the systems; report all results to the architect; and include all results in the installation, operation, and maintenance manuals. Engage qualified technicians for the testing and commissioning;
2. Perform sufficient technical and operational tests as required to ensure that the technical performance of the system meets or exceeds the intent of the Contract Documents, and meets or exceeds the requirements of all applicable codes and governing authorities. Typical testing shall include, but not be limited to,:
 - a. Verification of all meter readings, and proper installation and connection of all metering equipment;

- b. Communication systems connectivity; and
- c. Proper meter communication with all of the software platforms;
- 3. Provide all required optional functional testing, including end-to-end verification that all meters are operating properly; and
- 4. Demonstrate the complete operation (all features) of the systems to the user agency, at the times and on the dates which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period. Such demonstration shall include product training on how to program the electrical, power-and-energy-monitoring systems.

KK. Field Verification, Acceptance, and Training:

- 1. Provide all "AS BUILT" DRAWINGS and data showing each meter, serial number, address, cross reference, load, and CT ratio prior to field verification;
- 2. The system manufacturer's representative shall verify, adjust, and test the system. Verification of the electrical power-and-energy-monitoring system shall be carried out with the assistance of the project electrical subcontractor at all times. Upon completion, the system manufacturer shall issue a "Commissioning Report" to the architect, to the electrical consultant, to the project contractor, and to the owner;
- 3. The system manufacturer's representative shall demonstrate the complete operation of the system as follows:
 - a. Local and remote meter readings;
 - b. Phase diagnostics;
 - c. Submit manuals of the installed system; and
 - d. Ensure that the entire system is connected to the cloud, as required to communicate with the software servers; and
- 4. The software training is typically completed remotely via on-line instruction by the system manufacturer's technical support staff.

LL. Field Quality Control:

- 1. Submit a detailed testing-and-commissioning procedure narrative to the architect for review and approval prior to undertaking this work. Such procedure narrative shall indicate all of the test equipment which is required, as well as the acceptance criteria;
- 2. Upon completion of all testing and commissioning, submit a copy of the test and commissioning results; and
- 3. Undertake the testing and commissioning work with the manufacturer's factory representative(s).

MM. Instruction to Staff:

- 1. Upon completion of the installation, a competent instructor representing the system manufacturer shall provide a lecture to the facility operation-and-maintenance staff concerning the intent, use, operation, and maintenance of the system. This may be accomplished remotely.

1.46 FACILITY LIGHTNING-PROTECTION SYSTEM(S)

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the "Facility Lightning-Protection System(s)" shall include

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adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted and shall be labeled with a number corresponding to the respective paragraph number which is contained in these specifications, or in the respective addendum or change order, for such specified characteristic, feature, option, etc. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting and labeling, will not be reviewed and will be considered informal.

- B. Provide (a) lightning-protection system(s) (which is/are collectively referenced herein as "the system") at and for the entire facility (including, but not limited to, all separated buildings), where and as required to render lightning-protection-system protection and service to and for all facility buildings, structures, areas, etc., and to all equipment, that are involved in any way with this project, and where and as required to render (a) complete and functioning system(s) which is/are in strict accordance with the requirements of all applicable codes and governing authorities, and which is/are in strict accordance with all applicable standards. Provide all required design for the system.
- C. The system shall be in strict accordance with the requirements of all applicable codes and governing authorities, and shall be in strict accordance with the following standards:
 - 1. UNDERWRITERS' LABORATORIES, INC. Standard 96A.
 - 2. National Fire Protection Association NFPA No. 780.
 - 3. All Lightning Protection Institute (LPI) Standards.
- D. The system shall be the product of a manufacturer who is regularly engaged in the production of LPI-certified lightning-protection systems and who is listed by UNDERWRITERS' LABORATORIES (UL) as being an accredited manufacturer of lightning-protection systems. The system shall be of its manufacturer's latest design.
- E. The system materials which are utilized shall be labeled by UL as being for lightning-protection systems. Prior to ordering the materials, submit to the architect for review, a complete list of materials, catalog data, and shop drawings indicating the complete system design. Follow the project shop-drawing-design requirements for such submittal.
- F. The system shall consist of air terminals, conductors, groundings, and bondings of metal, and all other required equipment, materials, etc., which are designed to blend with the appearance of the facility so that it appears as part of the facility. The system shall be semi-concealed as required to meet the approval of the architect. All roof penetrations shall be as indicated in the architectural specifications and details, and shall be according to the architect's instructions. All attachments to the facility shall be as approved, in advance, by the architect.
- G. The conductors shall consist be copper or aluminum (as respectively required to be compatible with the adjacent metallic surfaces so as to avoid "dissimilar-metal" problems, etc.) and of a grade and of respective sizes which are normally

provided for lightning-protection work. The UL Label "A" shall be affixed every 10'-0" (maximum) to each main cable.

- H. The air terminals shall consist of solid copper or aluminum rods (as respectively required to be compatible with the adjacent metallic surfaces so as to avoid "dissimilar-metal" problems) of respectively sufficient diameter and height (as required to meet all applicable code and U.L. requirements, and the applicable standards), each having a configuration which will result in the greatest available safety against accidents (e.g., impalement, etc.) while furnishing the greatest possible lightning protection. Attach the air terminals to the facility buildings, structures, etc., in strict accordance with instructions from the architect, with respectively-proper bases as required to adapt to the facility design. The UL Label "B" shall be affixed to each air terminal. A 2-way path to ground shall be provided from each air terminal.
- I. Each down conductor shall be concealed within the respective building structure, shall be routed in PVC conduit, and shall terminate below finished grade at an exterior grounding, consisting of a special, copper-clad steel, ground rod of respectively sufficient diameter and length (as required to meet all applicable code and UL requirements, and the applicable standards), the appropriate grounding connector, and the proper grounding connection to the project underground ground ring. Each such grounding shall be properly tied into the facility lightning protection system. Verify all parameters and requirements in advance, and provide accordingly.
- J. Interconnect all metallic bodies, such as metallic roofs, electrical equipment, mechanical equipment, ventilators, stacks, pipes, gutters, downspouts, ducts, tracks, antennae, water pipes, ladders, and other similar metal, to the project, main, grounding system. The incoming electrical power service and the incoming communication services shall have a common ground with the system.
- K. Provide lightning arresters and surge protective devices (SPD's) where and as required to conform to all applicable codes and standards. Before submitting the project electrical-equipment shop drawings, verify with the project lightning-protection-system vendor/subcontractor, and with UL, that all of the SPD's which are proposed to be provided for the project are in strict accordance with the all UL requirements, standards, etc., as applicable to lightning protection systems, and that their provision will not, in any way, adversely affect the issuance of the UL Master Label. By submitting the project electrical-equipment shop drawings, including the required information which is relevant to the project SPD's, this contractor shall be certifying that they have indeed verified such facts with the project lightning-protection-system vendor/subcontractor, and with UL, so that no conflicts will ensue, and so that the UL Master Label will indeed be issued and erected. To the extent which is required, provide alternate SPD's which will meet all such UL requirements and all other project requirements (verify all parameters and requirements in advance, and provide accordingly), at no additional cost to the owner.
- L. Provide all air terminals, conductors, groundings, and bondings of metal, and all other appurtenances, which are required for a complete and functioning system

that is in strict accordance with the requirements of all applicable codes, standards, and governing authorities, whether so specified or not.

- M. The installation and connection of the system shall be performed in such a manner, and by such LPI-certified personnel, so as to allow this contractor to obtain and erect the UL Master Label plaque.
- N. The system shall be inspected by a representative of UNDERWRITERS' LABORATORIES, INC. who is authorized to issue written approval stating that the system (i.e., all components, as well as all system installation and connection) meets the requirements of the all applicable specifications, standards, and codes. Obtain such written approval and forward it to the architect before the acceptance of the work. Do not conceal any part of the system until such inspection has taken place. In addition, before the project completion, erect the UNDERWRITERS' LABORATORIES, INC. Master Label in the exact location which is stipulated by the architect and the owner (verify the exact desired location in advance), and deliver to the architect the LPI Maintenance Agreement. Include in the proposal for this project all costs which are required to conform to these requirements, including the costs of all additional materials, equipment, and labor which are required to obtain the above-mentioned approval (verify all parameters and requirements in advance, and provide accordingly).

1.47 EMERGENCY-ELECTRICAL-POWER-GENERATION SYSTEM (ALTERNATE-SOURCE-POWER-GENERATION SYSTEM)

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the "Emergency-Electrical-Power-Generation System (Alternate-Source-Power-Generation System)", as specified herein below and/or on the drawings, shall include adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting, will not be reviewed and will be considered informal.
- B. Provide the complete, emergency-electrical-power-generation system (alternate-source-power-generation system), which is herein referenced as "the system". The system shall be complete in every respect and shall include, but shall not be limited to:
 - 1. Three (3) engine-generator sets, each of which is referenced herein and on the drawings as a "genset", and each of which shall include:
 - a. The required reinforced-concrete slab and foundation;
 - b. A lockable, 150 mph-rated, Level-2 sound-attenuating, weatherproof enclosure with an integral, code-conforming, AC/DC, emergency, light kit (the DC portion of which shall be connected so as to be powered by the genset-starting batteries, and the AC portion of which shall be connected so as to be powered from the designated [on the drawings], branch, circuit breaker in the

- designated [on the drawings] project, circuit-breaker panelboard), and with an associated timer switch;
- c. All required access walkways/platforms, handrails, and stairs (if, where, and as required by OSHA, UL, NFPA 70:NEC, NFPA 101:Life Safety Code, the IBC, or NFPA 110: Standard for Emergency and Standby Power Systems, or by any other applicable code or standard, or required by any authorized governing authority; verify in advance, and provide accordingly);
 - d. A critical silencer with the required flexible connector, which is located within the enclosure;
 - e. Starting batteries, a battery rack, and a battery charger;
 - f. A weatherproof, "emergency-off", pushbutton station inside of a lockable, secure, vandal-proof enclosure, at the proper location on the outside of the genset enclosure;
 - g. The required natural-gas carburetion);
 - h. All required natural-gas lines, with flexible connectors;
 - i. All required supports and supporting apparatuses;
 - j. All required venting and venting apparatuses;
 - k. All required controls and instruments which are located within the genset enclosure;
 - l. All required vibration isolators;
 - m. Two (2) water-jacket (or engine-block) heaters;
 - n. An alternator, anti-condensation, strip heater;
 - o. A battery heater blanket with thermostat;
 - p. All required engine-lubricating oil, engine coolant, coolant filters, and air filters;
 - q. All genset-paralleling controls which are necessary to render control of all gensets for proper and desired genset-paralleling operation, as required and as further specified herein;
 - r. All ATS-load-pickup, and all ATS-load-shedding, controls which are necessary to render control of all three (3) automatic transfer switches (each of which is referenced herein and on the drawings as an "ATS"), for proper and desired, electrical-load-pickup and electrical-load-shedding operations, as required and as further specified herein; and
 - s. All other appurtenances which are directly related to the genset itself, and which are required for proper application and operation;
2. (If, where, and as required for proper and desired, genset-paralleling functions and operations, and for all proper and desired, ATS-load-pickup and ATS-load-shedding functions and operations; verify in advance) A main, system, control panel/cabinet which is equipped with all genset-paralleling controls that are necessary to render control of all gensets for proper and desired genset-paralleling operation, as required and as further specified herein; and which is equipped with all ATS-load-pickup and ATS-load-shedding controls that are necessary to render control of all three (3) ATS's, for proper and desired electrical-load-pickup and electrical-load-shedding operation, as required and as further specified herein;
3. A genset-paralleling, common-bus, connection cabinet, which is referenced herein and on the drawings as the "GPCBC", and which is equipped with:

- a. A common set of main power busses which are for the purpose of paralleling the output power of the three (3) gensets;
 - b. Three (3) sets of input-power lugs which are connected to such main busses, for accommodating the incoming, "emergency" power, feeder conductors of, and from, the three (3) gensets; and
 - c. One (1) set of output-power lugs which are connected to such main busses, for accommodating the outgoing, "emergency" power, feeder conductors to the dual-purpose, temporary-generator and portable-load-bank, docking station (which is referenced herein and on the drawings as "DPDS"), i.e., to distribute the total output power of all three (3) gensets, through the DPDS, to the ATS-distribution, switchgear line-up (which is referenced herein and on the drawings as "ATSDSL");
 4. A dual-purpose, temporary-generator and portable-load-bank, docking station (DPDS);
 5. An ATSDSL which is equipped with:
 - a. A common set of main power busses for distributing the incoming, output power from the GPCBC, through the DPDS, and via the three (3) output circuit breakers of this switchgear line-up, to and for the "emergency-source" lugs of the three (3) system ATS's;
 - b. One (1) set of input-power lugs which are connected to such main busses, for accommodating the incoming, "emergency" power, feeder conductors from the GPCBC, through the DPDS;
 - c. Three (3) "load", output, circuit breakers, each of which is dedicated to a different one (1) of the three (3) ATS's (i.e., for "emergency-source" power input to the "emergency-source" lugs of ATS-1, to the "emergency-source" lugs of ATS-2, and to the "emergency-source" lugs of ATS-3);
 - d. An integral surge-protective device (SPD3); and
 - e. The proper, NEMA 1 (indoor), switchgear enclosure;
 6. Three (3) ATS's, one (1) such ATS (i.e., ATS-1) being dedicated to the project, "life-safety" and "most-critical", electrical loads; one (1) such ATS (i.e., ATS-2) being dedicated to the project, "less-critical", electrical loads; and one (1) such ATS (i.e., ATS-3) being dedicated to the project, "least-critical", electrical loads;
 7. Three (3) remote annunciator panels, one (1) for each genset, and each with all required lights and indications, and with the associated, integral or separately-mounted-and-adjacent, genset manual-stop station and proper labeling;
 8. All required grounding apparatuses;
 9. All required interconnecting raceways and electrical cables; and
 10. All other required appurtenances which are relative to each genset, whether so indicated on the drawings and/or specified herein or not.
- C. The system, as manufactured, assembled, tested, delivered, installed, and connected, shall be in strict accordance with the all applicable standards, in strict accordance with the applicable requirements of all governing authorities, and in strict accordance with the requirements of all applicable codes including, but not limited to (verify all parameters and requirements in advance, and provide accordingly), NFPA 37, NFPA 70, NFPA 110, and NFPA 704, particularly (as

stipulated by the Louisiana Office of the State Fire Marshal specifically for this exact project):

1. NFPA 37:4.1.4 - Locate engines and weatherproof housings at least 5 ft. from wall openings and at least 5 ft. from combustible walls (... unless the adjacent structure wall has a fire resistance rating of at least 1 hour, or if the weatherproof enclosure is constructed of noncombustible materials and it has been demonstrated that a fire within the enclosure will not ignite combustible materials outside the enclosure.); and
 2. NFPA 110:5.6.9 - Generators shall comply with Article 445 of the 2020 Edition of NFPA 70 - National Electrical Code, and with the requirements of NFPA 110:5.6.9.1 through 5.6.9.9.
- D. Furnish to the architect and to the owner complete schematic and wiring diagrams for the entire system and complete test results from the testing of a prototype of the series of gensets which are being provided for this project.
- E. Upon completion of initial startup and system checkout, the supplier of the system shall perform a field test, at the time which is stipulated by the architect, to demonstrate the gensets' paralleling capabilities; the gensets' load-carrying capabilities; the gensets' voltage and frequency stabilities, with the entire, project-facility, electrical load at the maximum-designed operating level; and the capability of the ATS's properly to pick up load and shed load, as required, as specified, and as desired. A power failure shall be initiated by opening the three (3) circuit breakers (i.e., the designated, three [3], feeder, circuit breakers in Main ["Normal-Power"] Switchboard "MSB") which supply "normal" power to the three (3) ATS's (i.e., ATS-1, ATS-2, and ATS-3) and, thereby, to all project-facility electrical loads. For each of the three (3) gensets, records of the time-of-day; the coolant temperature; the cranking time until the prime mover starts and runs; the time which is required for the prime mover to come up to operating speed; the voltage and frequency overshoot; the time which is required to achieve steady-state condition with the ATS's transferred to the "emergency" position; voltage; frequency; current; oil pressure; ambient air temperature; kilowatts; power factor; and battery-charger rate, at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter, shall be maintained throughout the tests. Each of three (3) such load tests shall continue for a minimum of eight (8) hours (as a clarification, such three [3] tests, as related to the gensets, may be performed simultaneously), during which time the respective load changes and the respective resultant effect on voltage and frequency shall be observed and recorded. Then, during each such load test, "normal" power shall be restored and the time delay on retransfer (set for 15 minutes minimum) of all three (3) ATS's, as well as the time delay of the prime mover cool-down period and shutdown, shall be recorded. Upon completion of each such test, the prime mover shall be allowed to cool down for five (5) minutes. Then full-rated load (i.e., the total of the nameplate KW ratings of all three [3] gensets) consisting of all facility electrical load supplemented by a load bank, shall be applied. Unity power factor is acceptable for on-site testing. Such full-load pickup shall be in one (1) step, immediately upon reaching rated RPM.
- F. Install and connect the entire system in strict accordance with the manufacturer's recommendations, and supply the owner with an electronic copy, and at least

three (3) hard copies, of all applicable operation-and-maintenance manuals, including details, wiring diagrams, and parts lists.

- G. The entire system, including but not limited to, the three (3) gensets, and all appurtenances; the three (3) sound-attenuating weatherproof enclosures (one [1] for each genset), and all appurtenances; the main, system, control panel/cabinet (if, where, and as required for proper genset-paralleling, and as required for proper ATS-load pickup and ATS-load-shedding functions and operations; verify in advance); the three (3) remote annunciator panels (one [1] for each genset); the GPCBC, and all appurtenances; the DPDS, and all appurtenances; the three (3) ATS's (i.e., ATS-1, ATS-2, and ATS-3), and all appurtenances; and the ATSDSL, and all appurtenances, shall be warranted by the respective manufacturers against defective materials and workmanship for a minimum period of five (5) years, or 3,000 hours, whichever first occurs. Defective parts shall be repaired or replaced at the manufacturer's option, free of charge, for this period; and all associated labor, travel time, and mileage shall be provided free of charge for this period, without a deductible being applied. The warranty period shall commence when the system is first placed in service.
- H. For each of the three (3) gensets, provide the necessary lube oil for the engine crankcase, provide the air cleaner, and provide the necessary radiator coolant (likely to be a 50% solution of ethylene glycol; verify in advance and provide accordingly), in accordance with the manufacturer's recommendations.
- I. When the installation and connection of the system has been completed, employ and pay factory-trained technicians to check out the installations and connections, and to perform the initial start-up and testing of the system. After the above-mentioned check-outs, start-ups, and testing has been accomplished, demonstrate the complete operation of the system to the user agency, and to any personnel so chosen by the user agency, to the architect's and the user agency's satisfaction, at the time(s), and for the duration(s), which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period; include all associated costs in the project proposal. Furnish to the architect the complete test results prior to receiving final payment.
- J. The system shall be a package of new and current equipment comprising:
1. Three (3) natural-gas-fueled, engine-driven gensets, and all required appurtenances, to render standby power, each equipped with a 150 mph-rated, Level-2 sound-attenuating, weatherproof enclosure having an integral, code-conforming, AC/DC, emergency, light kit (the DC portion of which shall be connected so as to be powered by the genset-starting batteries, and the AC portion of which shall be connected so as to be powered from the designated [on the drawings], branch, circuit breaker in the designated [on the drawings] project, circuit-breaker panelboard, having an associated timer switch, and having access walkways/platforms, handrails, and stairs (if, where, and as required by OSHA, UL, NFPA 70:NEC, NFPA 101:Life Safety Code, the IBC, or NFPA 110: Standard for Emergency and Standby Power Systems, or by any other applicable code or standard, or required by any authorized governing authority; verify in advance, and provide accordingly); equipped

- with all required supports and supporting apparatuses; and equipped with a reinforced-concrete slab/foundation;
2. Three (3) engine, start-stop, control systems (one [1] for each genset) mounted on the respective gensets;
 3. Three (3) weatherproof, "emergency-off", pushbutton stations (one [1] for each genset) each inside of a lockable, secure, vandal-proof enclosure at the proper location on the outside of the respective genset enclosure;
 4. A main, system, control panel/cabinet (if, where, and as required for proper genset-paralleling functions and operations, and for proper ATS-load-pickup and ATS-load-shedding functions and operations; verify in advance);
 5. All genset-paralleling controls which are necessary to render control of all gensets for proper and desired genset-paralleling operation, as required and as further specified herein;
 6. All ATS-load-pickup and ATS-load-shedding controls which are necessary to render control of all three (3) ATS's, for proper and desired electrical-load-pickup and electrical-load-shedding operations, as required and as further specified herein;
 7. Three (3) remote annunciator panels (one [1] for each genset) with all required lights and indications, and with the associated, integral or separately-mounted-and-adjacent, genset manual-stop station and proper labeling;
 8. A GPCBC, and all required appurtenances;
 9. A DPDS, and all required appurtenances;
 10. An ATSDSL, and all required appurtenance;
 11. Three (3) ATS's, one (1) such ATS (i.e., ATS-1) being dedicated to the project, "life-safety" and "most-critical", electrical loads; one (1) such ATS (i.e., ATS-2) being dedicated to the project, "less-critical", electrical loads; and one (1) such ATS (i.e., ATS-3) being dedicated to the project, "least-critical", electrical loads;
 12. All required grounding apparatuses;
 13. All required interconnecting raceways and electrical cables;
 14. All required natural-gas-fuel lines, with flexible connectors (for each genset);
 15. Unit-mounted and remote accessories as specified, and where and as required (for each of the gensets);
 16. All other required appurtenances which are required, whether so indicated on the drawings and/or specified herein or not; and
 17. Single source warranty of all major system components.
- K. The supplier of the system shall have a factory-authorized service firm which is located within two hundred (200) miles of the project site, that maintains a stock of standard parts, and that has service personnel available on a "call basis".
- L. The system shall include, but not be limited to, the following major components:
1. Three (3) 800kW/1000KVA or 750kW/937.5kVA (minimum), 0.8P.F., 277/480V, 3-phase, 4-wire, 60Hz, 1203F.L.A. or 1128F.L.A. (minimum), 1,800RPM, 105-degree C., natural-gas-fueled, continuous-standby gensets, TAYLOR Model TG800-574RSL-6437-105DEGREE or CUMMINS Model Series C750N6-GTA50E-FR60378-105DEGREE, or prior-approved equivalent by CATERPILLAR or REHLKO (as a

clarification, based on instructions from the owner, and due to previous delays in parts availability, GENERAC gensets are unacceptable for this project and, therefore, shall not be provided), each of which is modified and augmented as specified herein, as required, and as intended, and each of which is complete with the following:

- a. An NFPA 110, Type 10 rating, for accepting full-rated load in a single step within ten (10) seconds of being called to start;
- b. A lockable, 150 mph-rated, Level-2 sound-attenuating, weatherproof enclosure with an integral, code-conforming, AC/DC, emergency, light kit (the DC portion of which shall be connected so as to be powered by the genset-starting batteries, and the AC portion of which shall be connected so as to be powered from the designated [on the drawings], branch, circuit breaker in the designated [on the drawings] project, circuit-breaker panelboard), and with an associated timer switch; and with all required access walkways/platforms, handrails, and stairs (if, where, and as required by OSHA, UL, NFPA 70:NEC, NFPA 101:Life Safety Code, the IBC, or NFPA 110: Standard for Emergency and Standby Power Systems, or by any other applicable code or standard, or required by any authorized governing authority; verify in advance, and provide accordingly);
- c. A 2071-cubic-inch/33.9-litre (minimum), 1118 gross horsepower (minimum), 3440 sKVA (minimum starting capability) at 30% voltage dip, engine;
- d. An automatic, battery-charging alternator, with solid-state voltage regulation;
- e. A 10-amp (minimum), dual-rate, battery float charger;
- f. A unit-mounted radiator cooling system, with thermostat temperature control, water pump, coolant filter, and high-coolant-temperature shutdown;
- g. A positive displacement lube oil pump, a full-flow oil filter, and a pressure relief valve;
- h. A microprocessor-based, genset monitoring, metering, control, and protection system, TAYLOR (BASLER) DGC2020HD or CUMMINS PowerCommand 3.3 Control System, or prior-approved equivalent by CATERPILLAR or REHLKO, which includes the following equipment:
 - (1) Generator AC Output Metering Devices: Displays for volts, hertz, and amps with not less than 0.5% accuracy throughout a temperature range of -40 to +70 degrees C. A distorted, generator-output-voltage waveform having a crest factor less than 5 shall not affect the metering accuracy;
 - (2) Engine Monitoring Devices: Display of operating hours, engine RPM, battery DC volts, oil pressure, and jacket-water temperature. The display shall annunciate fault shutdowns;
 - (3) Controls: A generator-voltage-level rheostat, an ammeter, and a voltmeter. The engine start-stop switch shall be door-mounted and shall include positions for off/reset, run/start, stop, and automatic mode. Start-stop logic shall

- have provisions for cycle cranking and cool-down operation;
- (4) Shutdowns and Annunciation: The genset shall shut down, and red flashing LED's shall signal operational faults of high water temperature, low oil pressure, overcrank, and overspeed;
 - (5) Safety Devices: An "emergency stop" pushbutton shall be provided, and all controls, annunciation, and monitors shall be labeled; and
 - (6) An Alarm Module: The latest NFPA requirements shall be satisfied by a solid-state, 12-volt DC, alarm module which is mounted in the panel, including visual alarms, and a silenceable audible alarm, which shall annunciate alarm conditions for high coolant temperature, low coolant temperature, low oil pressure, low DC voltage, low natural-gas pressure, and if the system is not in the "automatic" mode. Such audible alarm shall resound on subsequent alarms after silencing/acknowledgment, with the visual alarm displaying a solid light until the condition is corrected;
- i. An oil-pressure gauge, an oil-level indicator, and low-oil-pressure shutdown, coolant-temperature gauge, battery-charge-rate ammeter, and a solid-state engine-monitoring system;
 - j. An electronic (isochronous) engine speed governor having an electric actuator with speed droop which is externally-adjustable from isochronous to 5%, that will maintain the alternator output frequency to within +/- 0.25% from no load to full-load alternator output;
 - k. A 2-wire, remote starting system with a cranking limiter;
 - l. A solid-state voltage regulator, which provides a regulation of +/- 1%;
 - m. A frequency regulation rating limiting the variance to +/- 0.50% maximum, no-load to full-load;
 - n. An oil drain valve with hose extension;
 - o. Starting batteries, battery cables, and a battery rack contained within the sound-attenuating weatherproof enclosure;
 - p. Factory-provided vibration isolators between the genset and its structural steel skid, as well as contractor-provided, steel-and-rubber-pad-type, vibration isolators beneath the structural steel skid.
 - q. A welded steel mounting base;
 - r. A critical, silencing, exhaust muffler with flexible exhaust connectors mounted within the 150 mph-rated, Level-2 sound-attenuating, weatherproof enclosure. The muffler, bracketry, exhaust tubing, and all fittings shall be designed and furnished as a complete assembly by the genset-enclosure manufacturer;
 - s. All required natural-gas-fuel lines, with flexible connectors, and fuel filters. All fuel lines shall be the genset-manufacturer's standard fuel lines, with (code-approved) flexible connectors for withstanding vibration. All fuel lines shall be properly-located;
 - t. Natural-gas-fuel carburetion;

- u. Two (2) 4,000-watt (approximate), 208-volt, single-phase, thermostatically-controlled, engine-coolant, water-jacket (or block) heaters;
 - v. A 1000-watt (approximate), 120-volt, single-phase, alternator anti-condensation, strip heater;
 - w. A 160-watt (approximate), 120-volt, single-phase, thermostatically-controlled, battery-heater blanket, as required to maintain battery temperature above the minimum temperature which is required by the manufacturer for optimum genset starting, etc.;
 - x. A cycle cranker;
 - y. A genset-unit-mounted, 1200A/3P, 100%-rated, solid-state, LSIG, electronic-trip, electrical-motor-operated (for opening and closing), output, circuit breaker which is equipped with a shunt-trip function; one (1) set of auxiliary contacts; and a code-compliant, arc-flash, energy-reduction and maintenance system (ERMS); and which doubles as the genset, mainline, output, circuit breaker and the genset-paralleling circuit breaker (do not connect the ground-fault-sensing function of such main circuit breaker so as to trip such main circuit breaker, but connect such sensing function where and as required to render a ground-fault signal and alarm); and
 - z. A 105-degree C., salient-pole, brushless, self-ventilated, permanent-magnet-excitation generator (alternator), having 3-phase sensing and a single, maintenance-free bearing which is coupled directly to the engine flywheel housing with a semi-flexible coupling between the rotor and the flywheel. The generator shall comply with the latest edition of NEMA Standard MG1-1978, Parts 16 and 22. The insulation system shall be Class N. The generator shall be fully-guarded and dripproof as per the latest edition of NEMA MG1-1.25 and NEMA 1. The generator shall be capable of sustaining at least 250% of rated current for ten (10) seconds, in the event of a short-circuit condition. The voltage regulator shall have an adjustment for maximum voltage dip. The voltage regulator shall also have internal protection against under frequency and over excitation. The generator shall also have over-voltage protection. The voltage regulator shall have a built-in adjustable potentiometer to render at least a +/-5% voltage range, and a maximum 0.25% voltage regulation. The AC-waveform total harmonic distortion shall not exceed 5% total RMS from no load to full rated linear load, measured line-to-line. For any addition of load, up to and including 100% of rated load at 1.0 power factor, the voltage dip shall not exceed twenty percent (20%) of rated voltage. The voltage shall recover to +/- 2% of rated voltage within 1.0 second. For any addition of load up to 100% of rated load, the frequency shall recover to the steady-state frequency within 6.0 seconds;
2. Three (3) remotely-mounted annunciator panels (one [1] for each genset), each with all required lights and indications, and with an associated, integral or separately-mounted-and-adjacent, genset manual-stop station and proper labeling. Install such annunciator panels together in the exact location which is stipulated by the architect and the user agency (verify in

advance). Each such annunciator panel shall satisfy all of the latest NFPA requirements and shall be a panel which includes, relative to the respective genset, red and yellow indicating lights and a silenceable alarm horn for low-oil-pressure shutdown, low-coolant-temperature alarm, high-coolant-temperature shutdown, low-natural-gas-fuel-pressure alarm, overcrank shutdown, overspeed shutdown, battery-charger malfunction, and "generator on load"; and shall allow and accommodate the respective, remote, genset, manual-stop operation upon activation of its integral or separately-mounted-and-adjacent, genset manual-stop station. For each such remotely-mounted annunciator panel, provide the required interconnecting control/signal wiring between such remotely-mounted annunciator panel and the respective genset, and between the respective, genset manual-stop station and the respective genset. Upsize such interconnecting control/signal wiring conductors where and as required to mitigate the adverse effects of voltage drop, etc.;

3. A main, system, control panel/cabinet which is equipped with complete controls including, but not limited to, all genset-paralleling controls which are necessary to render control of all gensets for proper and desired genset-paralleling operation; and which is equipped with all ATS-load-pickup and ATS-load-shedding controls which are necessary to render proper and complete control of all three (3) ATS's, for proper and desired electrical-load-pickup and electrical-load-shedding operations;
4. A 4000A, 277/480V, 3-phase 4-wire, NEMA 3R, free-standing, GPCBC, which is equipped with:
 - a. A common set of 4000A, main, power busses which are for the purpose of paralleling the output power of the three (3) gensets;
 - b. Three (3) sets of 1200A input-power lugs which are connected to such main busses, for accommodating the incoming, "emergency" power, feeder conductors of, and from, the three (3) respective gensets; and
 - c. One (1) set of 4000A output-power lugs which are connected to such main busses, for accommodating the outgoing, "emergency" power, feeder conductors to the DPDS, i.e., to distribute the total output power of all of the three (3) gensets, through the DPDS, to the ATSDSL;
5. A DPDS which:
 - a. Has electrical components, devices, and accessories that are listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for the intended location and application;
 - b. Complies fully with NFPA 70;
 - c. Is listed (the entire package, not just components) to ETL or UL 1008 Standards;
 - d. Is warranted by the manufacturer against defective materials and workmanship as stipulated herein above for all system components (a warranty certificate shall be furnished);
 - e. Is a dual-purpose, temporary-generator and portable-load-bank, docking station;
 - f. Is TRYSTAR Model No. DBDS4-40-5-P-L-M-F-ACDFJK2MNPQ-ERMS, with a TRYSTAR One-Line Code of DBDS-4, or prior-approved equivalent by EATON;
 - g. Has a continuous-current rating of 4000A;

- h. Is rated for 277/480V, 3-phase, 4-wire, wye-connected application;
- i. Is equipped with a 4000A/3P, 100%-rated, UL 489 listed, main, circuit breaker (which is removable for service and maintenance) that is equipped with a code-compliant, arc-flash, energy-reduction and maintenance system (ERMS), for isolation between the temporary-generator connection and the connection for the permanent gensets (i.e., the connection for incoming "emergency" power from the GPCBC);
- j. Is equipped with kirk-key interlocking between such "isolation" circuit breaker and the temporary-genset-receptacle-compartment door;
- k. Is equipped with a 4000A/3P, 100%-rated, UL 489 listed, shunt-trip, circuit breaker (which is removable for service and maintenance) that is equipped with a code-compliant, arc-flash, energy-reduction and maintenance system (ERMS), for the load-bank connection, which will trip when any or all of the ATS's call(s) for "emergency" power (whether indicated on the drawings, or not, provide the required interconnecting cabling, and the associated raceway, from each of the ATS's to this shunt-trip, circuit breaker for accommodating the tripping of this shunt-trip, circuit breaker upon the closing of the control contacts at the respective ATS['s], and for deriving the required tripping power from the genset-starting batteries, or from another, available, proper, power source located at the respective ATS['s], as stipulated by the manufacturers of both the DPDS and the ATS's; verify in advance and provide accordingly);
- l. Is equipped with a pad-mounted, NEMA 3R (raintight), "extra-depth" enclosure which is constructed of 304GA aluminum, and which has a pad-lockable, front door;
- m. Is equipped with a hinged access plate at the bottom of the enclosure for the entry of cables from a temporary generator or a portable load bank (NEMA 3R integrity shall be maintained with such access plate open for cable entry);
- n. Is constructed so that the front and the side of the equipment is accessible through a front access panel, for maintenance, and so that the top, the side, and the bottom of the equipment is accessible through a front access panel, for permanent cabling;
- o. Has an enclosure which is painted after fabrication, with power-coat paint of the manufacturer's standard color;
- p. Has phase, neutral, and equipment-ground buses as follows:
 - (1) Material: silver-plated copper;
 - (2) Equipment-Ground Bus: 50% of phase-bus size, and bonded to the enclosure;
 - (3) Neutral Bus: rated to 100% of phase-bus rating; and
 - (4) All Buses: with rounded edges;
- q. Has temporary-generator connectors that are "Male", 16-Series, Cam-Lok style mounted on a gland plate, and that are color-coded as follows:
 - (1) Phase "A": Brown;
 - (2) Phase "B": Orange;
 - (3) Phase "C": Yellow;

- (4) Neutral: White; and
 - (5) Equipment Ground: Green
 - r. Has load-bank connectors that are "Female", 16-Series, Cam-Lok style mounted on a gland plate, and that are color-coded as follows:
 - (1) Phase "A": Brown;
 - (2) Phase "B": Orange;
 - (3) Phase "C": Yellow; and
 - (4) Equipment Ground: Green
 - s. Has protective flip lids on all temporary connectors, as required to prevent accidental contact;
 - t. Has permanent connectors that are the broad-range, set-screw type, located behind an aluminum barrier;
 - u. Has a short-circuit and withstand rating of 65kAIC (minimum);
 - v. Is equipped with a phase-rotation-monitoring relay, SIEMENS 3U4512-1AR20, or approved equivalent;
 - w. Is equipped with "mechanical" permanent connections;
 - x. Is equipped with 2-wire, auto start;
 - y. Is equipped with a 20A, 125V, GFCI, battery-charger, duplex receptacle; a 30A, 125V, L5-30R, block-heater, single receptacle; and a 50A 125/250V, twist-lock, single receptacle;
 - z. Is equipped with extra depth for bottom conduit access;
 - aa. Is equipped with a strip heater and thermostat;
 - bb. Is equipped with a surge-protective device;
 - cc. Is equipped with a load-shed receptacle; and
 - dd. Has been subjected to the following:
 - (1) Examine all elements and surfaces that are to receive this equipment, for compliance with all manufacturer-established installation tolerances, and for other conditions affecting the performance of the work;
 - (2) Provide the mounting and supporting hardware that is required for proper attachment respective wall surface (verify in advance);
 - (3) Arrange, and pay for, third-party tests and inspections to be performed. Perform each visual and mechanical, inspection and test that is stated in the applicable NETA Acceptance Testing Specification. Furnish documentation certifying compliance with all such test parameters; and
 - (4) Prepare all required test and inspection reports, including a certifying report that identifies the equipment and that describes all scanning results. Include notation of all deficiencies that are detected, all remedial actions that were taken, and all observations made after such remedial actions were taken.
6. An ATSDSL which:
- a. Shall be equipped with a common set of 4000A, 277/480V, 3-phase, 4-wire, main, power busses for distributing the incoming output power from the GPCBC, through the DPDS, and via the three (3) output circuit breakers of this switchgear line-up, to and for the "emergency-source" lugs of the three (3) ATS's (i.e., ATS-1, ATS-2, and ATS-3);

- b. Shall be equipped with one (1) set of 4000A input-power lugs which are connected to such main busses, and which are sized and rated as required to accommodate the incoming, "emergency" power, feeder conductors from the GPCBC, through the DPDS;
- c. Shall be equipped with three (3) 1200A/3P, 100%-rated, solid-state, "load", circuit breakers, each of which is located in a separate, vertical, switchgear-line-up section [meeting the requirements of 700.10(B) and Exhibit 700.2 of NFPA 70 NEC]; each of which shall be connected where and as required to feed the "emergency-source" lugs of a different one (1) of the three (3) ATS's (i.e., ATS-1, ATS-2, and ATS-3); each of which shall be equipped with fully-adjustable, long-time, short-time, and instantaneous trip with "flags" or "targets; and each of which shall be equipped with a code-compliant, arc-flash, energy-reduction and maintenance system;
- d. Shall be designed and fabricated as required to be applicable for generator switchgear;
- e. Shall meet all applicable requirements of UNDERWRITERS' LABORATORIES (UL);
- f. Shall be totally enclosed, dead front, and free standing, with complete, front-only accessibility and connectivity;
- g. Shall have a NEMA Type 1 (indoor-rated) enclosure;
- h. Shall have structural framework which is fabricated of UL gauge steel and which is secured together as required to support all cover plates, bussing, and component devices during shipment and installation. Formed, removable, closure plates shall be provided on the front, rear, and sides. Such closure plates shall be single-tool, screw removable. Ventilation shall be furnished where and as required. Each line-up section shall include a single-piece, removable, top plate;
- i. Shall have all of its painted parts pre-treated and furnished with a corrosion-resistant, UL-listed, baked, acrylic paint finish, as per ANSI Standard Z55.1 (latest edition), and the paint color shall be the manufacturer's standard color;
- j. Shall be suitable (the entire line-up, including all components) for operation at an available fault-current level of 65,000 RMS symmetrical amperes (minimum). The line-up shall be labeled so as to indicate the maximum fault-current rating, taking into account the structure, the bussing, and all line-up protective devices. The switchboard protective devices shall be fully rated for short-circuit current, or may have their short-circuit-current rating determined by UL-labeled, "series-connected" ratings, but only if all documentation which is required to verify such ratings is submitted with the genset-equipment shop drawings, the line-up-equipment shop drawings, and the ATS-equipment shop drawings, which shall be submitted simultaneously with the equipment shop drawings for all project switchboards and panelboards;
- k. Shall be equipped with through busses which are tin-plated or silver-plated copper. The line-up bussing shall be of sufficient cross-sectional area so as to meet all requirements of UL

Standard 891 for temperature rise. The through busses shall have a continuous-current rating which is equal to, or greater than, the larger of, the sum of the continuous-current ratings of the output circuit breakers of the line-up, or the continuous-current rating of the incoming, "emergency" power, feeder conductors from the GPCBC, through the DPDS, whichever is greater. The through busses shall be 100% rated and shall extend the full length of the line-up. The neutral bus shall be 100% rated. The line-up-distribution-section busses for each section shall be of the same material as the through busses, and shall have a continuous-current rating which is equal to, or greater than, the sum of the continuous-current ratings of the circuit breakers that are contained in the respective section of the line-up. The distribution-section neutral plates shall be of copper and shall be equipped with Cu/Al lugs. The equipment-ground bus shall be sized in strict accordance with UL Standard 891, and shall be of the same material as the through busses;

- l. Shall be rated for 277/480V, 3-phase, 4-wire operation, and as required for the exact application;
 - m. Shall be equipped with a 240kA/phase surge-protective device (SPD3), as specified elsewhere in the specifications;
 - n. Shall have circuit-breaker connections to the distribution-section busses which are of the "blow-on" design, such that the connections will grip the bus bars firmly under high-fault conditions;
 - o. Shall be equipped with incoming and outgoing cable lugs which are sized and rated for the respective incoming and outgoing electrical cables that are respectively required for the applications; and
 - p. Shall be furnished by the manufacturer of the gensets, i.e., by TAYLOR, CUMMINS, CATERPILLAR, or REHLKO, or prior approved equivalent; and
7. Three (3) 1200A (minimum continuous-current rating), 4-pole (switched neutral), 277/480-volt, 3-phase, 4-wire, 60Hz., free-standing, NEMA 1 (indoor-rated), ATS's, i.e., ATS-1 being dedicated to the project, "life-safety" and "most-critical", electrical loads; ATS-2 being dedicated to the project, "less-critical", electrical loads; and ATS-3 being dedicated to the project, "least-critical", electrical loads; ASCO 300 Series, Catalogue No. H03ATSB31200NGXC-11BE-30B3-73CC, or prior-approved equivalent by CUMMINS, CATERPILLAR, REHLKO, THOMSON, or EATON, that are modified and augmented as specified herein, as required, and as intended for the exact applications for which they are provided (verify all parameters and requirements in advance, and provide accordingly), each of which is complete with the following:
- a. Complete adherence to the National Electrical Code, U.L. certification, and conformity to U.L.-1008 and NEMA ICS 2-447 requirements;
 - b. Level 2 control;
 - c. Field-adjustable, undervoltage, overvoltage, under-frequency, and over-frequency sensing for all lines on both the "normal" side and the "emergency" side;

- d. A fault-current rating (at 480 volts) of 65,000RMS symmetrical amperes (minimum);
 - e. Manual operators;
 - f. A plug connector interface with control;
 - g. A switched-neutral bar;
 - h. Auxiliary control contacts (at least four [4] sets of normally-open and four [4] sets of normally-closed on the "normal" side, and at least four [4] sets of normally-open and four [4] sets of normally-closed on the "emergency" side; each such set of contacts may be the combination N.O./N.C. type);
 - i. Two-wire, engine-control, remote starting contacts;
 - j. Control-mode-status indicators;
 - k. Adjustable solid-state time delays for all possible modes;
 - l. A NEMA 1 (indoor-rated), key-locking, free-standing, completely front-accessible and front-accessible enclosure;
 - m. An integral, genset-engine, start-stop-automatic, control system;
 - n. NORMAL-EMERGENCY position-indicator lamps;
 - o. A TEST-NORMAL-RETRANSFER switch;
 - p. A 7-day exerciser clock, which is completely programmable at any time, including a WITH/WITHOUT LOAD selector switch;
 - q. A voltmeter, an ammeter, and a frequency meter, with a phase-selector switch;
 - r. An auto/manual retransfer selector switch; and
 - s. "In-Phase" transition and "Programmed" transition (inhibit function for protection against "out-of-phase loads" and "transients" during switching), which will delay the completion of the transfer both to "normal" power and/or to "standby" power by an adjustable period of 0 - 5 seconds (minimum range). Each ATS shall have a phase-monitor feature which will prohibit the transfer of power between "live" sources unless the sources are within the maximum allowable phase angle, voltage differential, and frequency differential, with each other.
- M. The generalized, automatic, system operation while utilizing the permanently-installed gensets (i.e., Genset-A, Genset-B, and Genset-C) shall be as follows:
- 1. Upon a loss of "normal" (utility) power at any, or all, of the three (3) ATS's:
 - a. Such ATS('s) shall send genset-start signals to the genset-paralleling, ATS-load-pickup, and ATS-load-shedding, control-and-management system (i.e., to the control systems of all three [3] gensets, and to the control system[s] for all three [3] ATS's);
 - b. All three (3) of the gensets shall start, shall come up to proper operating speed, and shall produce output power having the proper voltage and frequency characteristics;
 - c. When the first of the three (3) gensets produces output power having the proper voltage and frequency characteristics, its genset-control system shall cause its electrically-operated, output, circuit breaker immediately to close, thus energizing the busses of the genset-paralleling, common-bus, connection cabinet (GPCBC); thus energizing (through the dual-purpose, temporary-generator-and-portable-load-bank, docking station [DPDS]) the main power busses of the ATS-distribution, switchgear line-up

- (ATSDSL); and (assuming that all three [3] of the output circuit breakers of the ATSDSL are in the closed ["ON"] position) thus energizing the "emergency-source" lugs of all three (3) ATS's;
- d. Immediately after such genset-control system of the first genset causes the electrically-operated, output, circuit breaker of such first genset to close, such genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system shall cause ATS-1 (which is dedicated to the project "life-safety" and "most-critical" electrical loads) to transfer to the "emergency" position;
 - e. When the second of the three (3) gensets produces output power having the proper voltage and frequency characteristics, its genset-control system shall cause its electrically-operated, output, circuit breaker immediately to close, thus paralleling its output power with the already energized (from the first genset) busses of the GPCBC and, thus, paralleling its output power (through the DPDS) with the already-energized (from the first genset), main, power busses of the ATSDSL;
 - f. Immediately after such genset-control system of the second genset causes the electrically-operated, output, circuit breaker of such second genset to close, such genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system shall cause ATS-2 (which is dedicated to the project "less-critical" electrical loads) to transfer to the "emergency" position;
 - g. When the third of the three (3) gensets produces output power having the proper voltage and frequency characteristics, its genset-control system shall cause its electrically-operated, output, circuit breaker immediately to close, thus paralleling its output power with the already energized (from the first and second gensets) busses of the GPCBC and, thus, paralleling its output power (through the DPDS) with the already-energized (from the first and second gensets), main, power busses of the ATSDSL;
 - h. Immediately after such genset-control system of the third genset causes the electrically-operated, output, circuit breaker of such third genset to close, such genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system shall cause ATS-3 (which is dedicated to the project "least-critical" electrical loads) to transfer to the "emergency" position; and
 - i. Consequently, if only one (1) of the gensets starts and runs, only ATS-1 shall transfer to the "emergency" position, and only the "life-safety" and "most-critical", project, electrical loads will be energized; and if only two (2) of the gensets start and run, only ATS-1 and ATS-2 shall transfer to the "emergency" position, and only the "life-safety" and "most-critical", project, electrical loads and the "less-critical", project, electrical loads will be energized;
2. Upon the restoration of "normal" (utility) power at only any one (1) of the three (3) ATS's:
 - a. The affected ATS shall transfer to the "normal" (utility) position;

- b. The affected ATS shall send the proper signal, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, to the control systems of all three (3) gensets;
 - c. The genset control systems, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, shall cause the electrically-operated, output, circuit breaker of one (1) of the gensets to open; and
 - d. The genset control systems, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, shall signal to such genset to shut down (after its pre-determined, genset-cooling period);
- 3. Upon the restoration of "normal" (utility) power at only any two (2) of the three (3) ATS's:
 - a. The affected ATS's shall transfer to the "normal" (utility) position;
 - b. The affected ATS's shall send the proper signals, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, to the control systems of all three (3) gensets;
 - c. The genset control systems, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, shall cause the electrically-operated, output, circuit breakers of two (2) of the gensets to open; and
 - d. The genset control systems, via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system, shall signal to such two (2) gensets to shut down (after their pre-determined, genset-cooling periods);
- 4. Upon the restoration of "normal" (utility) power at all three (3) ATS's:
 - a. All three (3) ATS's shall transfer to the "normal" (utility) position;
 - b. All three (3) ATS's shall send the proper signals (via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system) to the control systems of all three (3) gensets;
 - c. The genset control systems (via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system) shall cause the electrically-operated, output, circuit breakers of all three (3) gensets to open; and
 - d. The genset control systems (via the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system) shall signal to all three (3) gensets to shut down (after their pre-determined, genset-cooling periods); and
- 5. As a clarification, upon any loss of "normal" (utility) power at fewer than all three (3) of the ATS's, the genset-paralleling, electrical-load-pickup, and electrical-load-shedding control-and-management system shall cause the affected ATS(s) to transfer to the "emergency" position and, thus, to be fed with "emergency" power, in the above-referenced order of priority (i.e., ATS-1 first, then ATS-2, and then ATS-3; for example, ATS-2 and/or ATS-3 will transfer to "emergency" power, even if ATS-1 does not transfer to "emergency" power).

- N. The generalized, manual, system operation while utilizing a temporary genset shall be as follows:
1. Upon a loss of "normal" (utility) power:
 - a. The DPDS, main, circuit breaker shall be manually opened (switched "off");
 - b. The three (3) output circuit breakers of the ATSDSL shall be manually opened (switched "off");
 - c. The temporary-genset-receptacle compartment door shall be unlocked, the compartment door shall be opened, the temporary-genset portable cabling shall be connected to the temporary-genset receptacles, and the compartment door shall be closed so as to establish a raintight environment for the connections (it should be noted that such DPDS compartment door cannot be unlocked and opened unless the DPDS, main, circuit breaker is in the "open" position [switched "off"], because they are kirk-key interlocked);
 - d. The temporary genset shall be started and brought up to proper operating speed, and proper temporary-genset-output voltage and frequency shall be verified;
 - e. Depending on the output-power rating of the temporary genset (i.e., EITHER large enough to accommodate the electrical load of only ATS-1, OR large enough to accommodate the total electrical load of both ATS-1 and ATS-2; OR large enough to accommodate the total electrical load of ATS-1, ATS-2, and ATS-3), EITHER just the ATS-1-designated, output circuit breaker of the ATSDSL; OR both the ATS-1-designated, output circuit breaker and the ATS-2-designated, output circuit breaker of the ATSDSL; OR the ATS-1-designated, output circuit breaker, the ATS-2-designated, output circuit breaker, and the ATS-3-designated, output circuit breaker of the ATSDSL shall be manually closed (switched "on");
 - f. ATS-1, ATS-2, and/or ATS-3 (as determined by which designated, output, circuit breaker(s) of ATSSDL has/have been closed) will automatically transfer to the "emergency-source" position; and
 - g. Then proper operation of the system shall be investigated and either verified, or established with remedial action; and
 2. Upon the restoration of "normal" (utility) power:
 - a. "Normal" (utility) power will automatically be restored at all three (3) ATS's, and all three (3) ATS's will retransfer to normal" (utility) power;
 - b. The temporary genset shall be manually stopped;
 - c. The temporary-genset-receptacle compartment door shall be opened and the genset-portable cabling shall be disconnected from the temporary-genset receptacles;
 - d. The temporary-genset-receptacle compartment door shall be closed and locked;
 - e. The DPDS, main, circuit breaker shall be manually closed (switched "on");
 - f. All output, circuit breakers of ATSSDL which are in the "open" position (switched "off) shall be "closed" (switched "on"); and

- g. Then proper automatic operation of the system utilizing the permanently-installed gensets shall be investigated and either verified, or established with remedial action.

1.48 LIGHTING FIXTURES, DRIVERS, LAMPS, ETC.

- A. Individually support each lighting fixture. Provide two (2) hangers for each suspended-type lighting fixture.
- B. Recessed lighting fixtures shall be compatible with the respective ceiling-suspension systems. Ascertain the type and manufacture of each project ceiling prior to purchasing the respective project lighting fixtures, and utilize all such information while deciding exactly which lighting fixtures to order.
- C. Firmly support each ceiling-mounted lighting fixture from the respective ceiling structure by using supports which are designed for the specific purpose; verify all parameters and requirements in advance, and provide accordingly. Such supports shall be attached to the main ceiling-system runners or ceiling joists, as applicable. Such supports shall have a test rating of at least thrice the weight of the respective lighting fixtures.
- D. Provide #9 galvanized steel wires at diagonal corners of each recessed, square or rectangular, lighting fixture, and provide one (1) #9 galvanized steel wire at each recessed, round, lighting fixture, in order to support such lighting fixtures. Firmly attach such wires to the structural system of the building.
- E. Securely bolt lighting-fixture hangers to the structural system of the building. Toggle bolts are unacceptable and shall not be provided for this purpose.
- F. Seal light leaks between the lighting-fixture trim and the ceiling at each recessed lighting fixture.
- G. Pendant-mounted lighting fixtures shall be equipped with ball-aligner or swivel-type hangers.
- H. Lighting fixtures in and for classrooms, study rooms, libraries, etc. shall comply with the applicable sections of the State of Louisiana Board of Health Regulations.
- I. Lighting-fixture drivers shall be U.L.-listed, high-power factor, and certified by CBM, if such certification is available.
- J. Provide dimming LED drivers in and for all project LED lighting fixtures which are indicated on the drawings, and/or are required and intended, to be controlled by lighting dimmers, whether dimming LED drivers are specified in the respective lighting-fixture descriptions in the lighting-fixture schedule on the drawings, or not. Provide LED lamps, dimming LED drivers, and LED lighting dimmers which are completely compatible with one another, as determined by their respective manufacturers, by UNDERWRITERS' LABORATORIES, and by good practice; verify all parameters and requirements in advance, and provide accordingly.

- K. Provide LED lamps for all lighting fixtures.
- L. LED lamps for interior lighting fixtures shall produce illumination having a minimum color-rendering index (CRI) of 82 and having the apparent correlated color temperature which is respectively indicated on the drawings.
- M. LED lamps for exterior lighting fixtures shall produce illumination having a minimum color-rendering index (CRI) of 75 and having the apparent correlated color temperature which is respectively indicated on the drawings.
- N. Provide lighting fixtures which have the respectively-proper input-voltage characteristics, based on the actual circuits from which they are fed, whether so indicated on the drawings and/or in the schedules or not (verify all parameters and requirements in advance, and provide accordingly).
- O. The lighting-fixture catalogue numbers which are indicated on the drawings do not necessarily contain the designations for all respectively-required options. Provide all necessary options, the requirements for which are made obvious by the respective lighting-fixture applications (verify all parameters and requirements in advance, and provide accordingly).
- P. Recessed lighting fixtures shall be equipped with thermal, safety-cutout devices, whether so designated in the respective catalogue numbers or not (verify in advance).
- Q. Connect to each lighting fixture which is installed in an accessible ceiling with flexible, galvanized-steel conduit which is routed from the respective branch-circuit outlet box to such lighting fixture (6'-0" maximum length) in such of a way that will not interfere with the removal of any lay-in ceiling panels, any lighting fixtures, etc. Each such branch-circuit outlet box shall be fed from the respective source (e.g., branch-circuit panelboard, next "upstream" junction or outlet box, etc.) with E.M.T. or rigid metallic conduit (as applicable), and shall serve no more than four (4) lighting fixtures. Do not loop from lighting-fixture-to-lighting-fixture with flexible conduit.
- R. Install exit lights so that their faces are visible from the respectively-required directions and so that their arrows (chevrons) point in the respective directions of egress, whether so shown on the drawings or not. Exit lights shall be the "red-LED" type.
- S. Each exit light shall be connected ahead of all switching for "emergency/night-light" operation.

1.49 CENTRAL LIGHTING-CONTROL SYSTEMS

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the central lighting-control systems, as specified herein below and on the drawings, shall include adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. Submittals which are received without all such required verbiage and/or other information will not be reviewed and will be considered informal.

- B. Provide LightLEEDer, or approved equivalent, central, lighting-control systems, where and as required to render central-lighting-control service and operation to all designated project areas, and where and as required to accommodate the project construction, work, etc. (verify all parameters and requirements in advance, and provide accordingly).
- C. As a clarification, each completely furnished, installed, connected, programmed, tested, certified, and commissioned, central lighting-control system is reference herein as a "system".
- D. Each system shall be completely compatible, in all aspects, with the respective, project, emergency-power-inverter system; with the project, emergency-electrical-power-generation system (alternate-source-power-generation system); and with the respective, project, lighting dimmers (verify all parameters and requirements in advance, and provide accordingly).
- E. All equipment, devices, interconnecting wiring, programming, etc. which are provided for such systems shall be completely compatible with each other, as determined by the systems' manufacturer, by UNDERWRITERS' LABORATORIES, by the state fire marshal, and by all other applicable governing authorities.
- F. INTERNATIONAL ENERGY CONSERVATION CODE (IECC) NOTE: At and for all project facility areas where detainees have access (with or without supervision), Exception No. 1 of IECC Section C405.2, which states "Lighting controls are not required for...areas designated as security... areas...", is being invoked.
- G. Otherwise, each system shall render all light-control (and other) functions which are stipulated, mandated, and described in the 2021 Edition of the International Energy Conservation Code (IECC), as adopted by the Louisiana Office of the State Fire Marshal, and as adopted by all other applicable governing authorities (verify all parameters and requirements in advance, and provide accordingly).
- H. Each system shall include all equipment, devices, materials, hardware, software, interconnections, certifications, commissioning, etc. which are generally and specifically required for such a system, for "single-source responsibility".
- I. Provide (completely under this division of the project), and be completely responsible for, each entire system.
- J. Each system shall be complete in every respect. Provide all equipment, materials, labor, supervision, inspections, testing, calibrations, certifications, etc. which are required for complete and functioning systems, as per the owner's needs, whether so indicated on the drawings and/or specified herein or not.
- K. Each system shall be installed and connected in strict accordance with installation and connection instructions, including interconnecting diagrams, from the systems' manufacturer. Request and obtain all required installation-and-

connection instructions directly from such manufacturer in advance of the commencement of the systems' installations and connections.

- L. Provide all necessary system rough-ins, including outlet boxes, junction boxes, pull boxes, raceways, electrical power cable, signal cables, monitoring cables, control cables, etc. where and as required.
- M. Provide all equipment, devices, materials, hardware, software, interconnections, system programming, certifications, calibrations, and adjustments, and all other appurtenances, which are required for the systems to render all operations and functions that are indicated, specified, required, intended, and desired, including all such system operations and functions that are required, intended, and desired by the owner. Program each system so that all such system operations and functions are indeed rendered by the system, to the complete satisfaction of the user agency. The respective locations which are indicated on the drawings for the various system equipment and components are approximate, and are shown only as a general guide. Locate all such equipment and components in the respective proper locations which are required for the best system operation, even if not so indicated on the drawings or not so specified herein.
- N. After the installation and connection of the systems are complete, test, adjust, calibrate, certify, and commission the systems (all components) as required for optimum operation, and as required for the systems to operate and function in strict accordance with the requirements, intentions, and desires of the user agency.
- O. The systems shall be designed, manufactured, installed, connected, tested, adjusted, calibrated, certified, and commissioned as required to be in complete conformity to the 2021 Edition of the IECC, as well as in conformity to the editions of all other relevant codes and standards, which are presently being enforced by the state fire-marshal's office, and by all other applicable governing authorities (verify in advance).
- P. Each system enclosure shall be equipped with lightning/surge protection against strikes/surges on both power wiring and remote signaling wiring.
- Q. Each entire system (i.e., all components) shall have a minimum short-circuit-current rating of 25,000 amperes RMS.
- R. All system interconnecting wiring shall be installed in raceways which are dedicated for such wiring (i.e., so as to be separate from all other wiring).
- S. Provide all materials, equipment, devices, mounting and supporting apparatuses, and connecting hardware, and all appurtenances, etc., which are required for complete and functioning systems, whether so indicated on the drawings and/or specified herein or not.
- T. After all system equipment, components, devices, materials, raceways, interconnecting wiring, etc. are installed and connected, completely program the systems so as to accomplish the exact lighting-control schemes which are desired by the user agency. In advance of such programming, meet directly with

the user agency (in the presence of the architect and the project electrical engineer), as many times as necessary (as determined by the user agency), so as to present to the user agency all lighting-control possibilities, to assist the user agency in making the proper lighting-control decisions, and to obtain the user agency's final decisions relative thereto; then utilize such obtained information in completely programming and re-programming the systems, as many times as necessary without limit, until the termination of the project one-year warranty period. Be advised that it is mandatory that the initial such meeting be scheduled with the user agency, the architect, and the electrical engineer so that the electrical engineer's preliminary-determined, control schemes can be presented as the starting point from which all final programming and control decisions will emanate. Be advised further that, if the initial such meeting is indeed scheduled without the user agency, the architect, and the electrical engineer being present, this contractor will be required to start the process over again.

- U. Provide to the user agency, to the user agency's complete satisfaction, system orientation and training by authorized factory representatives, at the times and on the dates which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period.

- V. The systems' equipment, components, devices, etc. shall include, but shall not be limited to (all equipment and devices shall be completely compatible with each other, and shall render all system operations, features, and characteristics which are indicated, specified, required, and intended; verify all parameters and requirements in advance, and provide accordingly; all catalogue and model numbers shown are LightLEEDer numbers; each entire system shall be manufactured by LightLEEDer, or shall be approved equivalent):
 - 1. All system software, factory programming, and field reprogramming which is required for complete system operation, including all system functions that are specified, required, and intended (verify all parameters and requirements in advance and provide accordingly);
 - 2. BACnet IP and Ethernet, native, communication-network protocols which are required for interfacing with, being complete compatible with, and networking with, the user agency's local area (data) network and the user agency's wide area (data) network (via internet). Verify all parameters and requirements in advance, and provide accordingly;
 - 3. Model LLEVO-TC LightLEEDer EVO, distributed control panels - with time clocks (the quantity required; verify);
 - 4. Model LSEVO-4X LightSync EVO, distributed control panels - 4-relay expansions (the quantity required; verify);
 - 5. Model LSG3-WH-3-MZD, LightSync G3, switches - white - 3-multi-zone-dim (the quantity required; verify);
 - 6. Model OAWC-DT-120W, 1200 sq ft, dual-tech, occupancy wall/corner sensors (mount up to 12'-0" A.F.F.; the quantity required; verify);
 - 7. Model ONW-P-1001-MV-W, 1000 sq ft, PIR, occupancy sensor switches (the quantity required; verify);
 - 8. Model PS-IND or PC-IND (as required; verify), photocell sensor heads - indoor (the quantity required; verify);
 - 9. Model R20D, remote relays with 0-10V dimming - 120/277V (the quantity required; verify);

10. Model SP20-RD4, SP20-RD4 switch racks (the quantity required; verify); and
11. Category-5- compliant data cable (the amount required; verify).

1.50 EMERGENCY-POWER INVERTER SYSTEMS

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the "Emergency-Power Inverter Systems", as specified herein below and/or on the drawings, shall include adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting, will not be reviewed and will be considered informal.
- B. Provide the emergency-power inverter systems, each of which is herein below referenced as "each system", and which is indicated on the drawings, specified herein, intended, and required.
- C. Each system shall include all equipment, devices, materials, hardware, software, interconnections, certifications, commissioning, etc. which are generally and specifically required for such a system, for "single-source responsibility".
- D. Provide (completely under this division of the project), and be completely responsible for, each entire system as indicated on the drawings, as specified herein, as required, and as intended.
- E. Each system shall be complete in every respect. For each system, provide all equipment, materials, labor, supervision, inspections, testing, calibrations, certifications, etc. which are required for a complete and functioning system, as per the user agency's needs, whether so indicated on the drawings and/or specified herein or not.
- F. Each system shall be installed and connected in strict accordance with installation and connection instructions, including connecting and/or interconnecting diagrams, from the system manufacturer. Request and obtain all required installation and connection instructions directly from such manufacturer in advance of the commencement of the installation of each system.
- G. Provide all rough-ins, including outlet boxes, junction boxes, pull boxes, raceways, electrical power cable, signal cables, monitoring cables, control cables, etc., where and as required for each system .
- H. Provide all equipment, devices, materials, hardware, software, interconnections, system programming, certifications, calibrations, adjustments, and all other appurtenances which are required for each system to render all operations and functions that are indicated, specified, required, intended, and desired, including all such system operations and functions that are required, intended, and desired by the user agency. Program each system so that all such system operations and functions are indeed rendered by the system, to the complete satisfaction of

the user agency. The respective locations which are indicated on the drawings for all system equipment and components are approximate, and are shown only as a general guide. Locate all such equipment and components in the respective proper locations which are required for best system operation, even if not so indicated on the drawings or so specified herein.

- I. After the installation and connection of each system is complete, test, adjust, calibrate, and certify the system (all components), as required for first-class operation, and as required for the system to operate and function in strict accordance with the requirements, intentions, and desires of the user agency.
- J. The specifications for each system require:
 - 1. That the system supply battery-backed-up power to and for the respective, unswitched (24-hour), lighting fixtures; to and for the respectively-designated, controlled, interior and exterior, lighting circuits of the respective, project, central, lighting-control system; and to and for the respectively-designated, locally-switched, lighting fixtures; and
 - 2. That the system be completely compatible with, and operate completely satisfactorily in conjunction with, such respective, project, central, lighting-control system, and with the project, emergency-electrical-power-generation system. The system shall be furnished with all required interconnecting diagrams, and all other relevant information, which are required to depict the proper interconnections between and among the system, and such, respective, project, central, lighting-control systems and such project, emergency-electrical-power-generation system.
- K. Each system shall be in strict accordance with the requirements of all applicable codes and governing authorities including, but not limited to, OSHA, NFPA70, NFPA101, UBC, and SBCCI; verify all requirements in advance and provide each complete system accordingly.
- L. Each system shall be complete with lightning/surge protection against strikes/surges.
- M. For each system, provide all materials, equipment, devices, mounting and supporting apparatuses, and connecting hardware, and all appurtenances, etc., which are required for a complete and functioning system, whether so indicated on the drawings and/or specified herein or not.
- N. Provide to the user agency, to the user agency's complete satisfaction, system orientation and training by authorized factory representatives, at the times and on the dates which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period.
- O. Each system shall:
 - 1. Be completely compatible with all of the types of lighting loads which are being provided for the project;
 - 2. Be an IGBT-based inverter;
 - 3. Have the KW/KVA, output, power rating which is respectively indicated on the drawings;

4. Have an input voltage/phase rating of 277 volts, single phase, two wire (plus equipment ground);
5. Have an output voltage/phase rating of 277 volts, single phase, two wire (plus equipment ground);
6. Be equipped with an input circuit breaker;
7. Be equipped with the number of integral, 20-amp, 1-pole, supervised, output, circuit breakers which is respectively indicated on the drawings, with output-trip alarm;
8. Have a 65kAIC (minimum) short circuit rating;
9. Be equipped with a single cabinet for the batteries and the inverter;
10. Be UL 924 listed, with NFPA 101, automatic self-testing, diagnostic, and data logging;
11. Be equipped with an e-mail modem;
12. Be equipped and arranged for "normally on" output;
13. Be equipped and arranged for 90-minute "emergency" battery backup at system full output load;
14. Be equipped with maintenance-free, rechargeable, 20-year, valve-regulated, lead calcium (VRLA) batteries;
15. Be equipped with a fast-charge battery charger which will recharge full discharged batteries in a 12-hour period;
16. Be equipped with an automatic event, test, and alarm log;
17. Be equipped with a NEMA 1 (indoor, general-purpose), free-standing, industrial-grade, powder-coat-paint-finished , cold-rolled-steel enclosure with 3-point, hinged, locking-latch doors, and with the required floor stand (where and as required);
18. Be equipped with maintenance bypass;
19. Be equipped with status-monitoring contacts;
20. Include a 5-year, extended, factory, electronics warranty;
21. Include factory start-up and training; and
22. Be MYERS Power Products #6-1E-****-G-R90-BD20**-C-E-F-M-T-2YW-5YW ("*****" = the KW/KVA rating which is respective indicated on the drawings; "***" = the number of output circuit breakers which is respectively indicated on the drawings), or prior-approved equivalent by ISOLITE.

1.51 ELECTRICAL, POWER-AND-ENERGY-MONITORING SYSTEM

- A. Documents:
 1. This section of the specifications forms part of the project contract documents, and shall be read, interpreted, and coordinated with all other parts of the project contract documents.
- B. System Description:
 1. It is intended that the products which are specified herein shall render a complete sub-metering solution. This solution shall be utilized to measure and monitor the electrical power and electrical usage of the following systems (loads) separately:
 - a. HVAC systems (i.e., heating, cooling, and ventilation, including fans, pumps, boilers, chillers, and water heating); this end-use category is referenced herein and on the project electrical drawings as "End-Use Category A";

- b. Interior lighting; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category B";
 - c. Exterior Lighting; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category C";
 - d. Power-receptacle (plug) loads; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category D";
 - e. Process loads; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category E"; and
 - f. Building operations and other miscellaneous loads (i.e., all other electrical loads); this end-use category is referenced herein and on the project electrical drawings as "End-Use Category F"; and
 - 2. The system shall comply with all requirements of all applicable, national and local, energy codes, and shall include all equipment and appurtenances which are required to meet the specific criteria of the latest edition of the International Energy Conservation Code (IECC).
- C. This Section Includes:
- 1. Electrical sub-metering equipment, data-collection systems, and data-management software systems including:
 - a. Standard, single-point, kWh, electrical sub-meters;
 - b. Advanced, single-point, kWh, electrical sub-meters;
 - c. Multi-point electrical sub-meters;
 - d. Data-collection hubs;
 - e. High-density pulse modules;
 - f. Open-protocol data-communication networks;
 - g. Wireless communication devices; and
 - h. Energy-monitoring software.
- D. Standards:
- 1. Provide the equipment, and all required appurtenances, of this section in full compliance with the following applicable portions of the latest revisions of the following standards:
 - a. ANSI C12.1 & C12.20 at 0.5 Accuracy Class;
 - b. UL Certified to IEC/EN/UL/CSA 61010-1 2nd Edition;
 - c. UL916:
 - (1) These requirements cover energy-management equipment and associated sensing devices which are rated 600 volts, or less, and are intended for installation in accordance with the National Electrical Code, NFPA 70; and
 - d. NEMA -ESM-1.
- E. Shop Drawings:
- 1. The installation and shop drawings shall include the following:
 - a. The system manufacturer's literature and specifications;
 - b. The system-component-connection wiring diagrams; and
 - c. The communications system specifications.
- F. Installation, Operation, and Maintenance Manuals:
- 1. Submit installation, operation, and maintenance manuals for the system data-collection system, and data-management software.

- G. Technical Performance:
1. The minimum, measured, technical performance of each piece of installed system equipment shall meet the specifications published by the respective manufacturer;
 2. Optimize the technical performance of all systems as required to produce the highest, achievable, technical performance, to the satisfaction of the architect, the electrical consultant, and the user agency; and
 3. Any deficiencies in the system, particularly information-communication errors, or operational deficiencies, shall be cause for rejection of the system. Rectify all such deficiencies prior to requesting the substantial-completion review.
- H. Warranty:
1. The system manufacturer shall furnish a comprehensive warranty for all products;
 2. All electrical sub-meters included in this specification shall be free from defects in materials and workmanship from the date of substantial completion for a period of five (5) years; and
 3. All data-collection-system components included in this specification shall be free from defects in materials and workmanship from the date of substantial completion for a period of five (5) years.
- I. Acceptable Manufacturers:
1. LEVITON Manufacturing;
 2. ELECTRO-INDUSTRIES;
 3. TBWC TECHNOLOGY/DENT;
 4. PACKET POWER;
 5. HONEYWELL E-MON;
 6. The basis-of-design systems are the LEVITON VerifEye Metering System and the TBWC TECHNOLOGY/DENT Metering System; and
 7. Requests for prior-approval substitutions shall be submitted in advance of project pricing, in accordance with the project submittal requirements which are stated elsewhere in the project specifications. Relative to such requests for substitution:
 - a. Show all substitutions as an add or deduct from base bid pricing;
 - b. Submit a manufacturer's reference list.
 - c. Clearly delineate all proposed substitutions as such;
 - d. Prior to rough-in, submit to the engineer for review and approval complete, engineered, shop drawings, including power wiring, with all deviations from the original design highlighted in an alternate color; and
 - e. By using pre-approved substitutions, the contractor accepts the responsibility and associated costs for all required modifications to circuitry, devices, wiring, etc.
- J. Meters and Current Transformers:
1. Standard, single-point, metering devices: LEVITON Mini-Meters, Series 1000 and Series 2000; or TBWC TECHNOLOGY/DENT DI Smart Meters;

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2. Advanced, single-point, metering devices: LEVITON Series 3500, Series 4000, and Series 4100; or TBWC TECHNOLOGY/DENT DI-SA Smart Meters;
 3. Multi-point metering devices: LEVITON Series 7000, 7100, 8000; or TBWC TECHNOLOGY/DENT DI-MMU Intelligent High-Density Meters;
 4. LEVITON or TBWC TECHNOLOGY/DENT solid-core or split-core, current transformers, with a full-scale output of 0.1A or 0.333V;
 5. LEVITON or TBWC TECHNOLOGY/DENT Rogowski-coil current transformers;
 6. Solid-Core current transformers which are available for 100A to 400A, and split-core current transformers which are available from 50A to 5,000A; and
 7. Current-transformer secondary-conductor wires can be extended:
 - a. 500 feet for 0.1A CT's;
 - b. 300 feet for 0.333V CT's; and
 - c. 20 feet for Rogowski-Coil CT's.
- K. System Description – Single-Point Metering Devices:
1. Provide single-point metering devices which are capable of metering 1PH/2W, 2PH/3W, 3PH/3W, and/or 3PH/4W loads;
 2. The meters shall be capable of directly metering North American 120/208/240V and 277/480V systems;
 3. The metering units shall be capable of metering loads between 50A and 5000A. Provide meters which are specific to the project, as indicated on project-construction drawings;
 4. The metering units may have the capability of paralleling up to three (3) sets of CT's per phase (such is not applicable to Rogowski-coil meters);
 5. Shall meet all ISO 9001 standards for quality control, where all meters test to a minimum of +/-0.2% or +/-0.5% accuracy, depending on the stated accuracy class;
 6. The system shall be as described below:
 - a. It shall consist of electronic meters with embedded communications capability, and solid-core, split-core, or Rogowski-coil, current-transformer technology. The current transformers shall have a full-scale output of 0.1A or 0.333V, and secondary voltage clamps for safety purposes;
 - b. The meters shall be used for power-and-energy-monitoring applications;
 - c. The meters shall be capable of remote communication from each metering device;
 - d. The Standard Meters shall have an isolated pulse output, with output ranges of from 10Wh to 1kWh;
 - e. The Advanced Meters shall transmit data via one of the following communication protocols:
 - (1) Isolated Pulse Output;
 - (2) Modbus TCP/IP;
 - (3) ACNet IP;
 - (4) Modbus RTU; or
 - (5) BACNet MS/TP;
 - f. Backup power shall be supplied by an on-board battery which maintains the real-time clock through power loss (Advanced

Meters only). Power and energy data shall be stored in non-volatile memory, as required to maintain values through power losses, and such memory shall be capable of holding sixty-five (65) days of historical data in default settings (Advanced Meters only);

- g. Failure of the building, normal, electrical-power system shall not result in a loss of data, and shall not require manual restarting of the metering system; and
- h. The system shall be a fully automated, micro-processor-based, electrical-energy-measurement system for measurement and verification purposes. The system shall incorporate complete metering, communications, and reporting functions; and energy-monitoring, and threshold-limit capabilities.

L. System Measurements – Single-Point Metering Devices:

- 1. The meters shall be complete with a Liquid Crystal Display (LCD), as required to access all power and energy measurements, and phase diagnostics when needed;
- 2. Standard Meter Power and Energy Parameters:
 - a. kWh real consumption; and
 - b. kW peak-resettable kW peak;
- 3. Advanced Meter Power and Energy Parameters:
 - a. Bi-directional energy measurements;
 - b. kWh real consumption;
 - c. kW peak resettable kW peak;
 - d. kW instantaneous real power;
 - e. kVAh apparent energy consumption;
 - f. kVA total apparent power;
 - g. kVARh reactive consumption;
 - h. kVAR total reactive power;
 - i. PF power-factor total;
 - j. Maximum kW peak demand, with time and date stamp; and
 - k. Hz line frequency;
- 4. Advanced Meter Phase Diagnostics: Parameters which shall be displayed for each individual phase of each metered load:
 - a. Voltage Phase-to-neutral and phase-to-phase;
 - b. Amps Instantaneous amperage for each phase;
 - c. kW Instantaneous real power;
 - d. PF Real power factor;
 - e. kVA Instantaneous apparent power; and
 - f. kVAR Instantaneous reactive power.

M. System Description -- Multi-Point Metering Devices:

- 1. The system shall be as described below:
 - a. It shall consist of electronic multiple-point meters with embedded communications capability, and with solid-core, split-core, or Rogowski-coil current-transformer technology. The current transformers shall have a full-scale output of 0.1A or 0.333V, N.C. outputs, and secondary-voltage clamps for safety purposes;
 - b. The meters shall be used for energy-monitoring applications;

- c. The meters shall be capable of being externally mounted in a NEMA 1 enclosure, or of being internally mounted in electrical panels or switchgear;
 - d. The meters shall be capable of remote communication from each metering device. Each device shall have IP sockets and RS-485 terminals as required to accommodate data transmission via Modbus RTU, Modbus TCP/IP, BACNet MS/TP, BACNet IP, and standard Ethernet. Data shall be transmitted by one, or a combination of, the following
 - (1) A standard Ethernet interface;
 - (2) An Ethernet connection to a PC or to a laptop via a crossover cable; and
 - (3) An RS-485 Network-Modbus RTU and BACNet MS/TP;
 - e. The system shall have backup storage power for key components, so that no data is ever lost during power outages. The system shall continue to function after the resumption of power; and
 - f. The failure of the building, normal, electrical-power system shall not result in a loss of data, and shall not require manual restarting of the metering system;
2. The system shall be a fully-automated, microprocessor-based, electrical power-and-energy-measurement system for measurement and verification purposes. The system shall incorporate the following:
 - a. Complete metering;
 - b. Communications;
 - c. Reporting functions;
 - d. Energy monitoring; and
 - e. Threshold-limits capabilities;
 3. The meters shall be capable of directly metering on board, North American 120/208/240V and 277/480V systems;
 4. The meters may require potential transformers (PT's) for 480V and 240V delta applications;
 5. The meters shall be capable of operating with two (2) distinct-and-independent, reference-voltage inputs as required to allow for monitoring two (2) separate electrical systems. Each meter shall allow any CT input to be referenced against either input voltage channel;
 6. The metering units may have the capability of accommodating a wiring-harness, single, incoming cable containing twenty-five (25) pairs of 22 AWG wire with associated current transformers (CT's), or have optional terminal strips with screw-terminal connections for the CT's. The metering units may also be configured with individual input channels for secondary wires of the CT's;
 7. The system shall meet all ISO 9001 standards for quality control, where all meters test to a minimum of +/-0.2% or +/-0.5% accuracy, depending on the accuracy class;
 8. The metering units shall be configured as required to meter the respective number of circuits which are required to be measured (provide multiple metering units where a single metering unit does not have enough capacity for the number of circuits which are required to be measured; verify in advance, and provide accordingly), e.g., the metering units shall be configured for:

- a. Twelve (12) single-pole circuits, six (6) two-pole circuits; or four (4) three-pole circuits;
 - b. Twenty-four (24) single-pole circuits, twelve (12) two-pole circuits, or eight (8) three-pole circuits;
 - c. Forty-eight (48) single-pole circuits, twenty-four (24) two-pole circuits, or sixteen (16) three-pole circuits; or
 - d. More circuits, where and as required for the respective applications.

- N. System Measurements – Multi-Point Metering Devices:
 - 1. Each meter shall be complete with a Liquid Crystal Display (LCD), as required to access the power-and-energy measurements and the phase diagnostics, when needed:
 - 2. Energy/Power Parameters:
 - a. kWh real energy consumption;
 - b. kW instantaneous power;
 - c. kVAh apparent consumption;
 - d. kVA apparent power;
 - e. kVARh reactive consumption; and
 - f. kVAR reactive power;
 - 3. Phase Diagnostics: Parameters which shall be displayed for each individual phase of each metered load:
 - a. Voltage Phase-to-neutral or phase-to-phase;
 - b. Amps Instantaneous amperage for each phase;
 - c. kW Instantaneous power;
 - d. PF Power factor;
 - e. PA Phase angle;
 - f. kVA Instantaneous apparent power;
 - g. KVAR Instantaneous reactive power; and
 - h. THD Total Harmonic Distortion - Theta.

- O. Meter-Data Collection and Communication:
 - 1. Data-acquisition server: LEVITON or TBWC TECHNOLOGY/DENT Energy-Monitoring HUB;
 - 2. Pulse-data collection: LEVITON or TBWC TECHNOLOGY/DENT High-Density Pulse Module; and
 - 3. Wireless data transmission: LEVITON ModHopper or TBWC TECHNOLOGY/DENT CS-IPM.

- P. System Description – Meter Communications and Data Collection:
 - 1. The system shall be as described below:
 - a. The system shall consist of energy-management hubs, pulse modules, wireless communication devices, and software which are used to transmit, collect, and display the data that is generated by the sub-metering equipment;
 - b. The system shall allow all data which is collected to be connected to IP-based applications, including ENTERPRISE Energy-Management Software, OPTERGY Energy-Management Software, Demand Response, and Smart-Grid Collection, for use in power measurement; and

- c. The data-collection system shall be all non-proprietary and compatible with industry-standard M&V software applications. Open protocols such as Modbus, pulse outputs, analog, resistive inputs, etc. shall be utilized. Proprietary or manufacturer-specific protocols between the meters and the data collectors are not acceptable, and shall not be provided.

Q. Product Requirements – Data-Acquisition Server:

1. Provide a data-acquisition server which measures and verifies data from the electrical meters;
2. The server shall comply with the following codes and standards:
 - a. FCC CFR 47 Part 15, Class A;
 - b. EN 610000;
 - c. EN 61326; and
 - d. CE;
3. The server shall be equipped with an ARM7 embedded CPU, an ARM7 I/O co-processor, 32MB of on-board RAM, 16MB of NOR flash memory, and a USB expansion port;
4. The server shall operate under the following conditions:
 - a. From 32 degrees F. to 122 degrees F. (0 degrees C. to 50 degrees C.), 0-90% RH, non-condensing; or
 - b. From 41 degrees F. to 104 degrees F. (5 degrees C. to 40 degrees C.), 0-90% RH, non-condensing;
5. The server shall have the capability to collect and log information at intervals from one (1) minute to sixty (60) minutes;
6. The server shall time stamp all acquired data and store such data in a non-volatile memory;
7. The server shall use modem connections and/or Ethernet connections for Internet access, thus allowing either static-IP (Internet-protocol) addressing or DHCP (Dynamic Host Control Protocol) addressing;
8. The server shall communicate with all metering data points via wired or wireless connections over the following protocols:
 - a. Wired communications:
 - (1) Pulse;
 - (2) Ethernet-Modbus TCP/IP; and
 - (3) RS-485-Modbus RTU;
 - (a) Modbus devices shall be connected via 18-gauge stranded bare copper, single-twisted-pair, shielded, instrumentation cables, or approved equivalent; or
 - b. Wireless communications:
 - (1) Wireless Modbus;
9. The server shall communicate with external devices via wired or wireless connections over the following protocols:
 - a. Wired communications:
 - (1) Ethernet LAN (Local Area Network) or WAN (Wide Area Network);
 - (2) TCP/IP;
 - (3) PPP;
 - (4) HTTP/HTML;
 - (5) FTP;
 - (6) NTP;

- (7) XML;
- (8) SNMP; and
- (9) BACnet-Optional Downloaded Module;
- b. Wireless Communications:
 - (1) GSM (Global System for Mobile Communications);
 - (2) GPRS (General Packet Radio Service); and
 - (3) PSTN (Public Switched Telephone Network);
- c. The server shall upload data at user-selectable scheduled intervals via HTTP or FTP, and shall download data in XML or custom formats;
- d. The server shall generate alarms for data points, including SNMP (Simple Network Management Protocol) traps; and
- e. The server shall be equipped with the following input and output connections:
 - (1) Input:
 - (a) RS485 Modbus serial input which is capable of supporting thirty-two (32) external devices. Such input shall be expandable at the user agency's option;
 - (b) Eight (8) Flex I/O inputs which are configurable for the following modes:
 - i) 0-10VDC, 4-20mA, Resistive;
 - ii) Standard KYZ pulse modes for A or C, dry-contact relay outputs; and
 - iii) Status; and
 - (2) Output:
 - (a) Two (2) Opto-FET dry-contact relays which are rated at 30VDC and 150mA maximum.

R. Product Requirements – High-density Pulse Modules:

- 1. Provide high-density pulse modules for the collection and distribution of all pulse-output data which are generated by all electric meters and sensors, and all other similar devices;
- 2. Each such module shall be equipped with on-board, adjustable, Modbus addressing, via dip switches with addresses from 1 to 128;
- 3. Each such module shall comply with the FCC CFR 47 Part 15, Class A, emissions standard;
- 4. Each such module shall be equipped with an ARM7 I/O processor having field-upgradable firmware;
- 5. Each such module shall communicate over a Modbus/RTU RS-485, two-wire network with the following network speeds:
 - a. 19200 Baud; and
 - b. 9600 Baud;
- 6. Each such module shall operate satisfactorily under the following conditions:
 - a. From 22 degrees F. to 158 degrees F. (-6 degrees C. to 70 degrees C.), 0-90% RH, non-condensing;
- 7. Each such module shall have a 32-bit pulse counter which rolls over at 4.295 billion pulses per channel, and stores pulse data in a non-volatile memory. The pulse rate shall be user-selectable;
- 8. Each such module shall have the following input and output connections:

- a. Input:
 - (1) Non-isolated pulse and power inputs;
 - (2) Modbus RS485 connection;
 - (3) Twenty-three (23) independent pulse-count inputs which are designed for use with dry-contact outputs. The pulse rate shall be user-selectable between the following:
 - (a) 10Hz: The minimum pulse width shall be 50ms;
 - (b) 50Hz: The minimum pulse width shall be 10ms; and
 - (c) 100Hz: The minimum pulse width shall be 5ms.
- S. Product Requirements – Wireless Transceivers:
 1. Provide the OPTIONAL wireless transceivers for the collection and distribution of all pulse outputs which are generated by electrical meters, and all other energy meters and sensors;
 2. Each transceiver shall comply with the following codes and standards:
 - a. FCC CFR 47 Part 15, Class A, emissions standard; and
 - b. FCC ID shall be OUR-9XTREAM;
 3. Each transceiver shall be equipped with a 60 MHZ ARM7 embedded CPU;
 4. Each transceiver's firmware shall be field upgradable;
 5. Each transceiver shall communicate over a self-healing, self-optimizing, wireless, mesh network and shall utilize frequency hopping, spread-spectrum, radio transmission and reception over a 900MHz band;
 6. Each transceiver shall have a line-of-sight range of 3000 feet indoors and 14 miles outdoors;
 7. The Transceiver broadcast power shall be 1 watt;
 8. Each transceiver shall operate under the following conditions:
 - a. From 32 degrees F. to 122 degrees F. (0 degrees C. to 50 degrees C.), 0-90% RH, non-condensing; and
 - b. 1.24 miles (2000m) maximum altitude, with Degree 2 pollution;
 9. Each transceiver shall be equipped with a pulse counter, with the pulse data being stored in a non-volatile memory; and
 10. Each transceiver shall have the following input and output connections, and the Modbus addresses shall be adjustable via DIP switches, with addresses between 1 and 247:
 - a. Input:
 - (1) Two (2) Pulse inputs with user-selectable pulse rates of 10, 50, 100, or 250 Hz.;
 - (2) Modbus RS485 input; and
 - (3) Connect a maximum of thirty-two (32) Modbus devices to the transceiver's input; and
 - b. Outputs shall be user-selectable between 100 Ohms and 2.5 kOhms;
 - (1) Two (2) Opto-FET dry-contact relays rated at 30VDC, 150mA max.
- T. Cloud-Based Energy-Information Software:
 1. The software package shall consist of one (1) or more of the following WEB-based system modules:
 - a. Basic Building Management Software: BMO Base Module; and/or

- b. ENTERPRISE Energy-Management Software or OPTERGY Energy-Management Software: BMO Advanced Reporting Module;
- U. Product Requirements -- Basic Software-BMO Base Module:
 - 1. The software shall be able to be integrated into the Building Energy Management System which is used for HVAC systems; and
 - 2. Provide a web-hosted software platform which is fully functional without software other than standard web browsers including, but not limited to, MICROSOFT Internet Explorer, GOOGLE Chrome and FIREFOX Mozilla:
 - a. The software shall support an unlimited number of meter-data points based on the subscription level; and
 - b. The software shall be able to be used for the collection, analysis, and reporting of the electrical power and energy data from the sub-metering equipment which is used to capture energy-power and energy-usage measurements that include, but are not limited to:
 - (1) HVAC systems (i.e., heating, cooling, and ventilation, including fans, pumps, boilers, chillers, and water heating); this end-use category is referenced herein and on the project electrical drawings as "End-Use Category A";
 - (2) Interior lighting; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category B";
 - (3) Exterior Lighting; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category C";
 - (4) Power-receptacle (plug) loads; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category D";
 - (5) Process loads; this end-use category is referenced herein and on the project electrical drawings as "End-Use Category E"; and
 - (6) Building operations and other miscellaneous loads (i.e., all other electrical loads); this end-use category is referenced herein and on the project electrical drawings as "End-Use Category F".
- V. Wiring and Connections:
 - 1. All wiring and connections shall meet or exceed all of the requirements of all applicable codes and governing authorities (verify in advance, and provide accordingly);
 - 2. Show on all submittals (shop drawings, etc.) all system metering points which will be furnished, installed, and connected, and only such metering points;
 - 3. Install all wiring in conduit;
 - 4. Provide a dedicated Ethernet drop as required to accommodate and report remote meter readings and diagnostics of the system;
 - 5. Perform all necessary system calibrations, testing, commissioning, and demonstrations as required; and

6. Prepare and submit record drawings, and installation, operation, and maintenance manuals, for this electrical power monitoring system, as required.
- W. Testing and Commissioning:
1. Perform all required final calibrations, testing, adjustment, commissioning, and demonstrations of the systems; report all results to the architect; and include all results in the installation, operation, and maintenance manuals. Engage qualified technicians for the testing and commissioning;
 2. Perform sufficient technical and operational tests as required to ensure that the technical performance of the system meets or exceeds the intent of the Contract Documents, and meets or exceeds the requirements of all applicable codes and governing authorities. Typical testing shall include, but not be limited to,:
 - a. Verification of all meter readings, and proper installation and connection of all metering equipment;
 - b. Communication systems connectivity; and
 - c. Proper meter communication with all of the software platforms;
 3. Provide all required optional functional testing, including end-to-end verification that all meters are operating properly; and
 4. Demonstrate the complete operation (all features) of the systems to the user agency, at the times and on the dates which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period. Such demonstration shall include product training on how to program the electrical, power-and-energy-monitoring systems.
- X. Field Verification, Acceptance, and Training:
1. Provide all "AS BUILT" DRAWINGS and data showing each meter, serial number, address, cross reference, load, and CT ratio prior to field verification;
 2. The system manufacturer's representative shall verify, adjust, and test the system. Verification of the electrical power-and-energy-monitoring system shall be carried out with the assistance of the project electrical subcontractor at all times. Upon completion, the system manufacturer shall issue a "Commissioning Report" to the architect, to the electrical consultant, to the project contractor, and to the owner;
 3. The system manufacturer's representative shall demonstrate the complete operation of the system as follows:
 - a. Local and remote meter readings;
 - b. Phase diagnostics;
 - c. Submit manuals of the installed system; and
 - d. Ensure that the entire system is connected to the cloud, as required to communicate with the software servers; and
 4. The software training is typically completed remotely via on-line instruction by the system manufacturer's technical support staff.
- Y. Field Quality Control:
1. Submit a detailed testing-and-commissioning procedure narrative to the architect for review and approval prior to undertaking this work. Such

- procedure narrative shall indicate all of the test equipment which is required, as well as the acceptance criteria;
 - 2. Upon completion of all testing and commissioning, submit a copy of the test and commissioning results; and
 - 3. Undertake the testing and commissioning work with the manufacturer's factory representative(s).
 - Z. Instruction to Staff:
 - 1. Upon completion of the installation, a competent instructor representing the system manufacturer shall provide a lecture to the operation-and-maintenance staff concerning the intent, use, operation, and maintenance of the system. This may be accomplished remotely.

1.52 EQUIPMENT CONNECTIONS

- A. Connect all project equipment, regardless of who actually furnishes such equipment.
- B. Provide junction-box connections and/or receptacles of the proper configurations, ratings, and sizes where and as required to accept the respective plugs on the equipment, and provide matching plugs on equipment cords where and as required.
- C. Information which is presented on the electrical drawings for connection of equipment is based on information which was furnished during the design phases of the project from certain manufacturers, from certain suppliers, and/or from the owner. The possibility exists that the actual requirements for the electrical connections for some or all of such equipment differ from the requirements which are respectively depicted on the project electrical drawings. Provide the facilities which are required for the equipment that will actually be installed. Make allowances in the project proposal as required to accommodate changes in the requirements of the equipment due to changes in the equipment which is actually furnished by such manufacturers, and/or due to changes in the equipment suppliers and/or manufacturers. Bring all conflicts to the immediate attention of the architect for resolution well in advance of the commencement of any work which is associated with equipment connections.
- D. Well in advance of preparing the project electrical-equipment shop drawings and well in advance of ordering any project electrical equipment, and as part of the requirements and work of this project division:
 - 1. Employ, coordinate directly with, and pay (if such payment is required) the respective suppliers/vendors of all project electrified equipment and/or the respective project subcontractors who are providing all project electrified equipment, as respectively applicable,:
 - a. To review all respective equipment electrical characteristics and requirements which are indicated and/or given on any of the project drawings and/or in any of the project specifications; and
 - b. To determine whether or not each bit of the information that is relevant to such indicated equipment electrical characteristics and requirements is accurate for the exact respective equipment which is being furnished for the project;

2. Have such suppliers/vendors and/or subcontractors, as respectively applicable,:
 - a. Verify, in no uncertain terms, with proper documentation, which bits of the information that is relevant to such indicated equipment electrical characteristics and requirements are indeed so accurate; and
 - b. Furnish the respective, properly-corrected, equipment electrical characteristics and requirements for all indicated equipment electrical characteristics and requirements which are not so accurate;
 3. Submit all such verifying and/or correcting documentation to the architect, in a timely manner, in the same formats in which the respective equipment electrical characteristics and requirements were originally indicated and/or given. For example,:
 - a. For all equipment electrical characteristics and requirements which were originally indicated and/or given in the form of equipment schedules, submit the respective, properly-corrected, equipment electrical characteristics and requirements in the form of corrected, similar, equipment schedules;
 - b. For all equipment electrical characteristics and requirements which were originally indicated and/or given in the form of equipment notes, submit the respective, properly-corrected, equipment electrical characteristics and requirements in the form of corrected, similar, equipment notes;
 - c. For all equipment electrical characteristics and requirements which were originally indicated and/or given in the form of specification verbiage, submit the respective, properly-corrected, equipment electrical characteristics and requirements in the form of corrected, similar, specification verbiage; etc.
- E. Rough-in in accordance with drawings and/or other information which is supplied by the respective equipment suppliers and/or manufacturers (request and obtain, well in advance and directly from the respective equipment suppliers and/or manufacturers, all relevant information).
- F. In, at, and for the Food Service Building, whether so indicated on the drawings or not, connect the cooking-hood, fire-extinguishing equipment, including providing all required raceways; electrical-power cables; electrical-signal cables; electrical-control cables; micro switches; auxiliary relays; contactors; and shunt-trip circuit breakers, and all other required appurtenances. Connect all gas solenoid valves where and as required by all applicable codes, laws, ordinances, rules, and regulations. Make all required connections so that, upon activation of the cooking-hood, fire-extinguishing equipment,:
 1. The shunt-trip circuit breakers which feed all electrified equipment that is located beneath the kitchen hood(s) shall trip and, thereby, de-energize the respective, associated equipment;
 2. The shunt-trip circuit breaker(s) which feed(s) the cooking-hood, supply fan(s) shall trip and, thereby, de-energize the associated fan(s). As a clarification, the cooking-hood exhaust fan(s), if operating at the time, shall not be de-energized and shall continue to operate; and the cooking-hood exhaust fan(s), if not operating at the time, shall be energized and

- shall be caused to operate (verify all parameters and requirements in advance, and provide accordingly);
- 3. The main, gas-supply, solenoid valve shall close; and
- 4. A general fire-alarm signal shall be sent to the respective, main or satellite (as applicable), fire-alarm-system control panel.

1.53 ELECTRICAL COORDINATION WITH THE PROJECT, BUILDING AND AUTOMATIC, TEMPERATURE CONTROLS (PRIOR TO MAKING THE PROJECT PROPOSAL)

- A. Given the nature of the evolving technology in the field of building and automatic temperature controls, as well as the differences between and among the equipment and systems of the various manufacturers, it is possible that temperature-control devices with various voltage characteristics and requirements (e.g., 120 volts, single-phase, 60Hz.; 24 volts AC or DC; etc.) have been specified in the HVAC divisions of the project (verify in advance).
- B. It is the responsibility of the project general contractor, the project mechanical subcontractor, the project electrical subcontractor, and the project temperature-controls subcontractor to coordinate, prior to making the project proposal, as required to ensure that all electrical provisions and accommodations for all project temperature-control devices and work (i.e., materials; equipment; raceways; circuit breakers; electrical power, signal, and control wiring; devices; terminations; connections; installation; labor; etc.) which are required to render a complete and working, temperature-controls system are included in the project proposal and work.
- C. If the project general contractor and such applicable project subcontractors fail to accomplish such coordination prior to making the project proposal, and/or if they fail to include all such electrical provisions and accommodations in the project proposal pricing, then the cost to provide such electrical provisions and accommodations shall be borne solely by the project general contractor and such applicable subcontractors.
- D. No additional cost will be paid by the owner to the project general contractor or to the applicable subcontractors for failure to accomplish such coordination prior to making the project proposal. Reference the applicable HVAC divisions of the project specifications, in advance, for the building and automatic, temperature-controls sequences of operation, EMS point lists, product data, etc.

1.54 GROUNDING AND BONDING

- A. Electrical work for the project, underground, ground ring, and for system grounding and bonding of circuits and equipment, shall conform fully to NFPA 70: National Electrical Code, particularly Article 250, including the other articles which are referenced in 250.4 for particular case applications.
- B. Provide the underground ground ring which is indicated on the drawings and specified herein, for all project, facility buildings, structures, equipment, etc. Such ground ring shall be in strict accordance with the requirements of all applicable codes (including, but not limited to, NFPA70:National Electrical Code)

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and governing authorities. Verify all parameters and requirements in advance, and provide accordingly.

- C. Each raceway system shall enclose a separate, insulated (with green-colored insulation), equipment-grounding conductor. Provide such ground-fault/transient-current return conductor regardless of whether or not the raceway system itself provides an adequate equipment-grounding return path.
- D. In, at, and for, the project Medical Areas, in patient-care spaces, the grounding of all receptacles, metal boxes and enclosures containing receptacles, and non-current-carrying conductive surfaces of fixed electrical equipment shall conform to NFPA70:517.13. The grounding terminals of all receptacles, all metal outlet boxes, metal device boxes, and all non-current-carrying conductive surfaces of fixed electrical equipment likely to become energized which are subject to personal contact, operating at over 100 volts, shall be directly connected to an insulated, copper, equipment-grounding conductor that is clearly identified along its entire length by green insulation, that is sized in accordance with NFPA70:250.122, and that is installed with the branch-circuit conductors in the wiring methods which meet the requirements of 517.13(A). As a clarification:
 - 1. An insulated equipment-bonding jumper, which directly connects to the equipment-grounding conductor, may connect the box and the respective receptacle(s) to the equipment-grounding conductor;
 - 2. Each metal faceplate may be connected to the respective equipment-grounding conductor by means of (a) metal screw(s) securing the faceplate to a grounded outlet box or grounded wiring device; and
 - 3. Luminaires located more than 7'-6" above the floor, and switches located outside of the patient-care vicinity, may be connected to an equipment-grounding return path complying with 517.13(A) or (B).
- E. Equipment-grounding conductors and equipment-bonding jumpers shall be sized in accordance with 250.122.
- F. In, at, and for the project Medical Areas, the equipment-grounding terminal buses of all branch-circuit panelboards serving the same individual patient care vicinity shall be connected together with an insulated, continuous, copper conductor not smaller than #10AWG (or the size which is respectively indicated on the drawings, whichever is larger), as per NFPA70:517.14. Such conductor may be broken in order to terminate on the equipment-grounding terminal bus in each panelboard.
- G. In, at, and for the project Medical Areas, for each feeder metal raceway which qualifies as an equipment-grounding conductor in accordance with NFPA70:250.118, the grounding of enclosures and equipment, such as the automatic transfer switches (ATS's); panelboards; switchboards; transformers; etc., shall be ensured by one (1) of the following bonding means at each termination or junction point of the metal raceway:
 - 1. A grounding bushing and a continuous, copper, bonding jumper, which is sized in accordance with NFPA70:250.122, with the bonding jumper connected to the junction enclosure or to the ground bus of the respective ATS, panelboard, switchboard, transformer, etc.;

2. Connection of the feeder raceway to threaded bosses on terminating enclosures; or
 3. Other approved devices, such as bonding-type locknuts or bushings. Standard locknuts shall not be used for bonding.
- H. In, at, and for the project Medical Areas, the equipment-grounding conductor for special-purpose receptacles, such as for the operation of mobile X-ray equipment, shall be extended to the reference grounding points of branch circuits for all locations likely to be served from such receptacles.
- I. In, at, and for the project Medical Areas, comply with the grounding requirements of NFPA 70:517.13 for patient care spaces, including, but not limited to, examining rooms, treatment rooms, recovery rooms, procedure rooms, trauma rooms, patient corridors, etc., and all other spaces where a patient might be in contact with medical equipment. Wiring in patient care areas shall comply with 517.13(A) and (B):
1. NFPA 70:517.13(A) - All branch circuits serving patient care spaces shall be provided with an effective ground-fault current path by installation in a metal raceway system. The metal raceway system shall itself qualify as an equipment-grounding conductor in accordance with 250.118; and
 2. NFPA 70:517.13(B) - The following shall be directly connected to an insulated, copper, equipment-grounding conductor that is clearly identified along its entire length by green insulation and installed with the branch-circuit conductors in the wiring methods as provided in 517.13(A):
 - a. The grounding terminals of all receptacles;
 - b. All metal boxes and enclosures containing receptacles; and
 - c. All non-current-carrying conductive surfaces of fixed electrical equipment likely to become energized that are subject to personal contact, operating at over 100 volts.
- J. System-grounding and equipment-grounding conductors shall be sized in strict accordance with Sections 250-66 and 250-122, respectively, of the National Electrical Code. Adjust the respective sizes which are indicated on the drawings as required to accommodate changes (such as design-manufacture differences, design changes, etc.), voltage drop, etc.
- K. Grounding conductors which are sized No. 8AWG or larger shall be stranded.
- L. Grounding-conductor connections shall be braze, irreversible-crimp, or thermal-weld connected to structural steel and to ground rods.
- M. Grounding-conductor connections to equipment-ground busses, fences, pipes, and wiring devices shall be mechanically bolted, clamped, or screwed, with the proper tightening torque, as required by the respective manufacturer, or by Article 110-14 of the National Electrical Code if the manufacturer's(s') recommendations are unavailable.
- N. Grounding-electrode conductors shall be installed in non-ferrous raceways to the full extent which is practicable.

- O. Grounding systems shall be tested for electrode-to-ground resistance utilizing instruments. Grounding-system electrode-to-ground-resistance magnitudes which exceed the respective, code-allowed, maximum values are unacceptable and shall be remedied.
- P. Grounding-electrode systems shall consist of the project, underground, ground ring; 3/4" diameter x 10'-0" long (minimum), copper-clad steel rods; facility structural steel; the metallic cold-water-pipe system; the metallic natural-gas-pipe system; and concrete-encased electrodes.
- Q. Building structural-steel columns shall be grounded in accordance with IEEE Green Book and industry standards.

END OF DIVISION 26 0000

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DIVISION 27 0000 - COMMUNICATIONS

1.01 BASIC ELECTRICAL REQUIREMENTS

- A. The specifications for the project electrical work are included in Divisions 26 0000, 27 0000, and 28 0000. The separation of the project electrical specifications into such divisions is for the sole purpose of convenience. The specifications of any of these divisions shall hold for all such divisions the same as if they were stated in each division.
- B. The word "shall", where used, is to characterize mandatory requirements, and the word "should", where used, is to characterize advisories. The word "may" is used in the permissive sense.
- C. Unless noted otherwise, the word "provide" shall be interpreted to mean "furnish, install, and connect as required to be complete and ready for the intended use" when referencing connectible items, equipment, and/or materials which are associated with the electrical work; shall be interpreted to mean "furnish and install as required to be complete and ready for the intended use" when referencing unconnectible items, equipment, and/or materials which are associated with the electrical work; and shall be interpreted to mean "furnish as required to be complete and ready for the intended use" when referencing electrical work which is neither installable nor connectible.

1.02 TELECOMMUNICATIONS BACKBOARD, DATA PATCH PANELS, VOICE-OVER-IP (VOIP) PATCH PANELS, FIBER-OPTIC PATCH PANELS, FIBER-OPTIC-TO-COPPER SIGNAL CONVERTERS, COPPER-TO-FIBER-OPTIC SIGNAL CONVERTERS, DATA AND PATCH-PANEL EQUIPMENT RACKS, DATA OUTLETS, VOIP OUTLETS, DATA JACKS, VOIP JACKS, COVER PLATES, RACEWAYS, DATA CABLES, FIBER-OPTIC CABLES, TESTING, PROVING, COMMISSIONING, ETC.

- A. Provide all labor, material, and equipment which is necessary for complete communications wiring systems where and as specified herein, where and as indicated on the drawings, and where and as required. Verify all parameters and requirements in advance, and provide accordingly.
- B. The project communications construction/work shall be in strict accordance with all applicable, Facility Planning and Control, and all Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams for Communications Cable/Wire and Related Building Facilities. Verify all parameters and requirements in advance, and provide accordingly.
- C. The latest, Facility Planning and Control, Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams, for Communications Cable/Wire and Related Building Facilities, dated October 2025, which are bound with these specifications, form an integral part of these specifications and contain project requirements which shall be followed the same as if such information were included herein. In each instance where there is a conflict between the requirements of such Facility Planning and Control, Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams for Communications Cable/Wire and Related Building Facilities, and

the requirements of the remainder of these specifications, the more stringent requirements shall govern; however, if the conflict is not a matter of stringency, the requirements of such Facility Planning and Control, Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams for Communications Cable/Wire and Related Building Facilities shall govern.

- D. Provide two (2) 4" empty conduits, with pull wires or pull ropes, from conduit stubups at the project, main, telecommunications backboards, underground, to the exact location near the project-site property line which is stipulated by AT&T, the user-agency-selected communications-service company (verify such location in advance), and cap them, as required for the project, incoming, telecommunications-service feeder, as per all AT&T requirements (verify in advance, and provide accordingly). Also, provide all required, associated, AT&T-approved, underground, pull boxes.
- E. Provide 4'-0" wide x 8'-0" high x 3/4" thick, fireproofed-plywood, main, telecommunications backboards on all walls of the main, communications, equipment/wiring room (which is identified on the drawings and herein as the "Main Distribution Frame" or "MDF"), where and as required, whether indicated on the drawings or not. Such backboards shall be painted with a fire-retardant, light-grey paint. Provide on such backboards the appropriate number of Category-6A-compliant, 110-type, termination/connection blocks, having the appropriate capacities that are required for all voice cables, except for the project voice-over-IP (VoIP) station cables which shall be terminated at dedicated VoIP patch panels. Before cutting and terminating each such voice cable at the telecommunication backboards, leave 10'-0" of slack cable. Provide all required cross-connects and patch cords.
- F. Provide all building-entrance protectors and building-protector modules which are required for proper protection of the incoming communication service to the facility.
- G. As a clarification, each project wireless-access point is referenced in these specifications as a "WAP", and is referenced on the project electrical drawings as a "wireless data network access terminal ("wi-fi" connection point)".
- H. Unless otherwise specifically stipulated on the drawings, specifically stipulated elsewhere in these specifications, and/or specifically stipulated in such latest, Facility Planning and Control, Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams, for Communications Cable/Wire and Related Building Facilities, all required signal distribution for data service, for VoIP service, for wireless-access-point (WAP) service, for security-camera-system service, for security-electronics-system service, etc. shall be from the respective, Category-6A-compliant, data patch panels in the respective, patch-panel, equipment racks to the respective, Category-6A-compliant, station jacks, via the respective, Category-6A-compliant, station cables.
- I. In the Infirmary, in Multi-Use Areas, and in the Cafeteria, in addition to the all-communication outlets (ACO's) and wireless-access-points (WAP's) which are required for the overall, facility, telecommunications system, certain ACO's and

WAP's which are dedicated to the AFIS System are required, and such dedicated ACO's and WAP's are so labeled and indicated on the drawings.

- J. In the Education Areas (i.e., the School), in addition to the ACO's and WAP's which are required for the overall, facility, telecommunications system, certain ACO's and WAP's which are dedicated to the ALTO Education System are required, and such dedicated ACO's and WAP's are so labeled and indicated on the drawings.
- K. The wired-data notes which are relevant to the Education Areas (i.e., to the School) are as follows:
 - 1. ALTO software is the user agency's present educational and testing software provider. "EDU" is a generic designation relative to the educational provider;
 - 2. For each computer workstation in the school, including such workstations in the Vo-Tech and SPED areas, and including the workstations for the youth and for the teachers, provide an ACO which is equipped with two (2) data jacks, one (1) such jack for the overall, facility, (OTS) data system, and one (1) "EDU" data-system jack (such "EDU" jack shall count as one [1] of the two [2] minimum data jacks per workstation which are required by the above-referenced, present, OTS, guideline specifications);
 - 3. At and for each teacher's desk area, including the teacher's desk areas in the Vo-Tech and SPED areas, provide an ACO which is equipped with three (3) data jacks, one (1) such jack for the overall, facility, (OTS) data system; one (1) "EDU" data-system jack (such "EDU" jack shall count as one [1] of the two [2] minimum data jacks per workstation which are required by the above-referenced, present, OTS, guideline specifications), and one (1) jack for a voice phone unit;
 - 4. Such "OTS" jacks shall be blue, and such "EDU" jacks shall be white;
 - 5. As required to reduce the number of ACO locations, provide four (4) jacks per ACO location, where practicable; and
 - 6. If there is an odd number of workstations in a line-up of workstations, provide two (2) additional data jacks for an additional workstation, in case the workstation furniture is rearranged at a later date resulting in such a workstation being added.
- L. Provide Category-6A-compliant patch panels which are separate and distinct for each of the following systems:
 - 1. General ACO data service for the overall, facility, telecommunications system;
 - 2. General WAP data service for the overall, facility, telecommunications system;
 - 3. ACO data service for the AFIS system;
 - 4. WAP data service for the AFIS system;
 - 5. ACO data service for the ALTO Education System;
 - 6. WAP data service for the ALTO Education System;
 - 7. VoIP service;
 - 8. Security-Camera-System service; and
 - 9. Security-Electronics-System(s) service.

- M. Provide all required, such dedicated (separate-and-distinct), data patch panels, VoIP patch panels, WAP patch panels, security-camera-system patch panels, security-electronics-systems panels, fiber-optic patch panels, fiber-optic-to-copper signal converters, copper-to-fiber-optic signal converters, etc.; and all required, associated, patch-panel, equipment racks, in the MDF, and in all additional, communications, equipment/wiring rooms (each of which is identified on the drawings and herein as an "Intermediate Distribution Frame" or "IDF"), where and as required to accommodate all fiber-optic cables, and all data-station cables which are being respectively provided for the project, plus 25% future data-station cables, and connect all such cables to such respective, separate-and-distinct, patch panels. Before cutting and terminating each such data-station cable at the respective patch panel, leave 10'-0" of slack cable. Provide all required cross-connects.
- N. Provide at and for each patch-panel equipment rack, two (2) adequately-sized and adequately-rated (verify in advance and provide accordingly), 20A, 120V, power-distribution unit (PDU), one (1) located on each side of such rack, and connect each such PDU where and as required to be fed for power from a separate (dedicated), 20A, 120V, branch circuit.
- O. Provide three (3) 3" raceways from the exact location in the MDF to an accessible location above the ceiling of the respective facility building which is stipulated by the user agency, and provide three (3) 3" raceways from the exact location in each IDF to an accessible location above the ceiling of the respective facility building which is stipulated by the user agency. Also provide three (3) 3" raceways between all separated, contiguous, accessible, above-ceiling spaces. As a clarification, such raceways shall be provided so that communications cabling will be able to be routed (presently or in the future) through them from any, project, above-ceiling space to the MDF, or to an IDF, as applicable (so as to avoid exposed communication cabling).
- P. Separate head-end equipment will be located in the MDF for accommodating the Starlink backup connection. For accommodating such system:
1. Provide a 2" EC routed to the Starlink Antenna, which will be located on exterior wall of the building, oriented toward the northern horizon, with an unobstructed view of the sky; and
 2. The Starlink cable will be factory-terminated and limited to a maximum length of 75'-0"; therefore, the gateway shall be located in a room with a direct path to the exterior.
- Q. No copper, telephone (voice) or data, station cable shall be longer than 320'-0", as required to accommodate proper signal propagation (verify in advance, and bring all conflicts to the immediate attention of the architect for resolution).
- R. The maximum cable length for each Category-6A-compliant cable which is provided for a security camera shall be 320 feet. Where cables that are longer than 320 feet are required for security cameras, provide, instead, fiber-optic (outdoor rated if, where, and as required) cables, with the proper fiber-to-copper or copper-to-fiber (as applicable), signal-transfer equipment at each end of each such cable.

- S. Communications cables which are routed without raceways, i.e., only through accessible ceiling spaces, shall be grouped and adequately supported via "J" hooks from the true ceiling above, and shall not lay on, or be supported by, the drop ceiling.
- T. Except in accessible ceiling spaces, all communications cables shall be routed through acceptable raceways, as stipulated in the above-referenced, latest, Facility Planning and Control, Office of Technology Services, Guideline Requirements, Specifications, and Wiring Diagrams, for Communications Cable/Wire and Related Building Facilities.
- U. Make all terminations and connections, in strict accordance with the ANSI/TIA/EIA-568 wiring convention, utilizing equipment which is appropriate for the respective applications (verify in advance).
- V. Completely test and prove all voice jacks, all voice cables, all voice patch panels, all data jacks, all data cables, all data patch panels, all fiber-optic connectors, all fiber-optic cables, all fiber-optic patch panels, all termination/connection blocks, all terminations, all connections, all equipment, all devices, etc., before and after installation and connection, to the architect's and the user agency's complete satisfaction, and as required for proper operation. Replace all voice jacks, all voice cables, all voice patch panels, all data jacks, all data cables, all data patch panels, all fiber-optic connectors, all fiber-optic cables, all fiber-optic patch panels, all termination/connection blocks, all terminations, all connections, all equipment, all devices, etc. which fail the respective tests, and then retest until all voice jacks, all voice cables, all voice patch panels, all data jacks, all data cables, all data patch panels, all fiber-optic connectors, all fiber-optic cables, all fiber-optic patch panels, all termination/connection blocks, all terminations, all connections, all equipment, all devices, etc. satisfactorily pass the tests.
- W. Communications raceways shall be as that which is specified herein for power with bushed ends. Each raceway shall not contain more than two (2) elbows or 90-degree angle bends between pull points, or more than one hundred (100) feet in length between pull points. Each bend shall be the "long-radius" type. Leave a #9 galvanized pull wire, or a nylon pull cord, in each raceway.
- X. Rod all underground communications raceways, and make certain that such raceways are free of dirt, water, and other debris. Seal all unused underground raceways.
- Y. Coordinate fully with AT&T, the user-agency-selected communications, service company, and with the user-agency, request them to make an inspection of the work, and make the respective work meet entirely with their approval.

1.03 AUDIO-VISUAL SYSTEMS

- A. The project, audio-visual systems (which are herein after referenced as "the systems") will be provided under a different division of the project, i.e., outside of Divisions 26 0000, 27 0000, and 28 0000.

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- B. Contact directly, and coordinate directly with, such audio-visual-system subcontractor; determine exactly which rough-ins and electrical-power connections/circuiting will be required for the systems; and provide, as part of this project construction contract, all such required system rough-ins and electrical-power connections/circuiting. Therefore, and as a clarification, all project work regarding and/or involved with the rough-ins and electrical-power connections/circuiting which are required for the systems shall fall under the scope and responsibility of the project electrical subcontractor (i.e., under this division of the project).
- C. The rough-ins for the systems shall include, but not be limited to, all required outlet boxes, trim rings, junction boxes, pull boxes, cover plates, raceways, pull wires, etc. (verify all requirement in advance, and provide accordingly).
- D. The electrical-power connections/circuiting for the systems shall include, but not be limited to, all required outlet boxes, trim rings, junction boxes, pull boxes, cover plates, raceways, pull wires, electrical cables, branch circuit breakers, receptacles, terminations, connections, etc. (verify all requirement in advance, and provide accordingly).
- E. Provide all required rough-ins and electrical-power connections/circuiting for the systems in a timely manner, the schedule for which shall be established and/or approved in advance by such audio-visual-system subcontractor, and by the owner.

END OF DIVISION 27 0000

DIVISION 28 0000 - ELECTRONIC SAFETY AND SECURITY

1.01 BASIC ELECTRICAL REQUIREMENTS

- A. The specifications for the project electrical work are included in Divisions 26 0000, 27 0000, and 28 0000. The separation of the project electrical specifications into such divisions is for the sole purpose of convenience. The specifications of any of these divisions shall hold for all such divisions the same as if they were stated in each division.
- B. The word "shall", where used, is to characterize mandatory requirements, and the word "should", where used, is to characterize advisories. The word "may" is used in the permissive sense.
- C. Unless noted otherwise, the word "provide" shall be interpreted to mean "furnish, install, and connect as required to be complete and ready for the intended use" when referencing connectible items, equipment, and/or materials which are associated with the electrical work; shall be interpreted to mean "furnish and install as required to be complete and ready for the intended use" when referencing unconnectible items, equipment, and/or materials which are associated with the electrical work; and shall be interpreted to mean "furnish as required to be complete and ready for the intended use" when referencing electrical work which is neither installable nor connectible.

1.02 FACILITY, FIRE ALARM, CONTROL, AND MONITORING SYSTEM

- A. Submittals of any kind (e.g., shop drawings, prior-approval requests, etc.) which are involved with the "Facility, Fire Alarm, Control, and Monitoring System", as specified herein and/or on the drawings, shall include adequate verbiage and/or other information, as required to indicate that all specified characteristics, features, options, etc. will be provided. In addition, the verbiage and/or other information verifying each specified characteristic, feature, option, etc. shall be highlighted. Submittals which are received without all such required verbiage and/or other information, and/or without all such highlighting, will not be reviewed and will be considered informal.
- B. Complete shop drawing information (both equipment brochures and drawings) shall be submitted to the architect for review, and all corrections which are required thereto shall be made prior to the submission of such documentation to the state fire marshal's office.
- C. Furnish all documentation (e.g., certification and/or proof of the possession of the proper licensing; shop drawings, system riser diagrams, and battery and power-supply calculations; submittal application forms; etc.) which is required by the state fire marshal's office, and by all other applicable governing authorities.
- D. Provide a complete, 24-volt D.C., fire alarm, control, and monitoring system (which is herein referenced as "the system") for the entire facility, including all buildings, where and as shown on the drawings, where and as specified herein, where and as required, and where and as intended.

- E. The system shall be fully-operational; shall be a U.L.-listed, electrically-supervised, analog-addressable (i.e., each initiating device and each monitoring device which is connected to the system shall be a separate addressable point), fully-programmable, multiplex-wired, non-coded system that is arranged for a 120-volts AC power input.
- F. Whether indicated on the drawings or not, the system shall be PC based, and shall include a system workstation. Verify the desired exact location for such workstation with the architect in advance, and install it accordingly.
- G. The system shall be equipped so that alarms and trouble conditions will be able easily to be recalled, at any time, in chronological order, for the purpose of creating an event history.
- H. The system shall have all options activated at the time of installation and connection. No codes shall be required to be entered in order to perform tests or repairs unless the requirement for such codes is approved in advance by the owner. If such codes are required to be entered (as approved in advance by the owner), such codes shall be given to the owner and shall not, in perpetuity, be changed or modified, in any way, without advanced, written consent of the owner.
- I. The system shall be equipped with the capability for "positive alarm sequence", which shall be field programmable and reprogrammable, and the system shall initially be programmed for activation of such feature.
- J. Unless indicated on the drawings or specified herein otherwise, the system shall (and after the time delays which are permitted and defined in the applicable chapters, sections, and paragraphs of NFPA72 and NFPA101 for the "positive alarm sequence"), during the times of all general fire-alarm conditions, produce in all areas of the facility, including all buildings, a general alarm consisting of audible indications (utilizing speakers with the appropriate pre-recorded evacuation message) and visual indications (utilizing strobes) that are completely code-approved and approved by the state fire marshal. The source for such pre-recorded evacuation message shall be computer chips; tape recordings and/or disc recordings shall not be provided for such function.
- K. The project smoke detectors shall be programmed so as to alarm only at the constantly-attended location(s) which is/are designated by the user agency and the state fire marshal (verify in advance), and consequently shall not accomplish a general-alarm notification, or a remote alarm to the remote monitoring station which is referenced herein.
- L. Whether indicated on the drawings or not, the system shall (and after the time delays which are permitted and defined in the applicable chapters, sections, and paragraphs of NFPA72 and NFPA101 for the "positive alarm sequence"), during the times of all general fire-alarm conditions, produce in all sleeping areas of the facility a general alarm consisting of audible indications (utilizing UL-listed and NFPA72-compliant, 520Hz., low-frequency sounders which meet all NFPA72 sleeping-space requirements) and visual indications (utilizing strobes which are

lettered "fire") that are completely code-approved and approved by the state fire marshal.

- M. In strict accordance with the accessibility requirements of ADA-ABA, the system shall include all accommodations which are needed for the future system notification devices that are required (even though not necessarily indicated). As part of this project, such accommodations shall include, but not necessarily be limited to, the required system addressable modules, battery capacity, power-supply capacity; etc. for accommodating all such locations.
- N. The system shall implement all control functions which are required by all applicable codes and governing authorities, whether so indicated on the drawings and/or specified herein, or not. Provide all equipment and items of work which are required to accomplish such, whether so indicated on the drawings and/or specified herein, or not.
- O. The system shall implement remote, general-alarm and trouble-alarm signals from auxiliary, general-alarm and trouble-alarm contacts which are located at the fire-alarm, control, and monitoring system, main, control panel (that is herein referenced as "the fire-alarm panel"), via the fire-alarm, IP/cellular, communicator system (which is specified herein below; for both IP and cellular communications), to the remote monitoring station that is selected by the owner (provide all equipment, materials, and work which are required to accomplish this remote monitoring, including all required relays; sending equipment; cellular-communications equipment; antennae; raceways; signal cabling; etc.; verify all parameters and requirements in advance, and provide accordingly).
- P. Provide the fire-alarm, IP/cellular, communicator system. Such system:
 - 1. Shall be completely acceptable to the Louisiana State Fire Marshal's Office for sole path transmission of remote fire-alarm-system-monitoring signals (verify in advance and provide accordingly);
 - 2. Shall be in strict accordance with the requirements of all applicable codes (including, but not limited to, NFPA 72) and governing authorities;
 - 3. Shall be rated for a 120-volts AC power input;
 - 4. Shall be a system which is completely compatible with the supervisory equipment that is located at the central station (i.e., at the remote monitoring station) that is selected by the owner, and which is listed to UL-864 standards;
 - 5. Shall be connected to the DACT telephone ports of the fire alarm, control, and monitoring system, and shall be capable of transmitting contact-ID-formatted alarms, supervisory alarms, and trouble alarms to such central station (i.e., to such remote monitoring station) via Ethernet over a private or public WAN/LAN, intranet, and/or ethernet, and also via GSM (cellular service);
 - 6. Shall include connections to the phone outputs of the fire alarm, control, and monitoring system, and shall convert the contact-ID protocol into both, ethernet packets and cellular signals;
 - 7. Shall be completely and locally, field programmable;
 - 8. Shall be capable of transmitting events in contact-ID format;
 - 9. Shall include vital system status such as:
 - a. Independent Zone (Alarm, Trouble, Non-Alarm, and Supervisory);

- b. Independent Addressable Device Status;
 - c. AC (Mains) Power Loss;
 - d. Low-Battery and Earth Fault;
 - e. System Off Normal;
 - f. 24-Hour Test Signal; and
 - g. Abnormal Test Signal (per UL requirements);
- 10. Shall support independent zone reporting via the Contact-ID format and cellular signals. This format and signaling shall enable the central station (i.e., the remote monitoring station) to have details concerning the location of the fire, for emergency response;
 - 11. Shall be capable of providing simulated phone lines to the fire-alarm panel;
 - 12. Shall communicate over GSM (cellular service) as primary, and shall be transparent to the project, fire alarm, control, and monitoring-system operation over phone lines;
 - 13. Shall be housed in a UL-listed cabinet, having a back box and a door which are constructed of steel, and with provisions for electrical conduit connections into the sides and the top of the backbox;
 - 14. Shall be equipped with a main power supply which is rated to operate on a 120 VAC, 60 Hz, power source, which shall have a 0.50-amp maximum load, and which shall supply all necessary power for the system;
 - 15. Shall be equipped with positive-temperature-coefficient (PTC) thermistors, circuit breakers, or another type of over-current protection for all power outputs. Such power supply shall be equipped with an integral battery charger, and the battery arrangement shall be able to be configured in the field. The main power supply shall continuously monitor all field wires for earth ground conditions; and
 - 16. Shall have batteries which are arranged so that, upon loss of primary (AC) power to the system, the batteries will have sufficient capacity to power the system for the required standby time (24 hours, minimum) followed by five (5) minutes of alarm. The batteries shall be completely maintenance free so that liquids are not required (and battery liquids will not be accepted and shall not be provided). Therefore, fluid-level checks for refilling, spills, and leakage shall not be required; and
 - 17. Shall be furnished with a pre-paid, 1-year, cellular-service subscription for the exact, qualified, cellular-service provider which is selected by the owner (verify in advance).

- Q. Because simultaneous total evacuation of occupants from the facility is impracticable due to building configuration, certain occupant restraints, etc., upon any general-alarm condition, the system shall notify initially only the occupants in the affected zone(s) (i.e., the alarming facility zone[s], etc.). The system shall include provisions for selectively notifying the occupants in other zones, so as to afford orderly evacuation of the entire facility.
- R. For the purposes of alarm annunciation, each separated fire and/or smoke area of the facility shall be considered as not less than one (1) zone. The facility automatic sprinkler system shall be annunciated on the system as a single zone.
- S. Whether so indicated on the drawings or not, the system shall cause the required shutdown of all project air-handling units upon activation of the appropriate duct-

type, smoke detectors; provide all electrical work, devices, and equipment which are required to accomplish such, including all required control relays, etc.

- T. Whether so indicated on the drawings or not, the system shall, upon activation, cause the closing of all project fire and smoke dampers; provide all electrical work, devices, and equipment which are required to accomplish such, including all required control relays, etc.
- U. Whether so indicated on the drawings or not, the system shall, upon activation, cause the muting of all sound systems at the facility, including all buildings; provide all electrical work, devices, and equipment which are required to accomplish such, including all required control relays, etc.
- V. The system, upon activation and following the appropriate time delay which is applicable for the occupancy classification, shall cause the electric release of all doors at the facility, including all buildings, which are equipped with electrically-operated locking mechanisms or hold-open devices (that shall be provided), and shall cause the closing of all doors at the facility, including all buildings, which are equipped with electrically-operated closing mechanisms, via the respective, system, door-release control relays (that shall be provided), whether so indicated on the drawings or not; verify all parameters and requirements in advance, and provide accordingly.
- W. The system shall implement the required monitoring of the sprinkler systems (i.e., at all flow switches, tamper switches, etc.) at the facility, including all buildings, in strict accordance with the requirements of all applicable codes and governing authorities (verify all parameters and requirements in advance, and provide accordingly). Provide all required (addressable-type) relays, auxiliary contacts, raceways, signal wiring, etc.
- X. Whether so indicated on the drawings or not, provide the required monitoring at and for each water-source backflow preventer (e.g., the monitoring of all tamper switches, the monitoring of the presence of power for the heating equipment and for the heat-tracing-equipment control panel [if applicable], etc.) which is involved in any way with the project, facility, sprinkler systems at all buildings, whether such backflow preventer is site located or located at a project building (provide all required raceways [underground where applicable], signal cabling, connections, etc.; verify all parameters and requirements in advance, and provide accordingly).
- Y. Whether so indicated on the drawings or not, provide the required power connection and circuiting for the heat-tracing equipment or the space-heating equipment (as applicable; verify in advance) at and for each water-source backflow preventer which is involved in any way with the project facility sprinkler system, whether such backflow preventer is site located or located at a project building (provide all required raceways [underground where applicable], electrical cables, safety switches, receptacles (weatherproof/GFI-type where required), circuit breakers, connections, etc.; verify all parameters and requirements in advance, and provide accordingly).

- Z. The system shall provide the required monitoring of all pre-action/deluge suppression systems (verify all parameters and requirements in advance). Provide all required (addressable-type) relays, auxiliary contacts, raceways, signal wiring, etc.
- AA. The system shall implement the required monitoring of each server-room, FM200, extinguishing system. Provide all required (addressable-type) relays, auxiliary contacts, raceways, signal wiring, etc.
- BB. The system shall implement the required monitoring of the cooking-hood, fire-extinguishing systems, including providing the proper signals for de-energizing all electrically-operated equipment which is located beneath such hoods, for closing the main gas solenoid valve(s), for de-energizing the cooking-hood supply fans, for energizing the kitchen-hood exhaust fans, etc. Provide all shunt-trip-type circuit breakers, (addressable-type) relays, and contactors, and all other appurtenances, which are required to accomplish such, whether so indicated on the drawings or not. As a clarification, the cooking-hood, exhaust fans, if operating at the time, shall not be de-energized and shall continue to operate; and the cooking-hood, exhaust fans, if not operating at the time, shall be energized and shall be caused to operate.
- CC. Whether indicated on the drawings or referenced in the specifications, or not, provide all required connections, and associated circuiting, etc., at and for the emergency-electrical-power-generation system (alternate-source-power-generation system), and at and to the facility, fire alarm, control, and monitoring system, as required for the emergency-electrical-power-generation system (alternate-source-power-generation system) to be properly monitored by the facility, fire alarm, control, and monitoring system, in strict accordance with the requirements of all applicable codes and governing authorities.
- DD. The system shall be in strict accordance with all applicable codes, including, but not limited to, NFPA 70, NFPA 72, NFPA 101, the International Building Code, and the Americans with Disabilities Act (ADA-ABA); and shall be in strict accordance with all requirements of the state fire marshal's office and all other governing authorities, and with all requirements and instructions of the owner.
- EE. As per NFPA 72:10.5.5., the primary power-supply connections for the system shall be via dedicated branch circuits. The locations of each of such dedicated-branch-circuit disconnection means shall be permanently identified at the respective, facility, fire alarm, monitoring, and control-system, main and satellite, control unit, and each such disconnecting means shall be identified as "FIRE ALARM CIRCUIT" and shall have a red marking. Such dedicated branch circuits and connections shall be protected against physical damage. Such circuit disconnecting means shall be accessible only to authorized personnel.
- FF. Install all interconnecting wiring in raceways which are dedicated for such wiring (i.e., so as to be separate from all other wiring); i.e., as per the owner's mandate, system wiring, cabling, etc. which is not enclosed in raceways is unacceptable, and shall not be provided.

- GG. The system shall be capable of supervising short circuits and open circuits within circuit-wiring loops, and of giving the appropriate trouble indications at the fire alarm, control, and monitoring system, main and satellite, control panels, and at the system remote annunciation panel which is located at the fireman control center (that shall be provided).
- HH. Interconnections shall be in strict accordance with wiring diagrams which are supplied by the system manufacturer; request and obtain all relevant information in advance. The conductor sizes shall be as recommended and required by the system manufacturer/supplier, taking voltage drop into account, and shall meet all requirements of Article 760 of the National Electrical Code for fire-alarm use.
- II. The system wiring and equipment, including all circuits which are controlled and powered by the system, shall be installed and connected in accordance with the requirements of NFPA 72 and of NFPA 70, National Electrical Code, Article 760.
- JJ. Label interconnecting wiring, and termination points, using a method which is approved in advance by the architect and the user agency. The exact designation which is used for each run of interconnecting wiring, and for each termination point, shall be as approved in advance by the architect and the user agency.
- KK. Locate the project, fire alarm, control, and monitoring system, main and satellite, control panels in the exact locations which are respectively stipulated by the architect (subject, of course, to approval by the governing authorities). If located in finished spaces, the project, fire alarm, control, and monitoring system, main and satellite, control panels shall be flush mounted or semi-flush mounted; if located in unfinished spaces, the project, fire alarm, control, and monitoring system, main and satellite, control panels shall be surface mounted (verify in advance).
- LL. The fireman control center, containing the remote annunciation panel and the live voice-activation station (with microphone), shall be flush mounted or semi-flush mounted, and shall be located in the exact location which is stipulated by the architect (subject, of course, to approval by the governing authorities) near the facility entrance that is designated by the local fire authorities. The fireman control center might not be indicated on the drawings near such particular facility entrance; verify with the local fire authority, in advance, the required facility entrance for the fireman control center and locate it accordingly.
- MM. Whether so indicated on the drawings or not provide either the main fire-alarm panel or a satellite fire-alarm panel in and for each project building. Verify the desired exact location for each such fire-alarm panel in advance with the architect, and locate it accordingly.
- NN. The main fire-alarm panel, and each satellite fire-alarm panel, shall have a see-through, lockable door and shall have the number of addressable modules which is respectively required by all applicable codes and governing authorities; which is dictated by good practice; and which is needed to accommodate all system devices that are respectively indicated on the drawings, specified herein, and

required for this project, including the future devices which are referenced herein above, plus at least twenty-five percent (25%) additional, future devices.

- OO. The main fire-alarm panel shall be equipped and arranged so that, at the main fire-alarm panel, all system alarms and trouble conditions will be able to be recalled, in chronological order, for the purpose of recreating event histories.
- PP. The system shall be PC-based, and a system workstation shall be provided.
- QQ. The main fire-alarm panel, and each satellite fire-alarm panel, shall be complete with lightning/surge protection against strikes/surges on both power wiring and remote signaling wiring.
- RR. Whenever any initiating device is activated:
 - 1. A red LED at the main fire-alarm panel, and at each satellite fire-alarm panel, shall light;
 - 2. A red LED at the remote annunciation panel shall light;
 - 3. A full LCD readout at the main fire-alarm panel, a full LCD readout at each of the satellite fire-alarm panels, and a full LCD readout at the remote annunciation panel, shall display the respective initiating-device type, the respective initiating-device location, and the date and time of the respective initiating condition;
 - 4. An audible alarm at the main fire-alarm panel, and at each satellite fire-alarm panel, shall sound, until manually silenced;
 - 5. A general alarm which is completely code-approved and approved by the state fire marshal shall (after the respectively-programmed delay at each building) occur in all areas of the facility, including all buildings;
 - 6. The muting of all sound systems at the facility, including all buildings, shall occur;
 - 7. The electric release of all doors at the facility, including all buildings, which are equipped with electrically-operated locking mechanisms or hold-open devices, and the closing of all doors at the facility, including all buildings, which are equipped with electrically-operated closing mechanisms, shall occur (after the respectively-programmed delay at each building);
 - 8. All other required control functions shall occur; and
 - 9. The appropriate general-alarm signal shall be sent, through the above-referenced, wireless, KELTRON system, to CENTURYLINK for remote monitoring.
- SS. Whenever trouble is detected by any supervising or monitoring circuit:
 - 1. An amber LED at the main fire-alarm panel, and at each of the satellite fire-alarm panels, shall light;
 - 2. An amber LED at the remote annunciation panel shall light;
 - 3. A full LCD readout at the main fire-alarm panel, a full LCD readout at each of the satellite fire-alarm panels, and a full LCD readout at the remote annunciation panel, shall display the troubled-device type, the troubled-device location, and the date and time of the trouble condition;
 - 4. An audible trouble alarm at the main fire-alarm panel, and at each of the satellite fire-alarm panels, shall sound, until manually-silenced; and

5. The appropriate trouble-alarm signal shall be sent, through the above-referenced, wireless, KELTRON system, to CENTURYLINK for remote monitoring.
- TT. The main fire-alarm panel, and each satellite fire-alarm panel, shall have rechargeable, long-life, battery backup. Such battery capacity shall be in strict accordance with all applicable codes, including, but not limited to, NFPA 70, NFPA 72, NFPA 101, and the Americans with Disabilities Act (ADA-ABA), and in strict accordance with all requirements of the state fire marshal's office and all other governing authorities, as required to accommodate all respective system devices which are shown on the drawings, specified herein, and required for this project, including the future devices which are referenced herein above, plus twenty-five percent (25%) spare capacity. Under maximum normal load of the system, plus twenty-five percent (25%) future load, such battery backup shall be sufficient to operate the system for twenty-four (24) hours (longer if so required by any applicable code and/or governing authority; verify in advance) and then, at the end of such period, be sufficient to operate all respective notification appliances which are used for evacuation or to direct aid to the location of an emergency for five (5) minutes (longer if so required by any applicable code and/or governing authority; verify in advance). In addition, such battery capacity, where and as used for emergency-voice/alarm-communication service (verify in advance), shall be capable of operating the system under maximum normal load, plus twenty-five percent (25%) future load, for twenty-four (24) hours (longer so if required by any applicable code and/or governing authority; verify in advance) and then be capable of operating the system during a fire or other emergency condition for a period of two (2) hours (longer if so required by any applicable code and/or governing authority; verify in advance). Reference NFPA72:1-5.2.5 for additional information.
- UU. The integral power-supply capacity at the main fire-alarm panel, and at each satellite fire-alarm panel, shall be in strict accordance with all applicable codes, including, but not limited to, NFPA 70, NFPA 72, NFPA 101, and the Americans with Disabilities Act (ADA-ABA), and in strict accordance with all requirements of the state fire marshal's office and all other governing authorities, as required to accommodate all respective system devices which are shown on the drawings, specified herein, and required for this project, including the future devices which are referenced herein above, plus twenty-five percent (25%) spare capacity.
- VV. Each initiating device and each monitoring device shall be an individual addressable point. The respective addresses shall be assigned with the use of dip switches and/or rotary switches. The respective addresses for all addressable items shall be capable of being assigned and re-assigned in the field. EPROM or EEPROM chips which are required for address assignments are unacceptable and shall not be provided. No special equipment shall be needed for address assignments.
- WW. The outlet box for each smoke detector and for each heat detector shall be flush-mounted; each smoke detector and each heat detector shall have an LED indicator; and each smoke detector and each heat detector shall be an individual analog-addressable (by way of dip switches) point (head).

- XX. Whether so indicated on the drawings or not, provide a smoke detector at the appropriate location near each piece of system equipment including, but not limited to, the main fire-alarm panel, each satellite fire-alarm panel, each fireman control center, each remote power supply unit, each battery-booster unit, each telecommunication backboard and patch panel, etc., in strict accordance with the requirements of all applicable codes and governing authorities. Verify all parameters and requirements, and provide accordingly.
- YY. In each location where a smoke detector is indicated on the drawings and/or specified herein to be provided, and, for any reason, a smoke detector would not operate properly for the application, provide, instead, a heat detector (verify all parameters and requirements in advance, and provide accordingly).
- ZZ. At and for all locations where smoke detection is required, but where the provision of area-type (spot-type) smoke detectors would not meet the requirements of all applicable codes and governing authorities, provide, instead, beam-type smoke detectors. The exact locations for all beam-type smoke detectors shall be in strict accordance with all applicable requirements of NFPA 72: National Fire Alarm and Signaling Code, and with the requirements of all applicable codes and governing authorities (verify in advance and locate beam-type smoke detectors accordingly). Each beam-type smoke detector:
1. Shall be an intelligent, single-ended, reflected type, beam smoke detector;
 2. Shall be approved for a 16-foot to 328-foot protection range;
 3. Shall be equipped with six (6) field-selectable, sensitivity levels;
 4. Shall be equipped with an integral, NFPA 72, sensitivity-test feature (provide the required, accompanying, remote, key-locking, test station);
 5. Shall be equipped with removable, plug-in, terminal blocks;
 6. Shall be equipped with built-in, automatic, gain control which will compensate for signal deterioration resulting from dust buildup;
 7. Shall be equipped with a paintable cover;
 8. Shall be listed by UL and FM for the exact application for which it is provided (verify in advance); and
 9. Shall be SYSTEM SENSOR Model BEAM200S-BEAMLRK-BEAMMMK-BEAMSMK-RTS451KEY/RTS151KEY, or approved equivalent.
- AAA. Each duct-type, smoke detector shall be complete with a duct-detector housing, a sampling tube, and contacts as required for alarm initiation and air-handling-unit shutdown, and shall be an individual addressable point. Whether so indicated on the drawings or not, provide a strategically-located, remote signal indicator for each duct-type, smoke detector which is located in an equipment room or in another area that is hidden from normal view.
- BBB. Whether so indicated on the drawings or not, provide a duct-type smoke detector at and for the supply-air duct of each project air-handling unit, and at and for the return-air duct of each project air-handling unit. Also, whether so indicated on the drawings or not, provide additional duct-type smoke detectors at and for the supply-air ducts of each project air-handling unit as required to accommodate air-duct configurations which cannot prudently be accommodated by a single duct-type smoke detector; and at and for the return-air ducts of each project air-handling unit as required to accommodate air-duct configurations which cannot

prudently be accommodated by a single duct-type smoke detector. Verify all parameters and requirements in advance , and provide accordingly.

- CCC. Each heat detector shall be the rate-of-rise type with a fixed temperature setting of 135 degrees F.
- DDD. Where ambient conditions prohibit installation of a smoke detector, provide a heat detector instead.
- EEE. Where possible, each alarm-indicating device shall be the flush-mounted type.
- FFF. Each visual device shall produce the illumination intensity that is respectively required by all applicable codes (including A.D.A. and NFPA 72) and by all applicable governing authorities for the particular application. Provide visual devices having the illumination intensities which are respectively required to meet such requirements. As a clarification, the locations which are respectively indicated on drawings for the visual devices are presented only as a general guide, with no guaranty as to accuracy. It is this contractor's responsibility to provide visual devices in the proper locations, and having the respectively-proper intensity ratings, which are required for the respective applications, at no additional cost to the owner. Verify all parameters and requirements in advance of producing the system shop drawings, and in advance of making the required system-shop-drawing submittal to the fire marshal's office; indicate the respectively-required, visual-alarm-device locations and intensity ratings in such shop drawings; and provide all such required devices accordingly. Provide all additional system visual devices which subsequently become required (e.g., as a result of the fire marshal office's review of the system shop drawings, during the project construction, during and/or following the fire marshal office's project final inspection, etc.), at no additional cost to the owner.
- GGG. Provide speakers (audible devices), with the appropriate taps, which will produce the sound levels that are respectively required so that the messages will be heard above all ambient noise. The total sound pressure which is produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance. Where audible appliances are provided in mechanical equipment rooms, the average ambient sound level which is used for design guidance shall be 85 dBA. To ensure that audible signals are clearly heard, they shall have a sound level at least 15 dB above the average ambient sound level or 5 dB above the maximum sound level having a duration of at least sixty (60) seconds, whichever is greater, measured at 5 feet above the floor in the area which is required to be served by the system, using the A-weighted scale (dBA).
- HHH. Further, provide audible devices (speakers) which are located as respectively required, which are equipped with the respectively-required taps, and which have the respectively-required, sound-producing intensities and sound-producing characteristics as necessary to meet all intelligibility requirements of all applicable codes (including ADA-ABA and NFPA 72) and applicable governing authorities for the particular applications. As a clarification, the locations which are respectively indicated on drawings for the audible devices are presented only as a general guide, with no guaranty as to accuracy. It is this contractor's

responsibility to provide audible devices in the proper locations, and having the respectively-proper sound-intensity ratings and characteristics, which are required for the respective applications, at no additional cost to the owner. Verify all parameters and requirements in advance of producing the system shop drawings, and in advance of making the required system-shop-drawing submittal to the fire marshal's office; indicate the respectively-required, audible-alarm-device locations and intensity ratings in such shop drawings; and provide all such required devices accordingly. Provide all additional system audible devices which subsequently become required (e.g., as a result of the fire marshal office's review of the system shop drawings, during the project construction, during and/or following the fire marshal office's project final inspection, etc.), at no additional cost to the owner.

- III. Where practicable, provide combination audible-visual-type, alarm-indicating devices in lieu of providing two (2) separate devices.
- JJJ. To the full extent which is practicable (i.e., where allowed by all applicable codes and governing authorities), provide system devices which are white in color.
- KKK. Locate audible-visual type and visual-only type, system alarm-indicating devices in strict accordance with the applicable articles, sections, and paragraphs of NFPA72.
- LLL. Wall mount each system pull station at 4'-0" A.F.F.
- MMM. For each system pull station which is required to be mounted to the framing of an aluminum-framed or steel-framed, glass wall, provide a pull-station back box (PSB) which is manufactured and rated for the exact application. Each such PSB shall be a SPACE AGE ELECTRONICS, INC. Part No. SSU03171 (Red), Part No. SSU03172 (White), Part No. SSU03173 (Black), or Part No. SSU03174 (Bronze) PSB, depending on the required color (which shall be as selected in advance by the architect; verify), or approved equivalent.
- NNN. Provide a vandal-resistant cover, with a local audible-visible (detering) alarm, at and for each system pull station.
- OOO. Whether indicated on the drawings or not, provide an audible-visual alarm device, or a visual-only alarm device, within fifteen feet (15'-0") of each end of each corridor, as per the requirements of all applicable codes and governing authorities.
- PPP. Provide (including all required materials and labor) an additional fifteen percent (15%), but no less than one (1), of each different type of initiating device, and of each different type of notification device, being otherwise provided, the exact locations for which will be established before the completion of the project construction. Deliver to the user agency for their use as spare devices, and obtain a signed receipt for, all such devices for which locations have not been established before the termination of the project.
- QQQ. Fully test and certify the system, including activating all alarm, monitoring, and control initiating devices, and all equipment, under simulated fire and power-

failure conditions, prior to acceptance. The tests shall be conducted by the system supplier, and shall be witnessed by the architect and/or the owner, or by their authorized representative (as determined in advance by the architect; schedule all such testing well in advance with the architect). The system shall be proven to operate in strict accordance with the requirements of all applicable codes and governing authorities, with all performance criteria which are stipulated herein and required, and with good practice. The system shall be proven to perform satisfactorily after a single break or ground-fault condition.

RRR. Furnish to the user agency, to the user agency's complete satisfaction, system orientation and training by authorized factory representatives, at the times and on the dates which are stipulated by the architect and the user agency, without limit, until the termination of the project one-year warranty period.

SSS. The system shall be manufactured by NOTIFIER, EST, FCI/GAMEWELL, TYCO/SIMPLEX/GRINNELL, FARADAY, SIEMENS, FARENHYT, HOCHIKI, MIRCOM, or JOHNSON CONTROLS, or shall be approved equivalent.

1.03 FACILITY SECURITY SYSTEMS (I.E., ACCESS-CONTROL SYSTEMS, SURVEILLANCE-CAMERA SYSTEMS, FACILITY-INTRUSION SYSTEMS, ETC.)

A. The project, facility security systems, i.e., access-control systems, surveillance-camera systems, facility-intrusion systems, etc. (which are herein after collectively referenced as "the systems"), will be provided under a different division of the project, i.e., outside of Divisions 26 0000, 27 0000, and 28 0000.

B. Contact directly, and coordinate directly with, such security-system subcontractor; determine exactly which rough-ins and electrical-power connections/circuiting will be required for the systems; and provide, as part of this project construction contract, all such required system rough-ins and electrical-power connections/circuiting. Therefore, and as a further clarification, all project work regarding and/or involved with the rough-ins and electrical-power connections/circuiting which are required for the systems shall fall under the scope and responsibility of the project electrical subcontractor (i.e., under this division of the project).

C. As a clarification, all required rough-ins and power connections/circuiting which are required for the project, facility, fire alarm, control, and monitoring system shall be provided with, and shall be a part of, such system, as specified herein above.

D. General electrical notes which are relevant to accommodations for the other electronic safety-and-security systems and equipment (all of which are referenced herein below as "the systems") are as follows:

1. Provide, under Division 28 0000 of the project, all labor, material, and equipment, and all other items of work, which are required for the rough-ins and power connections/circuiting for the systems. Verify all parameters and requirements in advance, and provide accordingly;
2. As a clarification, the project work which is described in the Division 28 0000 specifications and/or which is indicated on the Division 28 0000 electrical drawings; the project work which is described for the systems in

the specifications and/or indicated on the drawings of other project divisions that have been prepared by other project design consultants; and the relevant project work which is described in the architectural specifications and/or indicated on the project architectural drawings, is intended to be, and shall be, complementary and complete. Coordinate fully with the project general contractor, and with the subcontractors for the other project divisions (i.e., other than Divisions 26 0000, 27 0000, and 28 0000), before making the project proposal and during project construction, as necessary to ensure that all required project work will indeed be provided. Verify all parameters and requirements in advance, and provide accordingly;

3. In each instance where there is a conflict between and/or among the requirements of the Project Divisions 26 0000, 27 0000, and 28 0000 documents (i.e., drawings and specifications); the requirements of the documents (i.e., drawings and specifications) of other project divisions; and/or the requirements of the documents (i.e., drawings and specifications) of the project architectural divisions, the more stringent requirements shall govern; however, if the conflict is not a matter of stringency, the requirements of the documents (i.e., drawings and specifications) of the other project divisions and the requirements of the documents (i.e., drawings and specifications) of the project architectural divisions shall govern. Bring all conflicts to the immediate attention of the architect for resolution;
4. Reference the project, electronic safety-and-security-systems-and-equipment divisions, including all of the Security Electronics Drawings (i.e., the "SE" Sheets), and reference the architectural specifications and drawings, for rough-in and power-connection requirements, including, but not limited to, the respective quantities, descriptions, and locations for required backboxes (outlet boxes, junction boxes, etc.); the respective quantities, sizes, and routing for raceways (conduits, etc.) and pull wires; the respective raceway (conduit) stub-up locations; the respective, data outlets (weatherproof for exterior locations), jacks (weatherproof for exterior locations), station cables (outdoor-rated for exterior locations), etc.; the required power connections; etc., as well as other aspects of, and requirements for, such accommodations, and provide all such project work accordingly;
5. Such Division 28 0000 work shall include, but not necessarily be limited to, the provision of the following, which are associated with the project, electronic, safety-and-security, systems and equipment :
 - a. Raceways (conduits), raceway (conduit) innerducts, raceway (conduit) sleeves, pull wires, backboxes (outlet boxes, junction boxes, etc.), pathways, and plywood backboards;
 - b. Data outlets (weatherproof for exterior locations), jacks (weatherproof for exterior locations), station cables (outdoor-rated for exterior locations), etc.;
 - c. Grounding and bonding at and for the backboards and raceways, and the respective equipment rooms, including ground bus bars, etc.;
 - d. All required, properly-rated, sealing, firestopping (for penetrations through fire barriers), smokestopping (for penetrations through

- smoke barriers), etc., including such required firestopping and smokestopping at and for wall penetrations for raceways, etc.; and
- e. The required power connections, circuiting, etc.;
6. Coordinate the locations and mounting requirements for all system equipment and devices with the system suppliers, subcontractors, etc., and with the reflected ceiling plans, the lighting layouts, and all other project equipment, materials, and construction, etc.;
7. Reference the Security Electronics Drawings (i.e., the "SE" Sheets) for the respective backbox (outlet-box, junction-box), outlet-box, and data-outlet requirements and locations, conduit-size requirements, power-connection locations, etc., and all other rough-in requirements;
8. Particularly reference the Security Electronics Drawings (i.e., the "SE" Sheets) for the locations of the project surveillance cameras, and provide all required power connections/circuiting and rough-ins accordingly; and
9. Each surveillance-camera signal cable which is longer than 320 feet shall be a multi-mode cable (outdoor-rated for exterior cameras) which is rated and appropriate for the exact application, with the proper copper-to-fiber or fiber-to-copper (as appropriate), signal-conversion equipment (outdoor-rated at and for exterior camera locations) at each end of such cable.
- E. The rough-ins for the systems shall include, but not be limited to, all required outlet boxes, trim rings, junction boxes, pull boxes, cover plates, raceways, pull wires, etc. (verify all requirement in advance, and provide accordingly).
- F. The electrical-power connections/circuiting for the systems shall include, but not be limited to, all required outlet boxes, trim rings, junction boxes, pull boxes, cover plates, raceways, pull wires, electrical cables, branch circuit breakers, receptacles, terminations, connections, etc. (verify all requirement in advance, and provide accordingly).
- G. Provide all required rough-ins and electrical-power connections/circuiting for the systems in a timely manner, the schedule for which shall be established and/or approved in advance by such security-system subcontractor, and by the user agency (facility management).

END OF DIVISION 28 0000

SECTION 28 0500 - SECURITY ELECTRONICS - BASIC MATERIALS AND METHODS

PART 1— GENERAL

1.01 RELATED DOCUMENTS

- A. Provisions of the Contract and of the Contract Documents apply to this section.

1.02 DESCRIPTION OF WORK

- A. The work described herein this section of the specifications governs all sections of Division 28.
- B. The work described herein and on the drawings consists of all labor, materials, equipment, and services necessary and required to provide, terminate and test a complete security control system (SCS). Any material not specifically mentioned in this specification or not shown on the drawings but required for proper performance and operation shall be provided.
- C. Provide an IP based SCS that fully integrates all Division 28 systems and applicable Division 16 systems with the control system to ensure seamless integration and to allow for future expansion. This system shall allow any security function to be addressed by the control station in primary control of that particular area or by central control.
- D. The SCS is to include but not be limited to:
1. Programmable Logic Control System
 2. Control Stations
 3. Intercom System
 4. CCTV System
 5. Door Control System
 6. Auxiliary Control Systems
 7. Misc. Systems
- E. The Security Electronics Contractor shall provide and install, wiring and cabling required for a complete and fully functional system as intended by these specifications. All wiring and/or cabling shall be in conduit. Conduit with pull strings shall be provided by the Electrical Contractor. Security Contractor shall size and route raceways to accommodate the proper installation of the system cabling. Security Contractor shall properly terminate each device according to the manufacturer's recommendations
- F. The electrical contractor shall provide the following:
1. All Conduit with pull strings for Security System
 2. Emergency 120VAC power to all SCS equipment racks and cabinets.
 3. Emergency 120VAC power to all overhead and site vehicle barrier gates.
 4. Emergency 120VAC power to all control station locations.
 5. All wiring for branch circuits and switch legs for lighting and receptacle relay control panels.
 6. Terminate switch legs to all lighting and receptacle control relays.
- G. All SCS head end equipment shall all be housed in security equipment racks or cabinets (SER or SEC) specified herein this Division of the specifications.
- H. The Security Electronics Contractor shall provide and install all systems specified in Division 28 (including all equipment, wiring, etc.) in accordance with the Manufacturer's recommendations.
1. Installation of devices shall be in accordance with the Manufacturer's requirements as well as the requirements of the Contract Documents. Recommendations by the Manufacturer for the proper installation of the security control system and its equipment shall not preclude the requirement for the Contractor to comply with the requirements of the Contract Documents.
 2. Terminations for each system shall be in accordance with the Manufacturer's recommendations, applicable requirements of the National Electric Code (((NFPA 70))), ADA, other applicable Codes and the Contract Documents.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with conditions in the Contract.
- B. Shop Drawings: Submit typical wiring diagram of each system, plan of building(s) and site showing pathways with cable noted, detailed drawings of each device location, and control room and equipment room/rack elevations. Shop drawings detailing the SCS are to include but not limited to the following:
 - 1. All drawings shall be drawn to scale that detail racks, enclosures, and/or field devices. All devices shall be shown.
 - 2. All SCS drawings generated for this project shall be created utilizing AutoCAD LT 2010 or greater file format. Drawings shall be submitted on a minimum of 21" x 15" ("C" size) sheets of paper.
 - 3. Drawings shall be provided for each field device detailing wiring and mounting instructions.
 - 4. Point-to-point wiring data shall be provided, utilizing a combination of AutoCAD generated drawings and security control point schedules. The schedules shall be created with Microsoft Excel and shall cross-reference AutoCAD drawings as required. Schedules shall detail all equipment being provided and controlled/monitored by the SCS. The schedules shall be organized according to different system functionality. Typical schedules shall include, but not be limited to, sections for cabling information, control locations, door hardware interface, intercom, paging, cameras, monitors, etc. The drawings and schedules shall indicate the wiring of components and all connections to be made. All schedules shall be included with the product data sheets in three ring binders.
 - 5. Drawings for the PLC configuration shall include model numbers of each component used.
 - 6. Provide all control station screen layouts. Layouts shall be created using the HMI software and shall not consist of line drawings created by CAD programs. The owner reserves the right at the time of the submittal review to request the division 28 contractor to make changes to the control station screen layouts based on the owner's policies and procedures, without incurring any additional cost to the owner.
 - 7. Drawings of equipment cabinet(s) or racks shall detail the arrangement of all components installed.
 - 8. Provide power distribution and power loading detail drawings.
 - 9. Provide wiring diagrams, detailing wiring for power, signal and control, differentiating clearly between manufacturers installed wiring and field installed wiring. Identify labeling scheme to be used for all cabling, headend termination equipment, and communication outlets.
 - 10. Submit a power system design spreadsheet of power loading for all DC power supply circuits and AC UPS circuits required by the SCS. The spreadsheet shall consist of each circuit, each device controlled by the SCS with each device's steady state and in-rush load, and a loading summary of all device types for each circuit.
- C. Product Data: Provide product data sheet(s) for type of product specified within Division 28 of these specifications. Data sheets showing multiple products or models shall be clearly marked identifying the specific product or model being proposed. Provide original data sheets only. Fax copies are not acceptable. Product data sheets shall include the specification section that the product is located in at the top of each data sheet. Product data sheets shall be provided in three ring binders with tabs identifying each specification section.
- D. Submittals that do not include all items as listed above, and as required elsewhere in these specifications shall, at the discretion for the engineer, shall not be reviewed and shall be returned to the contractor for resubmittal.
- E. Attempts by the Division 28 contractor to use non-approved manufacturer's products shall not be permitted.
- F. Provide three (3) sets in hardcover binders

1.04 OPERATIONS AND MAINTENANCE MANUALS

- A. Provide maintenance data for materials and products, for inclusion in an Operating and Maintenance Manual. Provide complete manual material concurrently with the system submittal. Manuals shall include product data sheets for all equipment, operational description of all equipment software for each system using easy-to-understand terminology, programming/configuration instructions for all systems and all software programs, trouble shooting, repair, and preventative maintenance procedures. Manuals shall also include a complete list of PLC input and output points referencing the field device being controlled and/or monitored.
- B. Provide a list of spare parts that are being provided as a requirement of the Division 28 specifications. Provide direct telephone numbers for service (normal and emergency).

1.05 RECORD DOCUMENTS

- A. Within thirty (30) days of substantial completion, provide all information as required in sections 1.4 and 1.5. All information must be updated to reflect any and all changes made during the project. Clearly note all changes.
- B. Provide three (3) sets in hardcover binders

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Division/Section with minimum twenty-five (25) years documented experience. The Manufacturer shall produce components for the PLC, locking, intercom, access control, HMI software and PLC Software. The manufacturer must advertise backwards compatibility to product line for minimum of twenty-five (25) years. The locking control system components shall be UL 294 Listed.
- B. Security Electronics Contractor: Authorized distributor of specified manufacturer with minimum five (5) years documented experience.
- C. Security Electronics Contractor shall be properly licensed to install security control systems in the State of Louisiana.
- D. Only prequalified systems contractors are allowed to bid Division 28. Approval as a contractor is NOT to be deemed as an acceptance of any products typically used by the contractor.
 - 1. Approved Contractors:
 - a. R&S Corporation
 - b. Cornerstone Detention Products

1.07 MAINTENANCE SERVICE AND WARRANTY

- A. Comply with all provisions of the Contract and of the Contract Documents.
- B. Provide a warranty for all material and labor provided as part of this division for two (2) years from Date of Substantial Completion.

PART 2— PRODUCTS

2.01 GENERAL

- A. Uninterruptible Power Supply (UPS) System
 - 1. The Division 28 contractor shall provide a UPS system to provide backup power for the complete SCS. 120VAC power to locking devices shall be excluded from this requirement.
 - 2. The UPS system shall provide power to complete SCS for a period of ten (10) minutes in the event of a power failure.
 - 3. Provide the size and quantity of UPS units required to support the attached load with 25% headroom.
 - 4. Rack mount UPSs shall be provided to power all head end equipment. All rack mount UPSs shall be online (double conversion) type.
 - 5. All rack mount UPSs shall interface with the PLC System to provide annunciation of power failure and low battery alarms.

6. Each rack mounted UPS shall be provided with an external bypass switch. The bypass switch shall match the power rating of the UPS.
 7. Local UPSs shall be provided at each control, enrollment and viewing station/console. These UPSs shall have a minimum rated capacity of 780W/1300VA.
 8. Approved manufacturers:
 - a. GE
 - b. APC
 - c. CyberPower
- B. Security Equipment Racks
1. All SCS head end equipment, including power supplies, shall be mounted in 19" EIA racks. Racks shall be freestanding or wall mounted as shown on the contract drawings. If additional racks are required over the quantity shown on the contract drawings, the racks shall be provided as part of the bid.
 2. Racks shall be ventilated and provided with fan units, as required, according to manufacturer's recommendations and actual heat loads of installed equipment.
 3. Provide multi-outlet surge protection strips as required for installed equipment. All equipment shall plug into surge protection strips and not directly into UPSs or by pass switches.
 4. The depth of each rack shall be sized to accommodate the equipment contained in the rack. Equipment racks that include video recording equipment or servers shall be sized at a minimum depth of 30".
 5. Each freestanding rack shall include front and rear doors with locks provided and installed by the manufacturer. Each wall mount enclosed rack shall include a lockable front door. All locks shall be keyed alike.
 6. All wall mounted racks shall be rated for the total load of the equipment to be installed plus 25%.
 7. All wall mounted racks shall be hinged to allow the main body to swing out away from the wall to allow access to the back of the equipment installed in the rack. A lock shall be provided by the manufacturer on the hinge.
 8. Provide cable management devices as required to neatly dress/organize cables in and out of rack.
 9. Rack area to include two (2) 20 amp, 120 V duplex receptacles, each connected to separate 20 amp, 120V dedicated circuit. Mount in bottom area of rack.
 10. No floor rack shall be mounted closer than 36" from any surface horizontal and vertical.
 11. Approved Manufacturers:
 - a. Chatsworth Products
 - b. Middle Atlantic
 - c. Winsted.
- C. Security Equipment Cabinets
1. All termination boards shall be mounted in NEMA Type 1 wall mount enclosures.
 2. Provide cable management for routing all cabling.
 3. Cabinets shall be sized per contract drawings and/or manufacturer's recommendation. If additional cabinets are required over the quantity shown on the contract drawings, the cabinets shall be provided as part of the bid.
 4. Approved Manufacturers:
 - a. Hammond Manufacturing
 - b. Hoffman
 - c. Saginaw
- D. Edge Network Switches
1. Switches shall be rack mountable.
 2. Switches shall be 24 port and 48 port as applicable.
 3. Switches shall support up to a 100 Mbps connection speed on all ports.
 4. Switches shall support PoE on all ports.

5. Provide all required fiber transceivers to support the fiber connections as shown on the drawings. All fiber uplinks shall be 1 Gbps.
 6. Approved Manufacturer:
 - a. HP 2620 series or approved equal.
- E. Edge Network Switches
1. Switches shall be rack mountable.
 2. Switches shall be 24 port and 48 port as applicable.
 3. Switches shall support up to a 1 Gbps connection speed on all ports.
 4. Switches shall support PoE on all ports.
 5. Provide all required fiber transceivers to support the fiber connections as shown on the drawings. All fiber uplinks shall be 1 Gbps.
 6. Approved Manufacturer:
 - a. HP 2920 series or approved equal.
- F. Core Network Switch
1. Switch shall be rack mountable.
 2. Switch shall be 24 port and 48 port as applicable.
 3. Switches shall support up to a 1 Gbps connection speed on all ports.
 4. Switch shall support PoE on all ports.
 5. Switch shall support Layer 3 routing.
 6. Switch shall support multicast routing.
 7. Provide all required fiber transceivers to support the fiber connections as shown on the drawings. All fiber uplinks shall be 1 Gbps.
 8. Approved Manufacturer:
 - a. HP 3500yl series or approved equal.
- G. Category 6 Data Horizontal Cable
1. UTP cable shall be extended between devices and their associated equipment rack. The cable shall consist of 4 pair 23 gauge, solid copper conductors, Certified to the Category 6 standards. Cables shall be terminated on 8-position modular jacks provided at each control, enrollment and viewing station/console. Cables shall be terminated using RJ-45 connectors at each field device (i.e. cameras).
 2. Cable Insulation and Jacket: Cable jacket shall comply with Article 800 NEC for the environment in which the cable will be installed.
 3. Horizontal Cables drops from the equipment racks to specified outlet locations and field devices are to be without splices.
 4. Approved Manufacturers:
 - a. Superior Essex
 - b. Berk-tek Lanmark
 - c. Honeywell
- H. Category 6 Patch Panel
1. Equipment racks shall be equipped with 19" rack mounted, 24 or 48 position 110 patch panels for termination of all copper horizontal cables.
 2. Patch panels shall be tested to meet the Category 6 standard for component and channel performance and shall be modular-to-110, wiring shall be T568B.
 3. Designation strips for each port shall be provided on the patch panel. All cables shall be terminated in numerical sequence and each position labeled as to outlet number and jack position as is noted for the outlets.
 4. Patch panels shall be provided in 24 or 48 port configurations as required for the termination of all system outlets and field devices.
 5. Category 6 rated patch cords shall be provided for connections to patch panels or SCS components. Patch cords shall be a component part of the CAT6 channel solution and have been tested as such.
 6. Approved Manufacturers:

- a. Hubbell
 - b. Leviton
 - c. Commscope
- I. Fiber Optic Cabling
 - 1. Multi-mode and/or single mode fiber optic cabling shall be provided between equipment rooms as designated on the contract drawings.
 - 2. Backbone/Riser Fiber Optic Cable shall:
 - a. Have fiber strand count as specified and as called for on the contract drawings.
 - b. Cable installed in plenum spaces/areas shall be plenum rated and marked OFNP (UL).
 - c. Cable used for multi-story building risers must be marked OFNR (UL) and meet UL 1666 flame test or be plenum cable as specified above.
 - d. Underground and exterior cables shall be rated for wet locations.
 - e. All fiber cables shall be tight buffered.
 - f. Multi-mode fiber optic cables shall be 50/125 OM2.
 - 3. Approved manufacturers:
 - a. Superior Essex
 - b. Hubbell
 - c. Berktek
 - d. Remece
- J. Fiber Optic Termination
 - 1. Fiber optic cabling shall be terminated in rack mounted fiber distribution units (FDU) as described herein. FDUs shall be provided as required to terminate all fibers, complete with loaded SC Style adapter plates as required for terminations. All FDUs shall be provided with rack mounting hardware allowing the unit to be placed in a standard EIA 19" rack. Provide blank adapter in all unused openings in the FDU. All panels shall include strain relief points where fiber optic cable strength members shall be securely attached.
 - 2. All terminations shall be accomplished using fusion splicing. Mechanical terminations are not acceptable.
 - 3. Provide fiber optic patch cables as required to make all connections for the SCS.
 - 4. Approved Manufacturers
 - a. Hubbell
 - b. Leviton
 - c. Approved equal
- K. Surge Suppression
 - 1. The contractor shall have equipment installed on the AC voltage supply and other lines taking care to arrest damaging electrical transient and spikes which can cause damage to the components of all systems.
 - 2. All surge protection devices shall have the lowest surge voltage rating per U.L. 1449 that is consistent with the line levels.
 - 3. All exterior devices not mounted directly to a building or below the roof line of a building shall have surge protection installed to protect the connected head end equipment.
 - 4. 120VAC surge protection shall be installed on all circuits feeding security devices.
 - 5. Surge protection devices shall be installed in the cabinet or rack where the protected field device is terminated.
 - 6. Approved surge protection manufacturers:
 - a. Transtector
 - b. CyberPower
 - c. Phoenix Contact
 - d. Leviton
- L. Spare Parts
 - 1. Provide the following spare parts for all Division 28 specification sections:

- a. One (1) PLC
- b. One (1) Data Module
- c. Two (2) Discrete I/O Module
- d. One (1) Logic Power Supply
- e. One (1) 24VDC Power Supply (if used)
- f. Ten (10) Relays of Each Type
- g. One (1) Digital Intercom Amplifier
- h. Two (2) Remote Intercom Stations
- i. Two (2) Page Speakers of Each Type
- j. Two (2) Cameras of Each Type
- k. One (1) Control Station Computer. Computer shall have a fully licensed copy of the HMI and PLC software and all databases.

PART 3— EXECUTION

3.01 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is a factory trained service representative to perform the work in this division.
- B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electric Code."
- C. EIA Compliance: Comply with the Electronics Industries Association standards.
- D. Compliance with Local Requirements: Comply with the applicable building code, state and local ordinances, and regulations and the requirements of the authority having jurisdiction.
- E. NFPA Compliance: Provide systems conforming to the requirements of the NFPA 101, "Life Safety."
- F. UL Listing and Labeling: Provide components specified in this Section that are listed and labeled by UL.

3.02 EXAMINATION

- A. Examine conditions prior to installing SCS components.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. Verify that surfaces and areas are ready to receive work.
- D. Verify field measurements as instructed by manufacturer.
- E. Verify that required utilities are available, in proper location, and ready for use.

3.03 INSTALLATION

- A. Weatherproofing: Provide NEMA 4X rated enclosures for electronics which are to be mounted outdoors or exposed to weather.
- B. Repairs: Wherever walls, ceilings, floors or other building finishes are cut for installation, repair, restore, and refinish to original appearance.
- C. All system cables and power wiring shall be kept physically isolated from each other at all points. Lace and form wires from components to terminals and fasten securely.
- D. Wires and cables in equipment cabinets and service cabinets shall terminate on terminal strips or on connectors provided with equipment.
- E. Install system equipment panels in locations shown; arrange to provide adequate ventilation and access.
- F. Install the SCS in accordance with all applicable sections of the NEC and BICSI standards.
- G. All exposed wiring inside and outside the control console, cabinets, boxes and similar enclosures, shall be dressed down neatly and secured with wiring cleats or wire ties.

3.04 INITIAL PROGRAMMING AND CONFIGURATION

- A. Security Electronics Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by the contractor. Security Contractor shall consult with Security Consultant and Owner to determine operating parameters at the time of submittal review.
- B. Security Electronics Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings in the form of Autocad .DWG or .DXF files, as the basis for the creation maps.
- C. The owner, with the cooperation and assistance of Security Contractor, will enroll the template of each authorized system user.

3.05 FACTORY TESTING

- A. The SCS, excluding field devices, shall be assembled complete and 100% tested in the Division 28 contractor's facility prior to shipment of the head-end equipment to site. There shall be a testing meeting conducted with attendance required by: the architect, the owner, the project manager, the general contractor and the commissioning agent. All software for all systems shall be programmed and tested.

3.06 COMMISSIONING

- A. Place entire system into full and proper operation as designed and specified.
- B. Verify that all hardware components are properly installed, connected, communicating, and operating correctly.
- C. Verify that all system software is installed, configured, and complies with specified functional requirements.
- D. Perform final acceptance testing in the presence of OWNER'S representative, executing a point by point inspection against a documented test plan that demonstrates compliance with system requirements as designed and specified.
- E. Conduct final acceptance tests in presence of OWNER'S representative, verifying each device point and sequence is operating correctly and properly reporting back to control panel and control center.
- F. The system shall not be considered accepted until all acceptance test items have been successfully checked-off.

3.07 ADJUSTING, CLEANING, AND PROTECTION

- A. At final completion all hardware shall be left clean and free from disfigurement. The contractor shall make a final adjustment to all Division 28 devices, in strict compliance with manufacturer's instructions. Where hardware is found defective, repair or replace or otherwise correct as directed.
- B. Prior to final acceptance, clean system components and protect from damage and deterioration.
- C. The Security Electronics Contractor is responsible for the proper protection of all items of hardware, as it is stored on site in a covered and dry place, and is installed during construction.

3.08 TRAINING

- A. Train Owner's personnel in the procedures involved in the operating, maintaining and administration of the system. Provide sixteen (16) hours training during normal business hours. Training shall include two (2) sessions at eight (8) hours each classroom instruction for the people selected by the owner.

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- B. Schedule training with the owner through the architect, with at least seven (7) days advance notice.
- C. Provide a system specific DVD training video to the owner. The DVD training video shall contain training modules for each specific portion of the system. Each training module shall cover all system operation, maintenance and administration of the SCS. Provide a copy of the DVD training video to the owner upon substantial completion.
- D. The owner will designate personnel to be trained.
- E. Training shall be oriented to the specific system being installed under this contract as designed and specified.
- F. Training sessions are to be held at Owner's facility and are to be scheduled at the convenience of owner. Contractor shall provide written training outline and agenda for each training session prior to scheduling.
- G. Security Electronics Contractor shall provide ten (10) copies of written training materials.
 - 1. MAINTENANCE AND SERVICE
- H. The Security Electronics Contractor shall use technicians that are trained by the manufacturers of the SCS components.
- I. During the warranty period, all service (including equipment, labor, travel, expenses, etc.) is to be provided during normal working hours at no cost to the Owner. On-site service must also be made available at times other than normal working hours to the owner and shall be charged by the contractor's service representatives at current rates of labor and travel. The contractor shall provide the owner with a manned, 24-hour phone number for service. The contractor shall provide an on-site response time of one (1) business day for system critical items during regular business hours. "Critical" items are items that cause multiple devices to not function properly (i.e. power supplies, PLCs, control stations, etc.).
- J. The guarantee shall exclude acts of God, vandalism, physical abuse, power events or operator misuse. The contractor shall not be required to provide or diagnose problems associated with door position switch or lock problems without additional reimbursement. The contractor shall not be responsible for any existing field devices/equipment that is not functional for whatever reason.

END OF SECTION

SECTION 28 0510 - SECURITY ELECTRONICS - CONDUCTORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary
 - 1. Conditions and Division 1 Specification Sections, apply to the Work of this Section.

1.02 SUMMARY

- A. This section covers all conductors as shown on the drawings or as required to support the systems defined in these specifications. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the conductors required for the security electronics system.
- B. Related Work Specified Elsewhere: Refer to all other Security Electronics System specification sections and drawings, and to the specifications and drawings under the General Construction Contract to ascertain the extent of work included.

1.03 SUBMITTALS

- A. Submittals shall be packaged in accordance with specification Section 28 0500 – Basic Materials and Methods for Electronic Systems.
 - 1. When making the submittal as required by specification Section 28 0500 - Basic Materials and Methods for Electronic Systems, include this additional information.
 - a. A Security device location drawings and conduit routing information for electrical contractors use to provide security conduit

1.04 REFERENCES

- A. National Electrical Code.
- B. Underwriters' Laboratories, Inc. (UL) Publications:

1.	No. 44	Rubber-Insulated Wire and Cables
2.	No. 83	Thermoplastic-Insulated Wires
3.	No.493	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
4	No. 486	Wire Connectors and Soldering Lugs

1.05 SYSTEM DESCRIPTION

- A. Provide conductors for the Security Electronic System.

PART 2 - PRODUCTS

2.01 CABLES AND CONDUCTORS

- A. Power Conductors
 - 1. Insulated wire conductors for circuit voltage, 600 volts or less, shall be copper.
 - 2. Conductors shall have U.L. approved 600 volt insulation of the type specified below or elsewhere in the specifications.
 - Conductors No. 8 AWG and smaller shall be solid or stranded type THWN or XHHW, unless otherwise indicated.
 - Conductors No. 6 AWG and larger shall be stranded type THWN or XHHW, unless otherwise indicated.
 - 3. Minimum size of power conductors- No. 14 AWG, unless otherwise indicated.

4. Conductors in or below a building slab that is in direct contact with the earth, underground, outside the building, or other wet locations shall be type THWN.
 5. All conductor insulation shall be color coded to indicate phase leg, voltage, and use.
For power conductors, each phase shall be the same color throughout the entire facility and shall be a different color from the other phases. The following color code shall be used for all branch circuits:
Neutral White
Ground Green
Phase A Black for 120/208
Phase B Red for 120/208
Phase C Blue for 120/208
 6. Conductor insulation type, wire gauge and U.L. approval shall be printed with permanent white paint on all conductor insulation, continually repeating.
- B. Data and Signal Conductors
- a. Cables and conductors shall be of the types recommended by the equipment manufacturers to support the intended functions. Conductor transmission properties and wire size shall be selected to satisfy system requirements.
 2. Cables installed in exterior conduits or in other wet locations shall be gel filled or gelling tape wrapped, moisture proof, direct burial type cable.
 3. Cables installed in or below grade level slab in direct contact with the earth shall be rated for wet locations,
 4. Conductors for data circuits shall be shielded except for UTP data circuits such as Category 5, 6, etc.
 5. All conductor insulation shall be color coded to indicate its function. Color codes shall be consistent throughout the project.
 6. Conductor insulation type, wire gauge, and U.L. approval shall be printed with permanent white paint on all conductor insulation, continually repeating.
- C. CCTV Video Cable
- a. Coaxial video cables shall have a copper center conductor and a copper shield providing a minimum 93% coverage.
 2. Nominal dc resistance shall not exceed 12 ohms/1000 ft for 59/U-type cables, 8 ohms/1000 ft. for 6/U-type cables, and 4 ohms/1000 ft. for 11/U-type cables.
 3. Nominal impedance shall be 75 ohms.
 4. Cable runs shall not exceed 400ft. for 59iU-type cables, 600ft. for 6/U-type cables, and 900 feet for 11/U-type cables.
 5. Cables installed in exterior conduits or in other 'Net locations shall be gel filled or gelling tape wrapped, moisture proof, direct burial type cable.
 6. Cables installed in or below grade level slab in direct contact with the earth shall be rated for wet locations.
 7. Manufacturer:
 8. Dry locations: West Penn 815 (RG-59), 806 (RG-6), 811 (RG-11). Or approved equal.
 - a. Exterior conduits or in other wet locations: West Penn 5990 (RG-59), 6325 (RG-6), 1130 (RG-11). Or approved equal.
 - b. In or below grade level slab: West Penn 4815 (RG-59), 4806 (RG-6), 4811 (RG-11). Or approved equal.
 - c. Miniature: West Penn 825. Or approved equal.
- D. Local Area Network Outlet Cable:
1. The Local Area Network outlet cable shall meet EIA/TIA 568-B Category 6 UTP requirements. Cable shall be four (4) twisted pair 24 AWG, solid conductors, with thermoplastic- polyolefin insulation.
 - a. Cables installed in dry indoor locations shall be protected with a PVC jacket. The jacket color for the Local Area Network Outlets shall be color coded orange.

- b. Cables installed in exterior conduits, conduits installed in or below grade level slab, or in other wet locations shall be protected with a polyolefin jacket. The jacket color for these cables may be different than the jacket color for the dry location cables. The cables shall be flooded with a semi-dry flooding compound. Cables shall be VersaLAN by Mohawk or approved equal
- E. Door Control Conductors:
 - 1. Number of conductors shall be installed as required to provide the control and monitoring functions specified in the Security Electronics Specifications and in Division 8.
 - 2. All conductors from the SCC to 120VAC electrically operated door locks shall be minimum 14 gage copper THWN.
 - 3. All conductors from SCC to door position switches and bolt position switches at 120VAC locks shall be minimum 14 gage copper THWN
 - 4. 120VAC locks shall be minimum 14 gage copper THWN.
- F. Video 1/P Video Camera Cable:
 - 1. The video cable shall meet EIA/TIA 568-B Category 6 UTP requirements. Cable shall be four (4) twisted pair 24 AVVG, solid conductors, with thermoplastic- polyolefin insulation.
 - a. Cables installed in dry indoor locations shall be protected with a PVC jacket. The jacket color for the cameras shall be color coded green.
 - b. Cables installed in exterior conduits, conduits installed in or below grade level slabs that are in direct contact with the earth, or in other wet locations shall be protected with a polyolefin jacket. The jacket color for these cables may be different than the jacket color for the dry location cables. The cables shall be flooded with a semi-dry flooding compound. Cables shall be VersaLAN by Mohawk or approved equal.
- G. Dedicated Intercom and Public Address System
 - 1. Provide wire and cable of the type and size recommended by the equipment manufacturer.
 - 2. Cables installed in exterior conduits or in other wet locations shall be gel filled or gelling tape wrapped, moisture proof, direct burial type cable.
 - 3. Cables installed in or below grade level slab in direct contact with the earth shall be rated for wet locations.
 - 4. Cable shall be stranded, shielded, twisted pairs.
 - 5. Duct-Bank Cable:
 - a. Cables in the duct-bank shall be 18 AWG minimum.
 - 6. Remote Intercom Station Cable:
 - a. Provide a minimum of one pair for audio and one pair for call.
 - b. If the remote intercom station does not utilize an additional pair for call, the additional pair of conductors shall be provided as spares for future installations.
 - c. Unless prohibited by the manufacturer, all cable shall be minimum 20 AWG, single or multiple twisted pairs. All audio conductors shall be shielded.
 - 7. Public Address Station Cable:
 - a. All paging station cable shall be single or multiple stranded, twisted pairs minimum 18 AWG. Sized shall be as required to accommodate the total circuit load.
 - 8. Microphone Cable
 - a. Microphone cable shall be minimum 22 AWG, shielded, twisted pair.
- H. Card Access System
 - 1. Provide wire and cable of the type and size recommended by the equipment manufacturer.
 - 2. Cables installed in exterior conduits or in other wet locations shall be gel filled or gelling tape wrapped, moisture proof, direct burial type cable.
 - 3. Cables installed in or below grade level slab in direct contact with the earth shall be rated for wet locations.

2.02 MISCELLANEOUS

- A. Cable Connectors for Copper Branch Circuit Conductors
 - 1. For #10 AWG and #14 AWG THWN and XHHVV, connector body shall consist of a cone shaped, expandable coil spring insert, insulated with a nylon shell and 2 wings placed opposite to each other to serve as a "built-in" wrench. Shell shall be molded one-piece as manufactured by Ideal Industries "Wing Nut" connectors or approved equal.
 - 2. For #8 AWG, connectors shall be screw pressure lugs made of high strength structural aluminum alloy and UL approved for use with both copper and/or aluminum wire as manufactured by IISCO, T&B Burndy, O.Z. Companies, or approved equal.
- B. Cable tags shall be pre-marked, self-adhesive, wrap-around cloth type.
 - 1. Labels shall be compatible with the conductor and cable used.
 - 2. Labels shall be compatible with the environment where the conductor and cables are installed.
- C. Wire lubricating compound shall be suitable for the wire insulation and conduit.
 - 1. Lubricating compound shall not harden or become adhesive.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The requirements listed in Part 3 of Specification Section 26 05 19 Low Voltage Electrical power Conductors and Cables shall apply to the installation of all THWN or XHHW conductors.
- B. Deliver all conductors to the site on their original cable reels or in their original unbroken packages.
- C. Verify that the conduit and raceway system is complete prior to pulling conductors and cables.
- D. Completely and thoroughly swab raceway before installing conductors and cables.
- E. Utilize a pull rope for pulling conductors and cables.
- F. Pull all conductors and cables into a raceway at the same time.
- G. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radius.
- H. Utilize pull boxes and junction boxes for pulling conductors and cables.
- I. Security Electronics cables shall not be spliced except as approved in writing.
- J. Clean conductor surfaces before installing lugs and connectors.
- K. Cables shall be dressed and tie-wrapped in cabinets and at control panels and consoles to present a neat and orderly installation. At the discretion of the SEC, cable duct may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.
- L. Cables shall be secured to equipment cabinet backboards, console members, or to other system components using cable clamps and wraps. The SEC shall provide cable support posts if required to facilitate system installation.
- M. Cables and conductors shall be terminated with approved cable termination connectors compatible with the specific termination. If non-insulated type connectors are used tape the connectors with half-lapped, rubber-type tape, to 150% of the thickness of the conductor insulation, then cover the rubber-type tape with Scotch No. 33 Tape.
- N. Permanently label all conductors and cables with cable tags. Each continuous conductor or cable shall be labeled with nomenclature that distinguishes the conductor or cable from all other conductors or cable on the project.
 - a. Conductors and cables shall be labeled at each termination point including but not limited to the device, outlet, panel, and switch.
 - b. Conductors and cables shall be labeled at each head end equipment termination point including but not limited to the SCC, LAN rack, and Back Board.

3.02 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.
- B. Testing: The completed system shall be tested by the SEC prior to the acceptance test.

3.03 TABLES

- A. The SEC shall modify and complete the Table below to reflect the correct data for all conductor types required for the security electronic systems.

Cable Mark	Application	Description	Manufacturer/Product Number	Diameter (inches)	Max Area (in ²)
A	Interior video	24 AWG, 4 pair Cat 6	XYZ #0000	0.22	0.04
B	Exterior video	24 AWG, 4 pair Cat 6	XYZ #0000	0.22	0.04
C	120VAC Door Control	14 AWG THWN 4 cond.	XYZ #0000	0.18	0.025
D	DPS Indication at 120VAC door	14 AWG, 2 cond.	XYZ #0000	0.18	0.025
E	Intercom Station	20 AWG, 2 pair 1-shielded, 1-Unshielded	XYZ #0000	0.21	0.035
F	Exterior Intercom	18 AWG, 2 pair 1-shielded, 1-unshielded, direct burial	XYZ #0000	0.22	0.04
G	PLC/LAN Network	24 AWG, 4 pair, Cat 6	XYZ #0000	0.22	0.04
H	Access System	18 AWG, 8 cond. Shielded	XYZ #0000	0.29	0.07

*Note: This schedule is provided for example only. It is not intended to be complete or to necessarily represent the cable types required for this project. The actual cable types and conductor gauges must be selected based upon the system requirements and the specific requirements of the Specifications.

END OF SECTION

SECTION 28 0515 - SECURITY ELECTRONICS GUARANTEE, MAINTENANCE AND SERVICE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Work of this Section.

1.2 SUMMARY

- A. This section covers all guarantee; maintenance, and service of the security electronics system as shown on the drawings or as required to support the systems defined in these specifications. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the guarantee, maintenance, and service of the security electronics system.
- 8. Related Work Specified Elsewhere: Refer to all other Security Electronics System specification sections and drawings, and to the specifications and drawings under the General Construction Contract to ascertain the extent of work included.

1.3 SUBMITTALS

- A. Submittals shall be packaged in accordance with specification Section 28 0500 – Basic Materials and Methods for Electronic Systems.

1.4 REFERENCES

- A. National Electrical Code

1.5 SYSTEM DESCRIPTION

- A. There shall be no additional charges for Guarantee, Maintenance and Service work; all costs shall be included in the base bid for this project.
- B. The duration of the Guarantee, Maintenance and Service Period shall be two (2) years from the date of Substantial Completion. The SEC shall furnish and install all failed components of the Security Electronics System during the Guarantee, Maintenance and Service Period. The SEC shall provide routine maintenance as defined herein during the Guarantee, Maintenance and Service Period.
- C. Service
 - 1. Daily operations and inspections by the facility personnel shall determine the operational state of the systems. Service calls for component failures shall be initiated by facility personnel.
 - 2. The SEC shall maintain a 24-hours-per-day, 7-days-per-week toll-free phone number for Guarantee, Maintenance and Service requests. Calls to this number shall initiate the time response period.

3. Service Response Times: Classifications of component failures and the required response time for each classification are as follows:
- a. Critical Items which compromise the security of the facility or have an adverse effect on the operations off the facility. Items in this category shall be returned to service within eight (8) hours after receipt of a Maintenance and Service request. Service shall be available seven (7) days per week and twenty-four (24) hours per day. The SEC shall call the designated Owner's Facility Administrator within 2 hours of receiving the Guarantee, Maintenance and Service request to inform him of the estimated arrival time of the service personnel.
 - b. Sensitive- Items which adversely impact the operations of the facility but are **not considered "critical" as defined above. Items in this category shall be** returned to service within twenty-four (24) hours after receipt of a Guarantee, Maintenance and Service request. Service shall be available eight (8) hours per day during weekdays. The SEC shall call the designated Owner's Facility Administrator within 2 hours of receiving the Guarantee, Maintenance and Service request to inform him of the estimated arrival time of the service personnel.
 - c. Normal - Items which require Guarantee, Maintenance and Service support but are not "critical" or "sensitive" as defined above. These are typically items that facility personnel identify and accept that maintenance will be performed by the SEC during the next quarterly maintenance visit.

D. Maintenance.

- 1. Routine daily maintenance functions shall be performed by facility personnel. Quarterly scheduled maintenance of all Security Electronics Systems shall be performed during the Guarantee, Maintenance and Service Period by the SEC. Minimum maintenance tasks are listed in Table 17060-1.
- 2. If changes are made to the systems, modify drawings, schedules, and other documents as required to maintain accurate as-built documentation.
- 3. Upon completion of the Guarantee, Maintenance and Service Period, or subsequent service contracts, return all system documents to the Owner, including electronic files of all documentation.
- 4. The SEC shall develop maintenance reports and logs to record maintenance activities on the system. Included for each repair shall be a list of equipment required to make the repair or adjustment. If requested, the reports and logs shall be provided to the Owner on a monthly basis.
- 5. The SEC shall submit maintenance procedure manual to include details and instructions of their maintenance procedures for each device.
- 6. At the end on the maintenance period SEC shall clone all computers and servers using software and turn over images to owner on two separate medias

E. Spare Parts Inventory

An inventory of spare parts must be provided and maintained by the SEC to support the Guarantee, Maintenance and Service requirements defined in this Section.

2. During the Guarantee, Maintenance and Service Period, the SEC shall maintain a log of all component failures and parts replaced. Six months prior to the expiration of the Guarantee, Maintenance and Service Period, the SEC shall submit the replaced parts log, a list of recommended spare parts, and a parts price list to the facility. The facility shall use the replaced parts log and list to evaluate the spare parts inventory required for future maintenance.
3. At a minimum, the following spare parts shall be stored at the and shall be property of the Owner. This requirement is not intended to include all spare parts required to meet the service response time limits. The SEC shall replace any of these spare parts, if used for service work during the warrantee period within 10 days. The spare parts shall be the same type submitted and installed in the facility.
 - a. One (1) of each type of fiber optic module used, including the modules used for the PLC.
 - b. One (1) of each type of PLC I/O module.
 - c. One (1) of each type of Security Electronics Local Area Network switch used.
 - d. One (1) of each type of surge protector used.
 - e. Two (2) of each type of door control relays.
 - f. Three (3) of each type of door control relay interface boards (if installed).
 - g. Ten (10) of each type or size of door power fuses.
 - h. One (1) complete Touchscreen Spare Unit.
 - i. Four (4) Personal Alarm Transmitters.
 - j. Two (2) Panic Push Buttons
 - k. Four (4) of each type of camera used.
 - l. At least (1) of every type of varifocal camera lenses used. Provide a minimum of 5 lenses.
 - m. Five (5) dome mount camera "replacement domes".
 - n. Ten (10) of each type or size of camera power fuses.
 - o. Two (2) Digital Audio Board
 - p. One (1) intercom amplifier.

- q. One (1) master intercom station.
- L One (1) intercom station.
- Two of each of intercom control
- t. Three (3) of each type of intercom control relay interface boards (if installed).
- u. One (1) paging amplifier (100W minimum).
- v. Two (2) paging speakers.
- w. One Hundred (100) Card Access System Access Cards.
- x. One 3.0 KVA UPS.

F. Software Enhancements

- 1. If software that will enhance the system operation is introduced after system handed over, the SEC shall inform the Owner of the software, its features, and the cost (Including labor) to upgrade the existing software.
- 2. Any software change shall be logged and the electronic files backed up and given to the owner.

G. Insurance:

- 1. Insurance shall be maintained by the SEC during the Guarantee, Maintenance and Service Period.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All products used in parts replacement shall meet the specifications for the original equipment. Any substitutions must be approved in writing.

PART 3- EXECUTION

3.1 SCHEDULED QUARTERLY MAINTENANCE

- A. The maintenance tasks identified in Table 17060-1 represent the minimum tasks required for each system; the SEC shall expand these tasks as required to support the maintenance recommendations of the equipment manufacturers.

3.2 SERVICE

- A. See Part 1 of this specification section and Table 17060-2 for the response time categories and the restoration time response for each category.

3.3 SPECIAL SERVICE CONDITION

Lightning:

1. If there is evidence that the systems have incurred lightning damage, the SEC shall identify the nature and extent of the damage.
2. The SEC shall not be responsible for damage beyond his control. However, restoration of circuits or equipment caused by power surges or transients due to improper grounding or surge suppression devices or the installation of those devices will be the responsibility of the SEC.

3.4 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.

3.5 TABLES

- A. The system shall be guaranteed, maintenance, and serviced in accordance with the following tables:

TABLE 17060-1

SCHEDULED QUARTERLY MAINTENANCE

1. GROUNDING AND SURGE PROTECTION
 - A. Check surge protector status indicators where applicable.
2. CABINETS AND ENCLOSURES
 - A. Inspect and clean equipment enclosures.
3. FIBER OPTIC CABLE SYSTEM
 - A. Check all transmitters and receivers for proper operation.
 - B. Inspect and clean equipment enclosures.
4. PROGRAMMABLE LOGIC CONTROLLERS
 - A. Check communications lines and all I/O for proper operation.
 - B. Check and record condition of processor battery back-up.
5. TOUCHSCREENS
 - A. inspect and clean touchscreens.
 - B. Verify operational status with Security Officer.
6. DATA LOGGING AND REPORTING SYSTEM
 - A. Inspect and clean data logger,
 - B. Check data logger for proper operation.
7. SECURITY ELECTRONICS LOCAL AREA NETWORK
 - A. Verify that anti-virus software is up to date and operational.
8. CLOSED CIRCUIT TELEVISION VIDEO I/P SYSTEM
 - A. Verify proper video level at monitors.
 - B. Verify proper auto-iris operation.
 - C. Check video clarity for each camera.
 - D. Adjust monitor controls as required.
 - E. Adjust camera controls as required.

9. DIGITAL VIDEO RECORDING SYSTEM

- A. Check each server for proper operation.

10. CARD ACCESS AND IRIS SCAN ACCESS SYSTEM

- A. Review operational status with Security Officer.
- B. Check communication lines and all I/O for proper operation.
- C. Check operation of each reader and interface with door control system.
- D. inspect and clean terminals and equipment cabinets.

11. UNINTERRUPTIBLE POWER SUPPLY

- A. Review and record voltage and current for input and output.
- B. Check system diagnostics.
- C. Interrupt input power and test.
- D. Inspect battery system.
- E. Inspect and clean equipment enclosure.

TABLE 17060-2

SERVICE RESPONSE CATEGORIES

<u>SYSTEM</u>	<u>RESPONSE CATEGORY</u>
1. GROUNDING AND SURGE PROTECTION	
A. Evidence of damaging power transients	CRITICAL
2. FIBER OPTIC DISTRIBUTION SYSTEM	
A. Loss of transmission	CRITICAL
3. DOOR CONTROL	
A. Site perimeter doors and gates	CRITICAL
B. Other doors	SENSITIVE
4. PROGRAMMABLE LOGIC CONTROLLERS	
A. All components	CRITICAL
5. TOUCHSCREENS	
A. All components	CRITICAL
6. DATA LOGGING AND REPORTING SYSTEM	
A. All components	SENSITIVE
7. SECURITY ELECTRONICS LOCAL AREA NETWORK	
A. All components	CRITICAL
8. VIDEO I/P SYSTEM	
A. Door control cameras	CRITICAL
B. Cameras	SENSITIVE
C. Monitors	CRITICAL
D. Server	CRITICAL
E. Client Station	SENSITIVE
9. PAGING AND INTERCOM	
A. Loss of multiple paging stations. (amplifier loss)	SENSITIVE

	B.	Loss of single paging station	NORMAL
		Loss of multiple intercom stations Amplifier loss)	CRITICAL
	D.	Loss of intercom station	SENSITIVE
	E.	Stuck or missed aligned pushbuttons	SENSITIVE
10.	CARD ACCESS AND IRIS SCAN ACCESS SYSTEM		
	A.	All components	CRITICAL
11.	UNINTERRUPTIBLE POWER SUPPLY		
	A.	All components	CRITICAL

END OF SECTION

SECTION 28 0525 - SECURITY ELECTRONICS PROGRAMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Work of this Section.
- B. The work under this section consists of furnishing materials and equipment, including labor and services necessary for the installation of the programmable logic controllers required for the security electronics system.
- C. Related Work Specified Elsewhere: Refer to other Security electronics System specification sections and drawings, and to the specifications and drawings under the General Construction Contract indicate the extent of work included.

1.02 SUBMITTALS

- A. Submittals shall be packaged in accordance with specification Section 1. 7000 - Security
 - 1. For the Operations and Maintenance Manual Submittal include the following:

1.03 REFERENCES

- A. National Electrical Code

1.04 SYSTEM DESCRIPTION

- A. Programmable Logic Controllers (PLC)
 - 1. The PLC shall provide control and monitoring functions for systems as described on the drawings and in these specifications.
 - 2. PLC shall provide all necessary logic functions, memory, software, input/output points, and communication capabilities for the operating features required to meet all of the requirements of the specifications.
 - 3. The PLC shall be general purpose in nature and not custom designed and built for this isolated application.
- B. PLC Programming Terminal
 - 1. The PLC Programming Terminal shall perform all functions required to program and download programs to the Security Electronics System PLC's.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. PLC
 - 1. The PLC shall be the product of a manufacturer engaged in the production of controllers for industrial application for a minimum of five years.
 - a. The PLC manufacturer shall have both national and local parts distribution outlets.
 - b. The PLC manufacturer shall have 24 hour a day technical support via a 1-800 toll free telephone number.
 - c. The PLC manufacturer shall provide written guarantee to make parts and other supplies available for a period of ten (10) years.
 - 2. The PLC shall operate on 105 to 130 VAC, 60 Hz.
 - 3. The PLC shall contain an integral circuit breaker for overload protection.
 - 4. The PLC shall operate properly in temperatures of 0 to 60 deg C and up to 95 percent humidity (noncondensing).
 - 5. The PLC shall be tested to withstand shock of at least 10a for at least 10 minutes.
 - 6. Software:
 - a. The PLC program shall be in EEPROM or Flash Memory. RAM operation data base shall not be acceptable.
 - b. The programming format shall be traditional relay ladder logic utilizing basic and advanced instructions.

- 1) Logic functions shall include but not be limited to AND, OR and sufficient levels to provide operating features required to perform all of the functions required by the specifications.
 - 2) Timing functions shall include, but not be limited to, on-delay, off-delay, stepping and pulsing. Sufficient variations of programmable timing shall be available to provide all the operating features as required by the specifications.
7. Communications Modules:
- a. The PLC shall be equipped with communications capability as required to support the system configuration shown on the drawings.
8. I/O modules:
- a. The I/O modules shall contain the necessary coding/decoding solid state circuits for communicating with the processor.
 - b. The I/O modules shall include LED indicators to display the status of each point.
 - c. Input and output points of the I/O module shall be optically isolated to prevent transient voltages and static discharges from damaging internal components of the I/O module.
 - d. The I/O modules shall have removable terminal strips to effect quick replacement of the modules.
9. The PLC shall be Square D Maricon Series; Allen-Bradley PLC5 series; GE Fanuc Series 90, PAC System, or VersaMAX; Omron Series, or approved equal.
- B. PLC Programming Terminal
1. The programming terminal shall be laptop computer as defined in Section. 17070 - Security Electronics Computers, with these additional features:
 - a. Communications cards as required to communicate with LC and Security LAN.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Each PLC shall be equipped with a processor, I/O modules, communication modules, power suppliers, and accessories as required for a complete and functional unit.
- B. The PLC shall be generally nonlocal in its construction. The LC shall be made location specific and operationally customized by.
 1. Installing EEPROM (including FLASH Memory) with applicable program. The program shall be custom developed for each PLC on an individual basis to effect the functions of the PLC as dictated by the drawings and specifications.
 2. Installing the proper I/O modules to support the specific functions or applications.
- C. PLC Communication Network:
 1. The PLC system shall be configured as multiple distributed programmable logic controllers on the Security LAN as shown on the drawings. The Security LAID. shall be configured as defined in Section 28 0520 - Local Area Networks.
 2. A watchdog function shall be provided to monitor the operation of all of the distributed FL's on the system. When the Watchdog detects loss of communications any of the PLC's on the system, or a malfunction of any of the PLC's on the system, a PLC diagnostic alarm shall be displayed as described in Section 28 4619 - Touch Screen System
- D. Diagnostic alarms:
 1. In addition to the diagnostic alarms generated by the watchdog on the PLC communications network, a PLC diagnostic alarm shall also be initiated on trouble events to include.
 - a. Loss of battery at any PLC on the system.
 2. The LC diagnostic alarms shall be displayed as described in Section 28 4619 — Security Electronics Touchscreen Control System.
 3. Input cards and software must be configured to:
 4. Continuously monitor the status of the field devices, not just a change of state of the field devices. For example, if a door is unsecured when the PLC is re-booted or otherwise

comes on-line, the security system should immediately report that the alarmed door is unsecure. The door should not have to be secured and then re- opened for the security system to report that the door is insecure

- 5. Third party multiplexing equipment to support I/O functions shall not be acceptable.
- E. A full time modem connection for Contractor access to the PLC shall not be permitted during or after construction. Temporary modem connections shall not be left unattended.
- F. All PLC's installed for the Security Electronics System shall be of the same manufacturer.
- G. All software associated with the PLC shall be installed on the PLC Programming Terminal.

3.02 SYSTEM PERFORMANCE

- A. The systems shall be configured to affect the following system performance criteria:
- B.
 - 1. **CONTRO.** Outputs to field devices such as door locks, shall activate within 200 msec of the touchscreen or discrete control switch activation. RS-232 or RS-422 communications to field devices such as CCTV system shall activate within 200 msec of the control switch or icon activation. All inputs from field devices such as call buttons and control panel switches shall be read by the PLC. In no case should the system operator be required to hold a field device, such as a call button or control switch for more than 200 msec.
 - 2. **ANNUNCIATION:** The system, including the touchscreens, shall annunciate alarms in 200 msec or less from time the field device is activated.
 - 3. **SYSTEM FAULTS:** System faults or crashes, including those from the touchscreens, shall not be capable of activating field outputs such as door locks during system failure or reboot.

3.03 COMPLETION

- A. **General:** Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.
- B. **Testing:** The completed system shall be tested by the SEC prior to the acceptance test.

END OF SECTION

SECTION 28 0530 - SECURITY ELECTRONICS LOCAL AREA NETWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Work of this Section.

1.02 SUMMARY

- A. This section covers the security electronics local area network shown on the drawing or as required support the systems defined in these specifications. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the security electronics local area network required for the security electronics system.
- B. Related Work Specified Elsewhere: Refer to all other Security Electronics System specification sections and drawings, and to the specifications and drawings under the General Construction Contract to ascertain the extent of work included.

1.03 SUBMITTALS

- A. Submittals shall be packaged in accordance with specification Section 28 0500 - Basic Materials and Methods of these specifications.

1.04 REFERENCES

- A. National Electrical Code

1.05 SYSTEM DESCRIPTION

- A. The Local Area Network (LAN) shall provide the backbone communications "highway" for the video systems as described on the drawings and in these specifications.
- B. The Security Local Area Network (LAN) shall provide the backbone communications "highway" for all other systems as described on the drawings and in these specifications.
- C. All Local Area Network shall utilized managed high quality Ethernet switches.
- D. The drawings show a configuration of Ethernet Switches. The Contractor shall configure or select each Ethernet Switch to accommodate the port counts required at that switch for this project.
 - 1. If a Ethernet Switch is shown on the drawings and the necessary port count cannot be achieved with a single Ethernet Switch, the Contractor shall provide multiple Ethernet Switches.
- E. Data Speeds:
 - 1. Uplink data speeds between switches shall be Gigabit-Ethernet (1,000 Mbit/s).
 - 2. Data speeds shall be Gigabit-Ethernet (1,000 Mbit/s) for links that serve PCs, PC based devices and servers.
 - 3. The data speeds for all other data links shall be Fast-Ethernet (100 Mbit/s) minimum.
- F. Connectivity:
 - 1. Fiber Optics:
 - a. The Local Area Networks shall utilize fiber optic cable for communications inside a building where the link length exceeds 98.43 yards.
 - b. The Local Area Networks shall utilize fiber optic cable for building-to-building communications.
 - c. The Fiber Optic Cable shall be as specified in Section 28 0500 - Security Electronics - Basic Materials and Methods.
- G. Local Area Network Outlets shall be provided as shown on the drawings or as required to provided a complete and functional system.
- H. Section 28 0500 - Security Electronics - Basic Materials and Methods, for the security electronics local area network UPS power requirements.

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PART 2 - PRODUCTS

2.01 ETHERNET SWITCH:

- A. Managed, rack mountable, fixed configuration, Ethernet Switch.
- B. Shall be designed for advanced control of converged networks of video and data traffic.
- C. Switching capacity of at least 30 Gigabits per second with a throughput of at least 6.5 million packets per second (mpps). Throughput based on 64-byte packets.
- D. Per port multicast, broadcast, and unicast suppression (storm control) to prevent faulty end stations from degrading overall system performance.
- E. Snooping to limit bandwidth-intensive video traffic to only the requesters.
- F. Configured with fiber optic and copper Gigabit-Ethernet and Fast-Ethernet ports as required to meet with system performance herein specified or otherwise required to provide a complete and functional system.
- G. Capable of providing full powered PoE ports.
- H. Internet Group Management Protocol (IGMP) Snooping to limit bandwidth-intensive video traffic to only the requesters.
- I. Protocol Multicast to allow routing of traffic across Virtual LAN's.
- J. Supports QoS (quality of service) for prioritizing network traffic.
- K. Compatible with the fiber optic cable specified in Section 17120 - Security Electronics Fiber Optic Cable System. The Contractor shall utilize single mode or multi-mode fiber optic cable as required to meet the specified performance requirements. All converters and other necessary equipment shall be provided for the fiber optic cable selected.
- L. Shall be Cisco Catalyst 3750 Series Switch or approved equal.

2.02 LOCAL AREA NETWORK OUTLETS:

- A. Jacks: Each outlet shall have two EIA/TIA 568-B Category 6 UTP RJ-45 T568A modular type jack's with 10 style quick connect terminals. Tone jack shall be color coded the same color as the station Die jacket as confiner in Section— Security Electronics Conductors. Provide additional jacks per outlet as required.
- B. Cover plates: The cover plates for the outlets shall be in conformance (stainless steel, vinyl, etc.) with the cover plate requirements for duplex receptacles furnished and installed under Division

PART 3 - EXECUTION

3.01 INSTALLATION

- A. There are multiple systems utilize the same Local Area network. Boundaries shall be established by the Contractor to allocate network bandwidth to each of the systems. The bandwidth allocation shall be established by the Contractor to maximize efficiency, minimize the dominance of sub-system on the network!, eliminate "bottle necks", and establish priority of the sub-systems. The priority of the LC system shall be the highest.
- B. Switches shall be equipped with fiber optic and copper ports as required for system configurations as shown on the drawings and specified herein. Furnish and install 10"» spare Copper ports on each switch with a minimum of four. For PoE switches each spare part shall have full PoE power per IEEE 802.3af-2003.
- C. The Contractor shall provide fiber optic patch cables in quantities as required to interconnect all equipment as required to support the specific functions or applications of the drawings and specifications.
- D. Configure the system and program the software as required to affect the functions of the systems as dictated by the drawings and specifications.
- E. Install all Local Area Network switches in cabinets or racks.

- F. A full time modem connection for contractor access to the Local Area Networks shall not be permitted during or after construction. Temporary modem connections shall not be left unattended.

3.02 COMPLETION

- A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and leave the premises clean, neat and orderly.
- B. Testing: The completed system shall be tested by the SEC prior to the acceptance test.

END OF SECTION

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SECTION 28 0540 - SECURITY ELECTRONICS - INTERCOM / PAGING

PART 1—GENERAL

1.01 RELATED DOCUMENTS

- A. Provisions of the Contract and of the Contract Documents apply to this section.

1.02 SUMMARY

- A. This section includes the requirements and operational characteristics for an intercom system, which is an integral part of the SCS and integrated into the control stations. The intercom system includes:
1. Remote intercom stations, page speakers and speaker horns.
 2. Audio system head-end and control components.
 3. Control station audio components.
 4. Vehicle Loop Detectors and Intercom Pedestals.
- B. Provide all labor, equipment, materials, and supervision to install, program, calibrate, adjust, document, and test the total system as required herein and on the drawings.

1.03 SYSTEM DESCRIPTION

- A. Provide a PLC-controlled, facility-wide, intercom system, which is fully integrated with the SCS. The manufacturer of the intercom system, including the IP-based amps, shall be the PLC manufacturer. This system shall provide two-way intercommunication between control station(s) users and remote intercom stations. This system shall allow any remote intercom station to be answered by the control station in primary control of that particular area, or by the control station(s) in Central Control during a 'take-over' situation.

1.04 SYSTEM FEATURES AND SOFTWARE REQUIREMENTS

- A. The intercom system shall have the following system features and software requirements to allow for seamless control and future flexibility:
1. The audio system will be free from any 'popping', 'cracking', or 'humming' at all times.
 2. Provide all software and hardware necessary to provide digital audio recording to the SMS (reference section 28 46 19.26) of audio communications between control stations and remote intercom stations, speakers, and horns.
 3. Audio recording shall be transparent to the control station user both in station responsiveness and audio quality.
 4. Every control station shall have the capability to talk to any intercom station if desired by the owner. System shall provide for call forwarding/takeover from one control station to another.
 5. The intercom system shall interface with the CCTV system. When an intercom talk path is established, the CCTV system shall automatically call up any CCTV camera(s) on the spot monitor of the associated control station when the remote intercom station is in the camera(s) field of view.
 6. Each remote intercom station shall be annunciated on any control station in primary control of that intercom station or speaker's area. Reference section 28 46 19.13 for functionality requirements.
 7. Audio from remote intercom stations shall be driven through the control station computer speakers. Audio from the control station condenser microphone to the remote intercom station or page speaker shall only be active while the control station push-to-talk push button is depressed.
 8. The paging system shall have the capability of reaching individual areas of the facility, or the entire facility.
 9. The paging system shall have the capability of automatically playing pre-recorded sounds or messages when an alarm is received by the SCS.
 10. Remote intercom stations shall be programmed to call a designated control station when activated. If the designated control station is disabled or not logged in, the call shall be automatically forwarded to a secondary backup control station.

11. Dual Talk Paths shall be provided for all intercom stations in common controlled areas in order to allow simultaneous communications with intercom stations by the primary and central control stations. It is not required that the control stations be able to talk to the same intercom station at the same time.

PART 2—PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. The basis for most of the audio functions in this specification is a PLC-controlled intercom system. Provide all necessary PLC inputs and outputs to interface to the specified equipment for an operational intercom system. Audio control and field device components manufactured by companies other than those expressly approved shall not be acceptable.
- B. Remote Intercom Station
 1. Intercom stations shall be mounted directly into recessed, standard, readily available electrical back boxes.
 2. The station shall be vandal-resistant in design and shall be 11 gauge stainless steel with brushed finish. Tamper-proof mounting hardware as described elsewhere in this specification shall be provided.
 3. The station shall provide a momentary push-button type call-in switch. The switch assembly shall be of vandal-proof construction. The actuator shall be of metal construction.
 4. The station shall include a speaker-microphone. There shall be at least two baffles separating the speaker cone from the faceplate to prevent contact with the cone with a wire or other sharp object.
 5. Approved Remote Intercom Station:
 - a. Quam CIS4/25
- C. Call-In Only Station
 1. Call-in only stations shall be mounted directly into recessed, standard, readily available electrical back boxes.
 2. The station shall be vandal-resistant in design and shall be 11 gauge stainless steel with brushed finish. Tamper-proof mounting hardware as described elsewhere in this specification shall be provided.
 3. The station shall provide a momentary push-button type call-in switch. The switch assembly shall be of vandal-proof construction. The actuator shall be of metal construction.
 4. Approved Call-in Only Station:
 - a. Quam CIB2
- D. Page Speaker
 1. Page speakers shall consist of a 16 Watt speaker, a baffle, and appropriate back box for the required mounting. Provide all required transformers.
 2. Approved Page Speaker:
 - a. Surface Mount Speakers: Quam System 6VP
 - b. In-ceiling Speakers: Quam Solution1
- E. Speaker Horn
 1. The horn shall be suitable for exterior locations subject to direct water.
 2. The horn shall have a continuous power rating of 15 watts. The frequency range shall be 400Hz to 14,000Hz.
 3. The trumpet finish shall be beige baked epoxy. External connections shall be to screw terminals. The terminal housing and transparent cover shall function together as a cable strain relief. The trumpet shall be provided with a three-way adjustable mounting bracket.
 4. Approved Speaker Horn:
 - a. Quam QH16T
- F. Drive-up Intercom Pedestal
 1. Provide and install intercom pedestals as shown on the drawings.

2. Pedestals shall be constructed and mounted as shown on the drawings.
 3. Material shall be 12 gauge cold rolled steel, powder coated "safety yellow".
- G. Vehicle Detection Loop
1. The buried vehicle detection loop shall detect the approach of a vehicle and activate a 'call-in' on the associated control station. Once the operator answers the 'call-in', the associated intercom, if any, shall be activated, and the associated camera shall be automatically called up on the control station's spot monitor.
 2. The detection loop shall not be activated by a pedestrian and/or bicycle.
 3. The detector shall be installed such that it can be replaced without destroying the concrete/asphalt.
 4. The detection loop shall operate within the temperature range of -50 degrees to 140 degrees Fahrenheit.
 5. Approved Manufacturers:
 - a. Preferred Security Components, Inc.
 - b. U.S Traffic Corp.
 - c. EMX Industries, Inc.
- H. Single Channel Relay Selection Board
1. The relay selection board shall provide individual relay control of 16 speaker lines for intercom/paging. Provide all required PLC input and outputs for interface to relay selection board(s) for a fully-functional audio communications system.
 2. The board shall contain 16 control circuits, one per speaker line that shall provide for the selection of any line for intercom/paging. The board shall provide a common audio input for all 16 speaker lines. The board shall contain 16 relays that operate to connect the common audio input with the appropriate speaker lines as controlled by the intercom control circuits. The board shall contain a program bus that shall provide for program distribution to all speaker lines.
 3. The 16 panel relays shall be of sealed type construction with a life expectancy of 10,000,000 operations. Relay contacts shall be rated at 2A. Less than 0.75A at 12Vdc shall be required to operate all sixteen relays simultaneously.
 4. Boards shall be designed for wall mounted cabinets and shall provide for various switching of audio lines including page functions.
 5. The termination board shall have fifteen headers for audio threshold modules.
 6. Approved Single Channel Relay Selection Board:
 - a. MTI 81129 or equal
- I. Dual Channel Relay Selection Board
1. The relay selection board shall provide dual relay control of 16 speaker lines for intercom/paging. Provide all required PLC input and outputs for interface to relay selection board(s) for a fully-functional audio communications system.
 2. The board shall contain 32 control circuits, two per speaker line that shall provide for the selection of any line for intercom/paging. The board shall provide a common audio input for all 16 speaker lines. The board shall contain 32 relays that operate to connect the two common audio inputs with the appropriate speaker lines as controlled by the intercom control circuits. The board shall contain two program buses that shall provide for program distribution to all speaker lines.
 3. The 32 panel relays shall be of sealed type construction with a life expectancy of 10,000,000 operations. Relay contacts shall be rated at 2A. Less than 2A at 12Vdc shall be required to operate all thirty-two relays simultaneously.
 4. Boards shall be designed for wall mounted cabinets and shall provide for various switching of audio lines including page functions.
 5. Approved Dual Channel Relay Selection Board:
 - a. MTI 81229 or equal
- J. Digital Intercom Amplifier

1. Each control station shall communicate to remote intercom stations and paging speakers via a digital intercom amplifier. All communications between the control station and intercom amplifier shall be over Ethernet.
 2. Units shall have solid-state amplifiers capable of 4 watts RMS, with balanced inputs and balanced outputs for operations on 25-volt speaker lines.
 3. Units shall have 20dB of volume control.
 4. Frequency response shall be shaped to deliver maximum voice intelligibility, and hum and noise shall be at least 55dB below rated output.
 5. The speaker and talk/listen switch shall be integrated into the graphic control panels as shown on the drawings.
 6. The amplifier shall provide half-duplex operation during communication with remote intercom stations.
 7. Approved Manufacturer:
 - a. MTI 91743 or equal
- K. Paging Amplifier
1. Provide quantity and size as required to support the page zones as shown on the drawings. Paging amplifiers shall support all paging zones activated simultaneously.
 2. The paging amplifier shall be mounted in a standard 19-inch rack.
 3. Approved Manufacturers:
 - a. Atlas
 - b. Dukane
- L. Control Station Audio Components
1. The control station monitor's built-in speakers shall be used for digital audio communications. See section 28 46 19.13 for specifications of monitor.
 2. The microphone shall be a standard computer microphone plugged into the microphone input of the computer. The microphone shall have the following minimum specifications:
 - a. Sensitivity: -44+/- 3dB (0dB = 1 Pa, 1kHz)
 - b. Directivity: Omni-directional
 - c. Frequency: 20-16,000 Hz
 - d. Sensitivity reduction: Within -3dB at 2V
 - e. S/N ratio: More than 60dB

PART 3—EXECUTION

3.01 GENERAL

- A. All work required herein shall comply with section 28 05 00 Basic Materials and Methods for Electronic Systems.

END OF SECTION

SECTION 28 0545 - SECURITY ELECTRONICS - VIDEO SURVEILLANCE SYSTEM

PART 1—GENERAL

1.01 RELATED DOCUMENTS

- A. Provisions of the Contract and of the Contract Documents apply to this section.

1.02 SUMMARY

- A. Provide an IP Video Management System (VMS) which is fully integrated with the Security Control System.
- B. The VMS shall allow any remote camera to be viewed by monitors located in control rooms and controlled by the control station in primary control of that particular area, and by the control station(s) in Central/Main Control.
- C. Provide all labor, equipment, materials, and supervision to install, program, calibrate, adjust, document, and test the total system as required herein and on the drawings.

1.03 SYSTEM DESCRIPTION

- A. The IP video management system shall be an IP network-based, fully distributed digital video system. The security video system will utilize local area networks (LAN) as a transmission medium for video, configuration, as well as storage of all data.
- B. The security video system shall provide full video control at any point within the network from a workstation or a video console display. The security video system shall provide unlimited expansion capability for the addition or modification of video inputs.
- C. The IP video management system shall permit the normal and event monitoring of all secured areas on digital monitors as shown on the drawings or described in these specifications. Video monitoring stations shall be installed as shown on the drawings and described in these specifications.
- D. The Contractor shall furnish and install all security video cameras, mounts, housings, power supply systems, UTP cable, network cables, connectors, equipment racks, monitors and consoles, network switches, work stations, network video recorders, encoders, decoders, video console displays and all other hardware and software to provide a fully operational system.
- E. Review capabilities for the digitally recorded video via the secure network specified without interruption to recording capabilities.
- F. All cameras shall be recorded at each camera's maximum resolution and at 7fps. The system shall have enough storage to store the recorded video for thirty (60) days. Cameras shall be recorded on motion. An activity level of 60% shall be assumed for all cameras recording on motion.
- G. Network Video Recorders shall be configured using fault-tolerant RAID-5 drive arrays. Network Video Recorders shall be sized as specified herein and in the quantities as required to meet the storage requirements.
- H. The IP video management system shall have no restriction as to the resolution, frame rate, or number of standard resolution or mega pixel cameras that can be recorded, viewed, and managed on the system.
- I. The IP video management system shall be able to handle future expansion of an unlimited total capacity from what is shown in the drawings, including but not limited to cameras, monitors, alarm circuits and relay closures.
- J. The intent of this specification is to provide to the owner a networked digital security system supplied by the Contractor and shall be a complete and operational system per the performance requirements and objectives of these specifications. Contractor shall be responsible for the coordination of related work with other trades affecting his work or the work of others.

- K. All systems and components shall be provided with the availability of a toll-free (U.S. and Canada), 24-hour technical assistance program (TAP) from the manufacturer. The TAP program shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge for as long as the product is installed.
- L. All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and non-warranty items.

1.04 SYSTEM FEATURES AND SOFTWARE REQUIREMENTS

- A. The IP VMS shall have the following system features software requirements to allow for seamless control and future flexibility:
 - 1. Complete integration of video system with the PLC control system.
 - 2. All control stations shall have the ability to assign any camera to any monitor.
 - 3. The video system shall be programmed so that a description is associated with every camera. Contractor shall coordinate with owner.
 - 4. The video system shall provide for call-up of camera signals to assigned monitor locations based on pre-programmed responses to operator input utilizing the touch screen control stations.
 - 5. The video system shall be configured for automatic camera call-up for:
 - 6. Connected intercom calls.
 - 7. Duress Alarms

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Network Video Recording System (NVR) Manufacturer: Honeywell MAXPRO NVR SE Network Video Recording System, www.honeywell.com/security. Shall be the basis of design.
- B. Accepted Alternates: prior approved only during the bidding process. Other systems by Pelco or Bosch shall meet or exceed all aspects of this specification.

2.02 SYSTEM COMPONENTS

- A. NVR Server: The NVR Server shall contain the recording engine, database of all network-connected cameras and encoders, integrated components and their configurations. Server shall be provided as a combined hardware and software device.
- B. Workstation Software (NVR Client): The NVR Client software shall render video and act as a main human/machine interface.

2.03 OPERATIONAL REQUIREMENTS

- A. NVR shall provide a user-friendly graphical user interface (GUI) to configure the cameras, create schedules for recording, perform video surveillance and recording operations, and view various reports.
- B. NVR shall be configured to store and to view images captured by 64 cameras.
- C. NVR shall have following major capabilities:
 - 1. Record and monitor up to 64 IP channels HD per MAXPRO NVR SE. Network bandwidth/throughput supported per NVR with Incoming: 160 Mbps, Outgoing: 350 Mbps providing a total: 510 Mbps. Support for One-Way Audio (for specific IP cameras) with live, playback and clip export on NVR desktop client for up to 64 IP channels.
 - 2. Live viewing of up to 64 IP cameras on a single remote workstation with up to two (2) monitors set up at CIF resolution. For 4CIF and HD resolution, the number of live streams needs to be benchmarked based on client hardware configuration deployed. Cost-effective enhanced HD video rendering on remote desktop clients with support for monitoring of up to 14 1080p HD cameras in real time 1080p HD with no-time lapse using the GPU capabilities of in-built processor graphics with 4th generation Intel® Core™ Processors for client systems.
 - 3. Powerful investigation and video archive search tools from local or remote client.

4. Capable of managing motion detection-based recording with pre-event and post-event recording based on camera based motion detection or Server based motion detection events and "advanced" search on recordings from local or remote client.
 5. Preview and Calendar Search permitting search for videos and events based on user-selected date and time from local or remote client.
 6. Simultaneous use of multiple video compressions including MPEG-4 and H.264.
 7. Internationalization – supports the following languages: French, German, Russian, Italian, Spanish, Dutch, Arabic and English.
 8. Email on alarm.
 9. Instant clip creation from snapshot.
 10. Dynamic IP Camera Discovery – Automatically discover all compatible cameras connected to NVR.
 11. Multi-level user access rights for viewing and manages access to the recorder functions.
 12. Capable of managing continuous, scheduled, manual, event-based, and alarm-based recording features.
 13. Advanced security features with encryption support for communication between desktop client to NVR and secure https login for Web Client.
 14. Support for web client and mobile apps.
- D. Mode for User Login: NVR shall have the option of two modes of user logins:
1. Windows Authentication: Uses Windows logged-in user name.
 2. User DB Authentication: Uses preconfigured user name and password.
- E. Workstation (NVR Client) shall provide the following operator options:
1. Configuration: The operator (with Administrator privileges) shall have the option to configure the NVR. Live update of all configurations is supported. The following configurations shall be possible:
 - a. System Configuration: Provide options to configure the system level settings.
 - b. Camera Configuration: Provide options to add/edit/delete IP cameras and encoders.
 - c. Schedules: Provide options to configure schedule based recording for cameras connected to the NVR.
 - d. Input and Output: Provide options to configure camera input and output.
 - e. Sequences: Provide options to group a fixed number of cameras to view video.
 - f. User Management (Users and Roles): Provide option to add/edit/delete users.
 - g. Clip Deletion Settings: Provide the ability to automatically utilize more storage on event-initiated recording.
 - h. Independent deletion setting for continuous recording.
 - i. Independent deletion setting for event recording.
 - j. Surrounding Cameras: Provide option to grant a user the ability to view a single camera surrounded by the cameras programmed as the "Surrounding Cameras".
- F. Configurations for cameras connected to NVR:
1. Camera Configuration: The user shall be able to configure the following parameters for each camera connected to the NVR.
 - a. Camera Name
 - b. IP Address
 - c. Camera Type
 - d. Fixed/PTZ
 - e. Continuous Recording: All cameras added shall be defaulted to "24/7" recording with the option to select other recording modes.
 - f. Event Based Recording: Shall be "None" by default, with the option to select motion-based recording.
 - g. User name: Shall display and enable setting the user name for a camera.
 - h. Password: Shall enable setting the password for a camera.
 - i. Camera Advanced Settings: Shall enable configuration of Video Format, Compression Format, Resolution, Compression, Video Frame Rate, GOP, Record

- Quality Settings, Clip Deletion Settings, Launching Web View of camera for Advanced Setup, Motion detection zones configuration for Server based motion detection and Video Preview. Shall enable configuration of RTSP URL for cameras or encoders added with camera type – Generic RTSP.
2. The following video recording options shall be supported:
 - a. Scheduled based recording: The system shall support the ability to schedule recordings for each individual camera for times in the future. By default, the NVR shall be pre-loaded with the following four schedules: 24x7, Weekday, Daytime, and Nighttime, which cannot be edited. A maximum of 50 schedules can be created in the NVR.
 - b. User based recording: The user shall be able to configure user activated settings for recording moments of interest while viewing live video from a camera. After configuring the user activated settings, the operator can start recording of video when needed. The video is recorded for the time period specified in the System settings for user activated recording. The User based Recording Time Duration shall be selectable from a list of values ranging between 30 seconds and 5 minutes.
 - c. Event based recording: Event based recording shall be possible on Smart Video Motion Detection and alarm triggers. The NVR must be capable of managing motion detection-based recording with pre-event and post-event recording based on camera and Server-based motion detection events. The server-based Smart VMD analytics must be object-based and not traditional pixel-based, reducing false alarms due to changing light conditions, video noise, rain or other false alarm triggers that occur using pixel-based (traditional) VMD.
- G. Viewer: The NVR Viewer shall have the following minimum capabilities:
1. Main video viewing screen capable of showing 1, 4, 9, 16, and other customized split salvos of live or recorded video. Standard presets shall be customizable to the user preferences.
 2. Capable of saving current salvo as a View and allowing the user to drag this view at any later point in time.
 3. Capable of configuring and running scan sequences.
 4. Capable of adjusting the contrast, brightness, and saturation settings for each camera independently.
 5. Capable of exporting user selected image or video clips. A digital signature shall be attached to every exported clip.
 6. Capability to play back the video clips exported. Each video channel that is being recorded by the recording system shall be overlaid with text and a time stamp that is customizable by the user.
 7. Allow the user to initiate recording through the GUI or a controller.
 8. Capability of complete alarm management for the alarms coming from the NVR.
 9. Facility of surrounding camera view.
 10. Option to perform various operations through context menu on a particular video (live/recorded/sequence). These operations include: Full screen, point and drag, maintain aspect ratio, toggle text, digital PTZ, add bookmark, start recording, stop recording, mark in, mark out, save image, save image as, show surrounding cameras.
 11. Ability to manage timeline control of the recording device, which provides camera recording statistics. Timeline control shall have the following features: Mark input (with looping facility), bookmark, snapshot, time slider, time jump, play controls.
 12. Preference configuration including: frame rate of unselected panels, rendered type, preview pane, text display format.
- H. Search: The Search facility shall include search for recorded video and events based on date and time.
- I. Reports: The Report facility shall include event history report and audit log report.

2.04 NVR INTEGRATIONS

- A. NVR shall be compatible with the following interoperability standards:
 - 1. Physical Security Interoperability Alliance (PSIA)
 - 2. Open Network Video Interface Forum (ONVIF)
 - 3. Real Time Streaming Protocol (RTSP)
- B. NVR shall be compatible with the following Fixed and PTZ IP cameras:
 - 1. Honeywell Performance Series and eQulP® Series IP cameras
 - 2. Supports IP cameras from the following manufacturers. Please contact Honeywell for the complete list of manufacturers and models.
 - a. AXIS® Communications
 - b. Sony
 - c. Panasonic
 - d. Bosch
 - e. Samsung
 - f. Vivotek
 - g. Pelco
- C. NVR shall be compatible with the following encoders:
 - 1. Honeywell HVE Series Encoders
 - 2. Supports Encoders from the following manufacturers.
 - a. AXIS® Communications
 - b. Sony
 - c. Panasonic
 - d. Bosch
 - e. Samsung
 - f. Vivotek
- D. NVR shall be compatible with the following 360° Camera solutions.
 - 1. Onecam Grandeye
- E. NVR shall be compatible with the following IP Surveillance Control Keyboards:
 - 1. Honeywell HJK7000 UltraKey Plus
 - 2. Honeywell HJC5000 UltraKey Lite
 - 3. Or equal or better by Pelco or Bosch
- F. NVR shall be compatible with the following Multi-site Video Management Systems:
 - 1. Honeywell MAXPRO® Viewer
 - 2. Or equal or better by Pelco or Bosch
- G. NVR shall be compatible with the following Video Management Systems:
 - 1. Honeywell MAXPRO® VMS
 - 2. Or equal or better by Pelco or Bosch
- H. NVR shall be compatible with the following Access Control Security System:
 - 1. Honeywell Pro-Watch® Access Control System through MAXPRO® VMS and MAXPRO® Viewer
 - 2. Honeywell WIN-PAK® Access Control System
 - 3. Or equal or better by Pelco or Bosch
- I. Video Analytics supported through MAXPRO® VMS:
 - 1. Honeywell Active Alert
 - 2. Or equal or better by Pelco or Bosch
- J. IP Surveillance Control Keyboards supported through MAXPRO® VMS:
 - 1. Honeywell HJK7000 UltraKey Plus
 - 2. Honeywell HJC5000 UltraKey Lite
 - 3. Honeywell HJC4000 UltraKey Touch
 - 4. Or equal or better by Pelco or Bosch

2.05 SYSTEM HARDWARE

- A. MAXPRO NVR SE Server (Or equal or better by Pelco or Bosch)
- NVR Server shall operate with no performance degradation using the following minimum hardware and operating system configuration:
1. 2U 6 bay storage unit with SATA hard drives
 2. Processor: Intel® Core™ i7-4790, 3.6 GHz, Intel® HD Graphics 4600
 3. Memory: 8 GB
 4. Power supply: Single 400 W
 5. OS Partition: 100 GB partition in storage drive 1
 6. Operating system: Windows Embedded Standard 7, 64-bit SP1
 7. Database: Microsoft SQL Server Express 2008 R2
 8. Storage capacities: 1 TB to 36 TB with 6 bays – 1 operating system and storage drive, 5 field-upgradable, 1, 2, 3, 4 or 6 TB SATA hard drives
 9. Video Storage Hard Disk Options: 6 field-upgradable 1 TB, 2 TB, 3 TB, 4 TB or 6 TB SATA Hard Disk Drive options
 10. Optical drive: DVD-RW
 11. Network interface: Two 1 Gigabit Ethernet included
 12. Human Interface: 102-key keyboard and a mouse pointing device
 13. Monitor Output: Dual monitor support: HDMI, VGA, DVI-D, Display Port
 14. Rack kit: Rack kit for use with 2U chassis
- B. NVR Workstation: NVR Workstation shall operate with no performance degradation using the following recommended hardware and operating system configuration for rendering up to fourteen (14) 1080p HD cameras in real time @ 1080p HD with no time-lapse. Workstation configuration assumes two-monitor setup. Workstation is required for remote clients only; a local client is available on the NVR SE unit for configuration and monitoring. The performance specifications below are recommended for systems with fixed or PTZ cameras only. Oncom Grandeye 360 cameras are not supported with GPU rendering and use CPU rendering by default. On Windows 7 workstations, GPU rendering is only supported through the motherboard monitor outputs and any additional graphics cards should be disabled in BIOS.
1. Processor: Intel® Core™ i7-4790, 3.6 GHz or equivalent 4th generation Intel® Core™ Processors for client systems.
 2. Graphics Adapter: In-built Processor Graphics (GPU): Intel® HD Graphics 4600 or equivalent.
 3. System Memory (RAM): 8 GB
 4. Optical Drive: DVD-RW
 5. Hard Disk Drives: Single Disk or RAID 0 or 0+1 10K SATA 80GB or 10K to 15K SAS 73 GB.
 6. Network Interface Card (NIC): 1 Gbps
 7. Human Interface: 102-key keyboard and a mouse pointing device
 - a. Operating System: Microsoft® Windows 7 Professional 64-bit SP1

2.06 24" HD LCD MONITOR

- A. The flat panel LCD monitor shall have performance-enhancing features such as VGA, DVI and HDMI inputs, looping BNC output, and HD resolution.
- B. The flat panel LCD monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.
- C. The flat panel LCD monitor shall meet or exceed the following design and performance specifications:
1. Brightness 250 cd/m2 (typical)
 2. Contrast Ratio 1000:1
 3. Backlight Type LED
 - a. Refresh Rate 60 Hz
 4. Viewing Angle (H/V) 170°/160°

5. Response Time 5 ms
 - a. Native Resolution 1920 x 1080
 6. Panel Aspect Ratio 16:9
 7. Video Formats 480p, 576p, 720p, 1080i, 1080p
 8. Panel Life 30,000 plus hours
 9. Display Colors 16.7 million
 10. Speakers 2, internal (3W)
 11. Front Panel Controls Menu, source, down/up, power
 12. Indicators LED (power on/off)
 13. Power Consumption <33 W
 14. Input Voltage 100 to 240 VAC, 50/60 Hz
 15. Input/Output Interfaces 1 BNC; 1 S-Video; 1 HDMI; 1 DVI; 1 VGA
 16. Audio 1 3.5mm stereo jack
 17. Sync Format NTSC/PAL
 18. Operating Temperature 0° to 40°C (32° to 104°F)
 19. Operating Humidity 10% to 90%, noncondensing
- D. Approved Monitor
- a. Pelco PMCL524BL (Or equal)

2.07 32" HD LCD MONITOR

- A. The flat panel LCD monitor shall have performance-enhancing features such as VGA, DVI and HDMI inputs, looping BNC output, and HD resolution.
- B. The flat panel LCD monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.
- C. The flat panel LCD monitor shall meet or exceed the following design and performance specifications:
 1. Brightness 350 cd/m2 (typical)
 2. Contrast Ratio 3000:1
 3. Backlight Type LED
 4. Refresh Rate 60 Hz
 5. Viewing Angle (H/V) 178°/178°
 6. Response Time 6.5 ms
 7. Native Resolution 1920 x 1080
 8. Panel Aspect Ratio 16:9
 9. Video Formats 480p, 576p, 720p, 1080i, 1080p
 10. Panel Life 50,000 plus hours
 11. Display Colors 1.07 billion
 - a. Speakers 2, internal (10 W, 4 ohms x 2)
 12. Front Panel Controls Menu, source, down/up, vol +/-, power
 13. Indicators LED (power on/off)
 14. Power Consumption 120 W
 15. Input Voltage 100 to 240 VAC, 50/60 Hz
 16. Input/Output Interfaces Video 1 BNC, looping; 1 S-Video;
 - 1 DisplayPort; 1 HDMI; 1 DVI in; 1 VGA in, 1 VGA out,
 - 1 component
 17. Audio 2 audio in L/R, 1 PC audio in, 1 audio out L/R
 18. Sync Format NTSC/PAL
 19. Operating Temperature 0° to 40°C (32° to 104°F)
 - a. Operating Humidity 10% to 90%, noncondensing
- D. Approved Monitor
 - a. Pelco PMCL532BL(Or equal or better)

2.08 42" HD LCD MONITOR

- A. The flat panel LCD monitor shall have performance-enhancing features such as VGA, DVI and HDMI inputs, looping BNC output, and HD resolution.
- B. The flat panel LCD monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.
- C. The flat panel LCD monitor shall meet or exceed the following design and performance specifications:
 - 1. Brightness 500 cd/m2 (typical)
 - 2. Contrast Ratio 4000:1
 - a. Backlight Type LED
 - 3. Refresh Rate 60 Hz
 - 4. Viewing Angle (H/V) 178°/178°
 - 5. Response Time 6.5 ms
 - 6. Native Resolution 1920 x 1080
 - 7. Panel Aspect Ratio 16:9
 - 8. Video Formats 480p, 576p, 720p, 1080i, 1080p
 - 9. Panel Life 50,000 plus hours
 - a. Display Colors 1.07 billion
 - 10. Speakers 2, internal (10 W, 4 ohms x 2)
 - 11. Front Panel Controls Menu, source, down/up, vol +/-, power
 - 12. Indicators LED (power on/off)
 - 13. Power Consumption 150 W
 - a. Input Voltage 100 to 240 VAC, 50/60 Hz
 - 14. Input/Output Interfaces Video 1 BNC, looping; 1 S-Video; 1 Display Port, 1 HDMI, 1 DVI in, 1 VGA in, 1 VGA out, 1 component
 - 15. Audio 2 audio in L/R; 1 PC audio in, 1 audio out L/F
 - 16. Sync Format NTSC/PAL
 - 17. Operating Temperature 0° to 40°C (32° to 104°F)
 - 18. Operating Humidity 10% to 90%, noncondensing
- D. Approved Monitor
 - a. Pelco PMCL542BL(Or equal or better)

2.09 46" HD LCD MONITOR

- A. The flat panel LCD monitor shall have performance-enhancing features such as VGA, DVI and HDMI inputs, looping BNC output, and HD resolution.
- B. The flat panel LCD monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.
- C. The flat panel LCD monitor shall meet or exceed the following design and performance specifications:
 - 1. Brightness 500 cd/m2 (typical)
 - 2. Contrast Ratio 4000:1
 - 3. Backlight Type LED
 - 4. Refresh Rate 60 Hz
 - 5. Viewing Angle (H/V) 178°/178°
 - 6. Response Time 6.5 ms
 - 7. Native Resolution 1920 x 1080
 - 8. Panel Aspect Ratio 16:9
 - 9. Video Formats 480p, 576p, 720p, 1080i, 1080p
 - 10. Panel Life 50,000 plus hours
 - 11. Display Colors 1.07 billion
 - 12. Speakers 2, internal (10 W, 4 ohms x 2)
 - 13. Front Panel Controls Menu, source, down/up, vol +/-, power

14. Indicators LED (power on/off)
 15. Power Consumption 160 W
 16. Input Voltage 100 to 240 VAC, 50/60 Hz
 17. Input/Output Interfaces Video 1 BNC, looping; 1 S-Video; 1 Display Port, 1 HDMI,
1 DVI in, 1 VGA in, 1 VGA out, 1 component.
 18. Audio 2 audio in L/R; 1 PC audio in, 1 audio out L/R
 19. Sync Format NTSC/PAL
 20. Operating Temperature 0° to 40°C (32° to 104°F)
 21. Operating Humidity 10% to 90%, noncondensing
- D. Approved Monitor
- a. Pelco PMCL546BL(Or equal or better)

2.10 NETWORK DOME IP CAMERA

- A. The 1080p true day/night rugged minidome IP camera system shall meet or exceed the following camera specifications:
1. Image Sensor: 1/2.9-inch CMOS.
 2. Total Pixels: 1920 (H) × 1080 (V).
 3. Lens Type:
 - a. 2.8 mm fixed
 4. Angle of View:
 - a. Horizontal: 103° wide
 - b. Vertical: 59° wide
 5. Minimum Illumination: 0.18 lux color; 0.15 lux b/w @ 50 IRE, F1.2.
 6. Electronic Shutter Speed:
 - a. : 1/5-1/320000
- B. The 1080p true day/night rugged minidome IP camera system shall provide fully configurable motion detection settings.
- C. The 1080p true day/night rugged minidome IP camera system is designed to be surface mounted to a ceiling or wall.
- D. Approved Camera
1. Honeywell HC30W45R3 (Or equal or better by Pelco or Bosch)

2.11 NETWORK DOME PTZ IP CAMERA

- A. The HDZ Series true day/night indoor/outdoor IP PTZ dome camera system shall meet or exceed the following camera specifications:
1. Image Sensor: 1/2.8-inch Sony Progressive CMOS
 2. Total Pixels: 1920 (H) × 1080 (V); 1080p
 3. Optical Zoom:
 - a. HDZ22HD(X)/HDZ22HDE(X)/HDZ22HDIN(X): 22x
 - b. HDZ30HD/HDZ30HDE/HDZ30HDIN: 30x
 4. Focal Length:
 - a. HDZ22HD(X)/HDZ22HDE(X)/HDZ22HDIN(X): 4.3–3.72 inch
 - b. HDZ30HD/HDZ30HDE/HDZ30HDIN: 4.3–5.08 inch
 5. Focus Mode: Auto/PTZ trigger/Zoom trigger
 6. Iris Control: Auto/Manual
 7. Minimum Illumination: 0.5 lux (color) / 0.1 lux (B/W) @ F1.6
 8. Shutter Speed: 1/1–1/10,000 seconds
 9. Dual Audio Communication: Full-duplex, simplex (G.711/G.726 ADPCM)
 10. Communication: ONVIF Profile S support
 11. White Balance: Auto Tracking White Balance (ATW), Auto White Control (AWC), Indoor, Outdoor, Manual
 12. Signal-to-Noise Ratio: greater than 50 dB (AGC off)
 13. Backlight Compensation: On/Off

14. AGC: Auto/Manual (Max gain limit settings for Full Auto, Shutter Priority, and Iris Priority modes)
- B. The HDZ Series 1080p IP PTZ camera must be available with a 1080p super high-resolution color/monochrome (true day/night) advanced digital signal processing (DSP) camera and a 22X optical zoom 0.17 inch to 3.72 inch) or 30X optical zoom (4.3 mm to 5.08 inch). The HDZ Series 1080p IP PTZ cameras also support digital wide dynamic range (WDR).
- C. The HDZ Series 1080p IP PTZ color/monochrome (true day/night) camera shall utilize a 1/2.8" Sony Progressive CMOS technology with a minimum horizontal resolution of 1080p. The camera must provide sharp, detailed images down to 0.5 lux color, and 0.1 lux monochrome. When switching to monochrome mode, the camera must automatically remove the IR cut filter when necessary, which will increase the infrared sensitivity. When enough ambient light is available to produce an acceptable color image, the camera must automatically enable the IR cut filter. The HDZ Series 1080p IP PTZ camera must also utilize WDR technology, allowing for detail to be captured accurately even in high contrast scenes.
- D. The fully featured HDZ Series 1080p IP PTZ camera supports the following Protocols: IPv4/v6, TCP/IP, UDP, RTP, RTSP, HTTP, HTTPS, ICMP, FTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, Email, IEEE 802.1x, QoS, ONVIF.
- E. The HDZ Series 1080p IP PTZ camera shall be comprised of a high-speed pan/tilt assembly using precision stepper motors with a high-strength belt drive, resulting in quiet and accurate operation.
- F. The HDZ Series 1080p IP PTZ camera shall transmit images in simultaneous dual streams: H.264 and motion JPEG (MJPEG). The streams shall have the following features/functions:
1. Support for 1080p resolution (1920x1080) at 30 frames per second (NTSC) and 25 frames per second (PAL). The camera can also support lower resolutions: 720p, 1280x1024, 1024x768, 800x600, 640x480, D1: 720x480(NTSC)/720x576(PAL), CIF: 352x240(NTSC)/352x288(PAL) resolutions. Lower resolution frame rates (720p and lower) available at 60 frames per second (NTSC) and 50 frames per second (PAL).
 2. The HDZ Series 1080p IP PTZ camera shall transmit additional H.264 or MJPEG video streams simultaneously with the primary H.264 or MJPEG stream (up to 4/quad streams).
 3. The bit rate for the H.264 and MJPEG streams can be set to constant or variable bit rate. The resolutions and frame rates for all streams are adjustable by the administrator.
 4. The fully featured HDZ Series 1080p IP PTZ camera shall support three (3) H.264 profiles: High profile, Main profile, and Baseline profile.
- G. The HDZ Series 1080p IP PTZ camera shall include, as standard, a web based GUI that provides complete control of the IP PTZ dome settings. The web based GUI shall:
- a. Permit three (3) users @ 1080p resolution or five (5) users @ D1 resolution in simultaneous unicast.
 - b. Provide multiple user access levels with password protection.
 - c. Offer video access from a web browser. The web browser shall offer live viewing for up to three (3) users @ 1080p resolution or five (5) users @ D1 resolution with full-control of all camera settings available to the administrator.
 - d. Be easily discovered through Honeywell Device Search Tool or other appropriate device search tools.
 - e. Be available to record streaming video or snapshot images to a PC hard disk. The administrator/user must have the ability to turn the recording function on or off through the web based GUI.
 - f. Require the following hardware as a minimum for the web browser:
 - 1) Operating system: Windows 7 (32-bit/64-bit)
 - 2) Processor: Intel® Pentium® 4 processor, 3 GHz or faster
Intel® Core™2 Duo processor, 2 GHz or faster
 - 3) System memory (RAM): 1 GB (32-bit)
 - 4) Graphics card: AGP graphics card 64 MB RAM, DirectDraw
 - 5) Network card: 10Base-T (10 Mbps) or 100Base-TX (100 Mbps) operation

- 6) Web browser: Microsoft Internet Explorer 8.0 or later
 - 7) Viewer: ActiveX control plug-in for Internet Explorer
- H. The HDZ Series 1080p IP PTZ camera shall feature web GUI menus for programming dome parameters. A minimum of the following menus must be available:
- 1. Language
 - a. English
 - b. Czech
 - c. German
 - d. Spanish
 - e. French
 - f. Italian
 - g. Portuguese
 - h. Russian
 - i. Simple Chinese
 - j. Traditional Chinese
 - k. Dutch
 - l. Polish
 - m. Japanese
 - n. Display Options
 - o. Camera Message
 - p. Pan azimuth and the tilt elevation direction
 - q. Zoom Msg.
 - r. Change Camera Name
 - s. Time and Date
 - 2. Control Options
 - a. Program Alarms
 - b. Program Motion Detection
 - c. Program Network Failure Detection
 - d. Program Periodical Event
 - e. Program Network parameter/security
 - f. Schedule Recording to micro SD card/Network share recording
 - g. Event Recording to micro SD card/Network share recording
 - h. Recording file down load from micro SD card/Network share recording
 - i. Set Default Function
 - j. Auto Focus by three (3) modes
 - k. Diagnostic Options
 - l. View Parameter List
 - m. System log
 - n. Restore Default Settings
 - o. Camera Parameter Reset
 - p. Export and Import system configuration parameter
 - 3. Camera Options
 - a. Zoom and Focus
 - b. Exposure Control
 - c. White Balance
 - d. BLC
 - e. Flip – Mechanical/Image/Off
 - f. Rotate – Flip/Mirror/Inverse/Portrait
 - g. ICR function
 - h. Speed by zoom
 - i. WDR
 - j. 2D NR

- k. 3D NR
 - l. Motion Detection
 - 4. Function Programming
 - a. Program a Mimic Tour
 - b. Program a Preset tour
 - c. Program a Auto pan
 - d. Program Privacy zone
 - e. Program Home
- I. The HDZ Series 1080p IP PTZ camera shall include, as standard, the following PTZ features and functions:
 1. Incorporates a sealed, precision gold slip ring to provide three hundred sixty degrees (360°) of continuous rotation. The dome must automatically adjust pan and tilt speed in proportion to the zoom position for greater control. The same amount of picture shall appear to move across the monitor regardless of the zoom factor. Manual pan speeds must range from 0.5° to 200° per second, and manual tilt speeds must range from 0.5° to 84° per second.
 - a. Provides for three (3) auto focus modes: PTZ trigger focus, Zoom trigger focus, and Continuous auto focus. When the scene requires extra-fine control, the dome must allow the operator to override the auto focus settings. Auto iris with manual override must also be standard.
 2. Eight (8) mimic or learned tours. The administrator or user with privilege shall perform a series of pan, tilt, zoom movements that the dome must “learn”, when the pattern is recalled, the dome automatically repeats the movements. The duration of each pattern can be up to two (2) minutes or more.
 - a. Support for up to eight (8) programmable preset tours, each with up to sixty-four (64) preprogrammed positions. Each position can include a preset position, the speed, and the dwell time (dwell time defines the time the dome rests before going to the next preset position). The tour can be programmed to run continuously until halted by the operator. All programming of preset tours shall be done utilizing simple web GUI controls. A list of each dome’s programmed preset tours, displaying the tour numbers and titles, must be available for viewing on the web client.
 3. In order to quickly identify the specific PTZ an operator is viewing, the HDZ Series 1080p IP PTZ camera shall contain a text overlay with an up to 20-character on-screen display. This text overlay should be editable by the administrator.
 - a. Sixteen (16) programmable Dynamic Privacy Zones, which are protected by the Admin password, or a user who has the privilege.
 4. Incorporates flash memory to protect the programming for the privacy zones if power is lost. The flash memory shall retain the programming for a minimum of twenty (20) years.
 5. If the privacy zones have been programmed and the unit loses power, the video will remain blank until the PTZ dome finds its index position to prevent any area behind programmed privacy zones from being visible when power is restored.
 6. Include auto-pivot tracking (flip) circuitry to allow the dome to automatically turn 180-degrees when reaching its lower limit. This allows the administrator or user with privilege to automatically track an individual moving directly below the camera. The administrator must have the ability to enable or disable this feature using a web GUI menu. The HDZ Series 1080p IP PTZ camera shall be able to flip the image when tilting crosses the 90° direction.
 7. Supports auto-homing to activate a preset tour, mimic tour, or a preset position after a specified period of inactivity, programmable from one (1) to one hundred and twenty-eight (128) minutes.
 8. Able to set emulated joystick mode and set center mode. For emulated joystick mode, the PTZ will go pan/tilt by the mouse left button click on the live view image area. For set center mode, the PTZ will set the point to the center of the live view image by the mouse left button click on the image. The administrator shall also have the ability to enable the

- dome for a -10° tilt limit, allowing the unit to view slightly above the horizon without permitting the operator to view the inside of the housing.
9. Displays the pan azimuth and the tilt elevation/declination, in degrees, on the video. The administrator must have the ability to turn the coordinates on or off.
 10. Displays date and time in the video for viewing/recording. The administrator must have the ability to turn it on/off. The HDZ IP PTZ Series shall allow the administrator to enter an alphanumeric camera ID/name and insert the ID/name in to the video for viewing on a monitor (add text overlay on video). In addition, a digital zoom label shall be available on the video to display the current digital zoom magnification when zoom in/out. The administrator must have the ability to turn both IDs/names on or off.
- J. The HDZ Series 1080p IP PTZ camera must provide the option of restoring all displays, alarms, camera settings, and diagnostic settings to factory default with a Web GUI command. In addition, the unit shall offer a simple “reboot” with a Web GUI command.
 - K. The HDZ Series 1080p IP PTZ camera should provide a warning message through relay output/FTP/Email/HTTP, upload an image through FTP/Email or record video to a micro SD card/network recorder upon motion detection. The administrator must have the ability to turn the motion detection function on or off through the web GUI.
 - L. The HDZ Series 1080p IP PTZ camera should provide a warning message through relay output/FTP/Email, or record video to a micro SD card upon network failure detection, the minimum detecting period is 5 seconds. The administrator must have the ability to adjust the detecting period and turn the network failure detection function on or off through the web GUI.
 - M. The HDZ Series 1080p IP PTZ camera should provide a warning message through relay output/FTP/Email, upload an image through FTP/Email, move to a function line (move to Preset, Preset Tour, Auto pan, Mimic Tour) or record video to a micro SD card/network recorder when an alarm in signal occurs. The administrator must have the ability to turn the alarm function on or off through the web GUI.
 - N. The HDZ Series 1080p IP PTZ camera should provide micro SD card recording for backup when there is an event (Alarm, Motion detection, Network failure detection) or scheduling. The administrator must have the ability to turn the recording function on or off through the web GUI.
 - O. The micro SD card storage size can be varied from 8 GB to 64 GB. 64 GB has only been applied on SanDisk SDXC 64 GB. The micro SD card can be inserted, replaced or removed by the installer or the user. The HDZ Series 1080p IP PTZ camera does not come with a micro SD card installed. It is recommended to use a high quality micro SD card for recording, with the following minimum specifications:
 1. 8 GB MicroSDHC card (Class 10). (Notes: MLC).
 2. 16 GB MicroSDHC card (Class 10). (Notes: MLC/TLC).
 3. 32 GB MicroSDHC card (Class 10). (Notes: TLC).
 4. 64 GB MicroSDXC card (Class 10). (Notes: TLC).
 - P. The HDZ Series 1080p IP PTZ camera shall provide Network share recording for backup when there is an event (alarm, motion detection) or scheduling. The administrator must have the ability to turn the recording function on or off through the web GUI.
 - Q. The HDZ Series 1080p IP PTZ camera shall include four (4) on-board alarm inputs for normally open or normally closed dry contacts. The dome shall have the ability to go to a preset position, start a preset tour, or start a mimic tour when an alarm occurs. The dome must insert “A” and the alarm pin number to the video signal display for viewing on the monitor until the alarm returns to its normal state. When more than one alarm occurs, the latest alarm will be performed.
 - R. The HDZ Series 1080p IP PTZ camera shall include two (2) on-board alarm outputs for normally open or normally closed dry contacts. The dome shall have the ability to perform the relay out signal to the alarm equipment.
 - S. The HDZ Series 1080p IP PTZ camera shall be available in indoor configurations designed for installation of in-ceiling bracket (HDZINBKT), in-ceiling back can (HDZHINKIT) and pendant

mount configurations. The bottom domes must be designed to blend in with building aesthetics and shall be constructed of vacuum-formed, optically-graded acrylic available in smoke and clear IK10-rated finishes. Units include the clear IK10-rated acrylic as standard (only the outdoor units HDZ30HDE, HDZ22HDE, and HDZ22HDEX meet the IK10 impact resistance rating). Trim rings must be available in white finishes.

- T. The HDZ Series 1080p IP PTZ camera shall be available in a pendant housing specifically designed for installation in an outdoor environment, with an integral resistive type thermostat-controlled 24 V AC heater and blower to maintain a sufficient operating temperature. The pendant housing shall be IP66 rated. The bottom domes shall be designed to blend in with building aesthetics and shall be constructed of vacuum-formed, optically-graded acrylic available in smoke and clear IK10-rated finishes. Units include the clear IK10-rated acrylic as standard (only the outdoor units HDZ30HDE, HDZ22HDE, and HDZ22HDEX meet the IK10 impact resistance rating). Available mounting options shall include pendant, wall, roof, and parapet, as well as pole and corner adapters.
- U. The HDZ Series 1080p IP PTZ camera shall be available with Vandal Proof Acrylic/bubble for indoor or outdoor environments with tamper-resistant screws. The Acrylic/bubble shall be designed to blend in with building aesthetics and shall be constructed of optically-graded acrylic available in smoke and clear IK10-rated finishes. Units include the clear IK10-rated acrylic as standard (only the outdoor units HDZ30HDE, HDZ22HDE, and HDZ22HDEX meet the IK10 impact resistance rating). The unit shall have an Industry standard 1.5" NPT connections that shall work with all existing Honeywell PTZ mounts and brackets. The PTZ dome should be protected from direct sunlight in hot climates.
- V. Approved PTZ Camera
 - 1. Honeywell HDZ Series. (Or equal or better by Pelco or Bosch)

2.12 NETWORK DOME 360 IP CAMERA

- A. The camera shall be IP-rated for ingress protection against dust and moisture such that it is suitable for indoor and outdoor use.
- B. The camera shall be designed to provide H.264 and Motion JPEG video.
- C. The camera shall support resolutions up to 3200 x 3000 pixels.
- D. The camera shall provide video up to 30 frames per second.
- E. The camera shall operate on a embedded Linux platform and include a built-in web server.
- F. The camera shall be manufactured with solid state electronics with no moveable components.
- G. The camera shall have both FTP and server capabilities.
- H. The camera shall support a SD memory card.
- I. Approved 360 IP camera.
 - 1. Oncam Grandeye Evolution 12MP (or Equal or better)

2.13 CAMERA HOUSINGS, SUPPORTS AND ACCESSORIES

- A. Provide all accessories to accomplish the specified mount according to the camera schedule.
- B. All cameras shall be mounted with required housings for a complete installation. All housings must be vandal resistant.
- C. Wall mounted cameras shall be provided with appropriate mounting arms and brackets.
- D. All camera back boxes in plenum areas shall be plenum rated per the NEC.
- E. Provide all necessary fiber media converters for cameras designated to use fiber cabling in the camera schedule. Fiber media converters at camera locations shall be located within the camera housing/bracket or a separate NEMA 4X enclosure. Rack mounted fiber media converters shall be provided at head end locations.
- F. Provide 24 VAC power supplies as required to provide power to all cameras using fiber cabling. Power supplies shall be rack mounted and each output must be individually fused.

- G. Cameras located in inmate cells shall be mounted as close as possible to the corner of the cell and towards the ceiling to obtain the greatest possible view of the room.

PART 3—EXECUTION

3.01 GENERAL

- A. All work required herein shall comply with section 28 05 00 Basic Materials and Methods for Electronic Systems.

END OF SECTION

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SECTION 28 0550 - SECURITY ELECTRONICS - ELECTRONIC MONITORING AND CONTROL SYSTEM

PART 1—GENERAL

1.01 REFERENCE STANDARDS

- A. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

1.02 RELATED DOCUMENTS

- A. Provisions of the Contract and of the Contract Documents apply to this section.

1.03 SUMMARY

- A. This section includes the requirements and operational characteristics for the Programmable Logic Control (PLC) System.

1.04 SYSTEM DESCRIPTION

- A. The PLC System provides the logic control for the SCS. Unless noted otherwise, all user-initiated interfaces to the PLC system is performed through the control stations (reference section 284619.13).
- B. The PLC System CPU program(s) shall execute all system commands and operations. The control station(s) are for operator interface only. All control functions are to be executed by the PLC CPU program(s).
- C. The SCS network shall be a distributed, fault-tolerant network. PLC CPU or communication failures shall not affect other PLC's or control station(s) on the network.

1.05 SYSTEM REQUIREMENTS

- A. Provide a complete and fully functional Ethernet based PLC System using materials and equipment of types, sizes, and rating, as required to meet performance requirements. Use materials and equipment that comply with referenced standards and manufacturer's standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- B. All components of the PLC System shall be regularly sold to the corrections market. The PLC manufacturer must advertise its policies on backwards compatibility. The PLC manufacturer must guarantee the availability of spare parts for the life of the facility.
- C. A licensed copy of the PLC programming software shall be provided on each control station computer. Unlocked copies of all jobs specific files shall be provided to the owner as part of the as-built package.
- D. The PLC manufacturer will provide unlimited free training for owner representatives at the manufacture's facilities. The manufacturer shall not be responsible for travel expenses.
- E. Modular components of the system shall be UL 294 listed or recognized.

PART 2—PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. PLC Central Processing Unit
 - 1. The central processing unit (CPU) shall be microprocessor based and shall provide the logic control functions and data transfer based upon the program stored in memory and the status of the inputs and outputs. The controller must be able to support up to 4,096 input and outputs.
 - 2. All PLC communications shall be done over a single Ethernet port.
 - 3. The PLC Network shall follow the network guidelines previously set forth in these specifications.
 - 4. The minimum standard control functions of the CPU shall include:
 - a. Higher Language Programming (spread sheet type format).
 - b. Latching relays

- c. Timer clock pluses (.02s, 1s, 0.2s, 1s, & 1m) and timers (.01 & 0.1 sec. Increments).
 - d. Counters (up/down)
 - e. Data comparison (=, >?, <?), data range comparison, and data table comparison.
 - f. One-shot output and input controls.
 - g. Master control relays (interlocks)
 - h. I/O Refresh on command, immediate I/O inputs, and scheduled interrupt on command.
 - i. On-line program edit capabilities.
5. The following minimum modes of operation of the CPU must be selectable using programming software commands:
 - a. PROGRAM – Processor is not scanning program in memory and all outputs are held OFF.
 - b. MONITOR – Processor is executing program and changes in user memory and data memory are allowed
 - c. RUN – Processor is executing program in memory and outputs are controlled by the program. No editing of program or data registers is allowed.
 6. The above settings shall require using programming software loaded on a computer to change the operating mode of the CPU.
 7. The processor shall incorporate extensive self-diagnostic features, which will not halt the processor. In addition, separate visual indicators will annunciate at the following conditions:
 - a. POWER – Logic power is applied to the CPU and I/O rack from the power supply.
 - b. RUN – Processor is executing the program in memory and outputs are being controlled according to the program.
 - c. NETWORK ACTIVITY – Indicating the CPU communication with the network.
 - d. NETWORK LINK – Indicating the CPU is connected to a network.
 8. In addition to visual self-diagnostic indicators (LEDs) the processor shall have a specifically designated block of at least 100 words and bits. These shall provide more detailed system status and fault diagnostic information accessible by programming equipment or intelligent peripherals.
 9. The processor must contain an error log area. This area must be able to log what error occurred and when the error happened, giving exact time and date. This area must be able to store a minimum of 1,000 records.
 10. The PLC shall support a web browser interface for configuration and diagnostics.
 11. The PLC shall be UL 294 listed.
 12. Approved PLC:
 - a. MTI 91795 Embedded Controller or Equal
- B. Data Module
1. The module shall support 8 independent data channels. Each channel must support up to 64 inputs and outputs.
 2. All communications between the PLC and data module shall be Ethernet based.
 3. Each data module shall distribute all power to the local discrete I/O modules and termination boards.
 4. Data Modules shall be powered by a 12V DC power supply and shall be capable of supplying up to 12 watts of power to each data channel.
 5. The data module shall be UL 294 listed.
 6. Approved Data Module:
 - a. MTI 91620 Data Module or Equal
- C. Discrete I/O Module
1. Each discrete I/O module shall be a self-contained unit housed within an enclosure so that no part of its circuit board is exposed to contact by handling.
 2. Discrete I/O modules shall be UL listed.

3. It shall be possible to replace any I/O module without removing or disturbing user field wiring.
 4. All I/O modules units shall be solid state in nature. The output units shall be transistor types for long life and high DC reliability.
 5. I/O modules should control 16 outputs and monitor 16 inputs.
 6. The I/O modules shall communicate with the Data Module
 7. I/O updates shall take no longer than 50 milliseconds.
 8. The discrete I/O module shall be UL 294 listed.
 9. Approved Discrete I/O Module:
 - a. MTI: 81650 Decoder or Equal
- D. Electric Lock Termination Board
1. Provide an electric lock termination board between the PLC and electric locks, door position indicators, door operators and door control components.
 2. If the door hardware allows, the system shall monitor the status of the door position and lock position switches. The door position and lock position switches shall be terminated in series at the door and shall be monitored by a single input to the PLC.
 3. Each locking termination board shall provide terminations for 16 doors and shall have the following features:
 - a. Normally open, normally closed, fused line, and common connections per address for door control
 - b. Door status input per address
 - c. Input supervision
 - d. Socket relay connectors
 - e. Individually fused door lock circuits
 - f. Capability of providing isolated line voltages to the first and last eight addresses
 - g. Pluggable, screw type connectors for field device terminations
 4. Provide low voltage power supplies as needed at each termination board to provide power to locking devices. 120VAC shall be provided by the electrical contractor at each termination board as needed for locking devices. Roll-up door or gate operators shall have a dedicated power circuit provided by the electrical contractor. Special low voltage power supplies required to be installed in close proximity to REX locking devices shall be provided and installed by others.
 5. The lock termination board shall be UL 294 Listed.
 6. Approved Electric Lock Termination Board:
 - a. MTI #81623 or Equal
- E. Relays
1. All locks shall be controlled using mechanical relays. The relays shall plug into the locking termination board. Each relay shall have a normally open and closed output rated at a minimum of eight amps.
 2. Approved Relay:
 - a. Omron G2R-1 Series or Equal
- F. Input Termination Board
1. Provide an input termination board between the PLC and all dry contact input devices.
 2. Each input termination board shall provide terminations for 16 inputs and shall have the following features:
 - a. Input supervision
 - b. Pluggable, screw type connectors for field device terminations
 3. The input termination board shall be UL 294 Listed.
 4. Approved Input Termination Board:
 - a. MTI #81222 or Equal
- G. PLC Programming Software

1. The PLC programming should be done in high level language (such as a spreadsheet format). Ladder logic programming is acceptable, but the PLC supplier shall provide unlimited technical support at no charge to the end user.
 2. It shall be possible to program and monitor any PLC from a single host computer via the LAN.
 3. Programming software must be compatible with all current Microsoft operating systems.
 4. It shall be possible to delete part of the program without affecting the remainder of the program.
 5. It shall be possible to force any input, output, or internal bit ON or OFF using the programming software.
 6. The programming software shall protect access to the schedules using passwords.
 7. Approved PLC Software:
 - a. MTI PLC Software or Equal
- H. Logic Power Supplies
1. Logic Power Supplies feed power to the PLC, Data Modules, Intercom Amplifiers, and Discrete I/O Modules.
 2. Power supplies should be sized per manufacturer's recommendation.
 3. Power supplies for the Data Modules and Discrete I/O Modules shall be din rail mountable.
 4. Power supplies should accept an input voltage range of 90-264VAC.
 5. Approved Manufacturer:
 - a. Lambda DSP Series or Equal

PART 3—EXECUTION

3.01 3.1 GENERAL

- A. All work required herein shall comply with section 28 0500 Basic Materials and Methods for Electronic Systems.

END OF SECTION

SECTION 28 0580 - SECURITY ELECTRONICS - DOOR CONTROL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Work of this Section.

1.02 SUMMARY

- A. This section covers the door control system shown on the drawings or as required to support the systems defined in these specifications. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the
- B. Related Work Specified Elsewhere: Refer to all other Security Electronics System specification sections and drawings, and to the specifications and drawings under the General Construction Contract to ascertain the extent of work included

1.03 SUBMITTALS

- A. Submittals shall be packaged in accordance with specification Section 28 0500 - Security Electronics - Basic Materials and Methods of these specifications.
- B. Product Data Submittal: Submit wiring diagram of door relay interface boards.
 - 1. National Electrical Code

1.04 DELINEATION OF DOOR CONTROL INTERFACE RESPONSIBILITIES

- A. The SEC's Responsibilities shall include the following:
 - 1. Coordinate with specific electrical mechanical hardware used by the Builders Hardware Installer for builders hardware and the Detention Equipment Sub- Contractor for security hardware to ensure that the specified electrical mechanical hardware can perform the functions and operations required by the Security Electronics System. review both current and voltage ratings of all switches. provide written notification of any discrepancy between the Security Electronics requirements and the Division 8 electric door hardware requirements.
 - 2. Provide control conductors from the SCC to the electrical mechanical locks and devices specified in Division 8.
 - 3. Connect the control conductors to the electrical mechanical lock and device connector "pigtails" at the door. Connect the control conductors to the Electronics System in the SCC
 - 4. Provide relay interface equipment in the SCC to interface the Security Electronics System with the electrical mechanical locks and devices.
 - a. When the electrical mechanical lock and device operate single phase 120 volts:
 - 1) 120 volts or less:
 - (a) Extend control power from the SCC to the electrical mechanical lock and device.
 - (b) Evenly distribute electrical loads in each SCC over all three phases (where applicable) to avoid overloading one phase.
 - b. Electrical mechanical lock and device operate at greater than single phase 120 volts:
 - 1) Extend low voltage control circuits from the SCC to the electrical mechanical lock and device.
 - 2) Coordinate power interface with Electrical Sub-Contractor.
 - 5. Provide all control hardware and systems including power supplies as required to control and monitor the electrical mechanical locks and devices in accordance with the requirements of the Security Electronics Specifications and drawings with the wiring diagrams provided by the Detention Equipment Sub-Contractor.
 - a. Some Builders Hardware electrical mechanical locks may require a specific power supply that is either listed with the hardware or is identified by the electrical mechanical lock manufacturer as no-equal. These power supplies shall be furnished by the Detention Equipment Sub-Contractor but installed by the SEC. Where allowed by

code and the manufacturer, these power supplies shall be installed in the SCC. Conductor size between power supply and electrical mechanical locks shall be increased as necessary.

6. Verify proper operation of all electrical mechanical locks and devices after installation.
 7. Coordinate all interfaces with the Fire Alarm System interface that may be required from the door control system. Connect Fire Alarm System door release circuits to the door lock and device power supplies as required to release specific doors upon alarm notification in designated building areas.
- B. Detention Equipment Sub-Contractor responsibilities shall include the following:
1. Furnish wiring drawings and other information as required for design and installation of the door control system. Shop drawings shall be furnished to the SEC for coordination and installation.
 2. Provide boxes or pockets in the door frame for the door position switches, locks, keyswitches, push buttons, etc.
 - a. Extend the lock pocket to accommodate jamb mounted push buttons and/or keyswitches or provide a means to install and maintain these devices.
 - b. Provide interconnecting conduit in the door frame to interconnect the boxes and pockets.
 3. Provide door locks, door position switches, limit switches, lock feature switches, key switches, and push buttons for the system to perform the functions specified throughout all specification sections
 - a. Locking hardware that has direct current (DC) solenoids shall include diodes for transient protection.
 4. Interconnect all components described herein to a cable harness that provides single point of interconnection for the SEC.
 - a. For swing doors, the interface point between the door control system and the door hardware shall be the lock pocket. For sliding doors, the interface point between the door control system and door hardware shall be a junction box in the transom and shall be shown on the shop drawings.
 - b. The cable harness shall include a 6 inch minimum "pigtail" terminated with Molex type connectors. This connector(s) shall provide all of the interconnection between the components at the door and the door control system.
 5. Adjust all locks and switches for proper mechanical alignment after installation. The door position switch shall be adjusted to provide an open indication before the door or gate is opened far enough to provide a 1/16 inch gap between the strike plate and the lock.
- C. The Builders Hardware Installer's responsibilities shall include the following:
1. Furnish wiring drawings and other information as required for design and installation of the door control system. Shop drawings shall be furnished to the SEC for coordination and installation.
 2. Some electrical mechanical locks and devices may require a specific power supply that is either listed or packaged with the hardware. These power supplies shall be furnished by the Builders Hardware installer and connected by the SEC.
 3. Provide boxes or pockets in the door frame for the door position switches, locks, keyswitches, push buttons, power transfer hinges, etc.
 - a. Extend the lock pocket to accommodate jamb mounted push buttons and/or keyswitches or provide a means to install and maintain these devices.
 - b. Provide interconnecting conduit in the door frame to interconnect the boxes and pockets.
 4. Provide door locks, door position switches, limit switches, lock feature switches, keyswitches, and push buttons for the system to perform the functions specified throughout all specification sections.
 - a. Locking hardware that has direct current (DC) solenoids shall include diodes for transient protection.

5. Interconnect all components described herein to a cable harness that provides a single point of interconnection for the SEC.
 - a. For swing doors, the interface point between the door control system and the door hardware shall be the lock pocket. For sliding doors, the interface point between the door control system and the door hardware shall be a junction box in the transom and shall be shown on the shop drawings.
 - b. The cable harness shall include a 6 inch minimum "pigtail" terminated with Motex type connectors. This connector(s) shall provide all of the interconnection between the components at the door and the door control system.
6. Adjust all locks and switches for proper mechanical alignment after installation. The door position switch shall be adjusted to provide an open indication before the door or gate is opened far enough to provide a 1/16 inch gap between the strike plate and the

1.05 SYSTEM DESCRIPTION

- A. Door control system shall be controlled by the Programmable Logic Controller which shall accept the various inputs from the system being interfaced with the doors and cause operations described in this Section and elsewhere in the documents and provide outputs to the various door systems.
- B. Type A1 - Sliding door or gate:
 1. Touch screen/control panel controls and indicators shall be provided as described in Section 28 51 70 — Security Electronics Touchscreen Control System and Section 28 53 00 — Security Electronics Control Panels and Consoles.
- C. Type A2 — Sliding or roll-up vehicle door or gate::
 1. Touch screen controls and indicators shall be provided as described in Section — Security Electronics Touchscreen Control System.
- D. Type B - Swing door or gate:
 1. Touch screen controls and indicators shall be provided as described in Section — Security Electronics Touchscreen Control System
- E. Type C1 - Sliding inmate cell door.
 1. Touch screen/control panel controls and indicators shall be provided as described in Section 28 5170 - Security Electronics Touchscreen Control System and Section 28 5300 - Security Electronics Control Panels and Consoles.
- F. Type C2 - Swing inmate cell door:
 1. Touch screen/control panel controls and indicators shall be provided as described in Section 28 5170 - Security Electronics Touchscreen Control System and Section 28 5300 - Security Electronics Control Panels and Consoles.
- G. Type D - Alarmed door or gate.
 1. Touch screen controls and indicators shall be provided as described in Section — Security Electronics Touchscreen Control System.
- H. Type E - Emergency Exit:
 1. Touch screen controls and indicators shall be provided as described in Section — Security Electronics Touchscreen Control System.
- I. Type K1 - Card Reader/Key Pad Door (Sliding):
 1. When a valid card or Personal Identification Number is presented to the associated card reader/key pad an open signal shall be sent to the door.
- J. If a valid card or Personal Identification Number is presented to the associated card reader/key pad when the door is open, a close signal shall be sent to the door. The close signal shall be of sufficient length to allow the door to become secure.
 1. If the door is not secure after a predetermined period of time, an alarm shall be generated at the control position.
- K. Type K2 - Card Reader Door (Swing):

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1. When a valid card is presented to the associated card reader the door's lock bolt shall be retracted for a minimum of one second after one second has elapsed the bolt for the lock shall extend unless the door has NOT been swung open. If the door has NOT been swung open during the one second hold, the bolt for the lock shall extend as soon as the door is swung open. If the door is not swung open in a predetermined period of time the lock shall automatically reload.
- L. Request to Exit:
 1. Where shown on the drawings, a request to exit switch shall be provided at free exit doors to shunt the door alarm when the door is used for existing a protected area. The request to exit device shall be integrated into the door hardware unless otherwise indicated.
- M. Interlock-
 1. When the door is in the unlocked or open position, the door control logic circuits shall inhibit any other door in the interlock group from being unlocked or opened. The interlock shall not prevent a door from being closed or relocked. In addition, to prevent the simultaneous operation of the door locks when the switches are operated simultaneously, the other outputs in the interlock group shall be inhibited when an unlock output is activated.
 2. Each interlock for an electrically operated door must utilize the unlock command signal for the lock.
 3. Verify interlock groups with owner and provide additional grouping as required.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Multiplexed relay cards shall not be permitted to interface the door relays to the PLC. Passive relay boards with connectorized wiring to the PLC output cards with multipin connectors shall be permitted. Relay boards shall have removable= connector blocks for door wiring connections, integral door power fuses, and pluggable relays. Door control board shall be UL listed.
- B. Exit Pushbutton:
 1. Detention grade wall mounted pushbutton. Unit shall have the following features and/or characteristics.
 - a. Single gang standard electrical box mounting.
 - b. 11 ga. stainless steel faceplate with security screws. Nominal faceplate size, 4.5"H x 2.75"W.
 - c. Vandal resistant switch.
 - d. Red LED status switch.
 - e. The designation "Exit" shall be engraved on the faceplate with red backfill.
 - f. Unit shall be Harding Instruments Model COD-210 Call Operating Device or approved equal.
 - g. Unit shall be Harding Instruments Model COD-210 Call Operating Device or approved equal.
- C. Call Light:
 1. Detention grade ceiling mounted call light. Unit shall have the following features and/or characteristics:
 - a. Single gang standard electrical box mounting.
 - b. 11 ga. stainless steel faceplate with security screws.
 - c. Red call light (single bulb).
 - d. Unit shall be ABC Controls Model R or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Programmable Logic Controllers (PLC) shall be utilized to perform functions as specified. PLC's shall be as specified in Section 17160 — Security Electronics Programmable Logic Controllers.

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- B. Electro-magnetic locks shall be powered by an Uninterruptible Power System.
- C. All doors and gates shall be controlled via door control relays installed by the SCC.
 - 1. The relays shall be the types, sizes, and ratings required for compatibility with applicable door hardware sets.
- D. Door monitoring circuits shall be configured so that they are closed when the door is secure. Where interposing relays are used to separate Class 1 from Class 2 monitoring circuits the relays shall be configured so that the contacts that are monitored by the PLC are closed only when the door is secure.
- E. Both the Door Position Switch and Pole Position Switch shall be monitored individually with PLC I/O. The intent of providing individual monitoring of these switches is to give a mechanism to the Control System that can be used to extend the latch bolt as soon as the
- F. Provide a ground wire to all locks operating at 120 VAC or greater.

3.02 COMPLETION

- A. General: Upon completion of the work, remove access debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.
- B. Testing: The completed system shall be tested by the SEC prior to the acceptance test.

END OF SECTION

SECTION 28 4619 - TOUCH SCREEN SYSTEM

PART 1—GENERAL

1.01 REFERENCE STANDARDS

- A. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020 (Corrigendum 2022).

1.02 RELATED DOCUMENTS

- A. Provisions of the Contract and of the Contract Documents apply to this section.

1.03 SUMMARY

- A. This section includes the requirements and operational characteristics for the control stations (CS) comprised of the following equipment that shall be 100% integrated with the SCS:
 - 1. Computers and Monitors
 - 2. HMI Software
 - 3. Design Software
 - 4. Wireless Tablets

1.04 SYSTEM DESCRIPTION

- A. The CS shall operate as a graphical interface between the correction officer and the electronic security monitoring and control equipment. The CS shall display the status of monitored points and shall control output points.
- B. A network connection shall exist between all CSs and the Programmable Logic Controllers (PLC). The CS shall not directly control the security devices. The security devices shall be controlled by the PLC using interposing relays as described elsewhere in this specification.
- C. Provide wireless tablets (if utilized) as described in these specifications for the areas indicated on the contract drawings. The wireless tablets shall connect to the SCS via IEEE 802.11 protocol and shall support VOIP (Voice over IP) so that wireless tablets can be used as Master Intercom Stations.
- D. The SCS shall allow for all CSs to operate together as a seamless, integrated system.

1.05 SOFTWARE REQUIREMENTS

- A. The CS shall have the following software requirements to allow for seamless control and maximum flexibility:
 - 1. Control Icons
 - a. Central Control shall have the ability to view and control all screens of the facility with status of all devices regardless of which CS has primary control of those devices.
 - b. Local CSs shall display icons of doors, intercoms, cameras, etc., which are under its' primary control. Local CSs shall have the ability to be assigned to different 'task groups' to allow for maximum operational flexibility.
 - 2. Takeover
 - a. The Central Control CS(s) shall have the ability to takeover or disable any combination of local CSs.
 - b. Upon takeover from Central, the intercom queues from the disabled stations will rollover to the Central Control CS(s).
 - 3. Touchscreen Login Validation
 - a. Each CS shall require Login Validation from the Security Management Server (SMS) via a PIN code. On the Login Screen, the CS shall display a keypad for the operator to enter a PIN code.
 - b. As an option, the CS shall require Login Validation from the SMS via a local proximity card reader or a USB fingerprint reader connected to the CS.

- c. Login Validation shall be integrated with the SMS's database to allow tracking of the operator's name for all functions at each CS until it is logged off.
 - d. If the CS cannot communicate with the SMS, then the CS shall authenticate users against a local cache of credentials generated from the previously successful authentication attempts.
 - e. An operator remains the current operator until logged out or until the CS is taken over or disabled.
- 4. Event Logging
 - a. All actions taken by the CS operator shall be logged to the SMS.
 - 5. Graphic display call-up time of 500 milliseconds maximum for all graphics.
 - 6. Variable update time of 500 milliseconds for variables from multiple PLC's.

1.06 SYSTEM OPERATION

- A. Unlock Function – Swing:
 - 1. Pressing the door icon will apply power to the lock and activate the unlock cycle.
 - 2. The icon will illuminate steady red when the door is open or unlocked. The icon will be black when the door is closed and locked.
 - 3. Two or more doors may be in an interlock group. When any door in an interlock group is open or unlocked, the remaining doors in that group cannot be opened without using interlock override. (See: "Interlock Operation")
- B. Open/Stop/Close Operation
 - 1. Pressing the open icon will cause the door/gate to begin opening. The door/gate will continue opening until fully open or until the stop or close icon is pressed.
 - 2. While in motion, pressing the stop icon will cause the door/gate to stop.
 - 3. Pressing the close icon will cause the door/gate to begin closing. The gate will continue closing until fully closed or until the stop or open icon is pressed.
 - 4. The icons will illuminate steady red when the door/gate is open or unlocked. The icons will be black when the gate is closed and locked.
- C. Monitored Door Operation:
 - 1. The icon will illuminate steady red when the door is open or unlocked. The icons will illuminate steady green when the door is closed and locked.
- D. Intercom Operation:
 - 1. When a call button on a remote intercom station is pressed, the icon will flash green and an audible intercom tone will sound.
 - 2. Pressing the intercom icon will cause the flashing green icon to illuminate steady green, silence the audible tone and connect the remote intercom station speaker to the CS's intercom amplifier.
 - 3. While connected, sound in the area of the remote intercom station will be transmitted to the CS.
 - 4. The CS operator can talk to the selected intercom station by pressing and holding the Push to Talk (PTT) icon on the CS. When the PTT icon is released, sound from the intercom station shall again be transmitted to the CS.
 - 5. Pressing the intercom icon again will disconnect the remote speaker from the CS's intercom amplifier and turn the icon back to gray.
 - 6. The CS operator may connect the remote intercom station to the CS's intercom amplifier as in item 2 without the remote call button being pressed as in item 1.
 - 7. Intercoms can also be answered / reset by using the intercom icons.
 - a. When a remote intercom station is pressed, the intercom call will be listed in the intercom queue. The queue shall show the intercom station call-ins in the order received.
 - b. Pressing the Select (SEL) icon will connect the intercom station at the top of the queue and change the screen to display the selected intercom station.
 - c. The intercom-reset icon will disconnect any currently connected intercom station.

- d. If the control system has CCTV system integration included, the camera associated with a selected intercom station shall be pulled up on the spot monitor when an intercom station is selected.
- E. Duress Operation:
 1. Pressing a duress button anywhere in the facility will generate a “duress alarm” condition.
 2. The associated duress alarm icon will flash, an alarm description will be displayed in the alarm status bar, an audible duress alarm will sound, and the “go to alarm” icon will flash red.
 3. Pressing the flashing “go to alarm” icon will change the screen to display the active alarm.
 4. Pressing the flashing duress alarm icon and then pressing the acknowledgement button will silence the audible tone and turn the duress alarm icon to a steady red.
 5. After the alarm condition has been cleared (the duress button has been reset), pressing the duress alarm icon and then selecting the reset button will reset the alarm and the duress alarm icon will disappear.
 - F. Emergency Release Operation:
 1. Pressing the emergency release icon will activate a red pop up window displaying the text “EMERGENCY RELEASE – ARE YOU SURE? YES or NO”.
 2. Pressing the YES button will activate the emergency release function. The emergency release icon will flash red, and all associated doors will open and REMAIN open.
 3. Pressing the NO button will close the pop-up window and cancel the action.
 - G. Group Release Operation:
 1. Pressing the group icon will open all of the doors in that group. Individual doors may be removed from group release by touching the ‘Protect/Isolate’ icon and then touching the desired door. When a door has been isolated from the group mode, the door icon will
 2. become shaded grey and that action will be recorded to the Alarm/Event logging. To remove a door from the protect/isolate mode, touch the ‘Protect’ icon and then the door icon. The grey shading on the icon will disappear and that action will be logged to the activity report screen.
 - H. Camera Operation:
 1. Pressing a camera icon will display the associated camera on the spot monitor, and the icon will illuminate green.
 2. Pressing the camera icon a second time will turn the associated camera icon to gray.
 - I. Interlock Operation:
 1. If any door in an interlock group is open or unlocked, the other doors in that group will have a yellow border around their icons.
 2. To open more than one door in an interlock group, press the interlock override icon and the next door in the interlock group you wish to open. This action will be displayed in the activity/event screen and logged.
 3. The interlock function remains active for a period of time adjustable from 0-30 seconds.
 - J. CS Disable Operation:
 1. To disable a CS, press the CS disable icon. All functions of the selected CS will be disabled immediately and will be transferred to Central Control.
 2. The CS disable icon will be shown with an “X” over it.
 3. To enable the control panel, press the CS disable icon. All functions of the selected CS will be enabled and will be transferred back to the selected CS.
 4. The enabled CS operator will have to log in to the control software to fully restore control.
 5. The CS disable icon will be shown without the “X” over it.
 6. The Central Control CS(s) shall have the ability to disable and enable any remote CS.
 - K. Utilities Control
 1. Utilities control is a feature that allows the operator to control and/or monitor other systems or devices in the facility. Pressing a utility icon shall cause the utility to be turned

on if it is off, or turned off if it is on. The icon will change color and state when changing from off/on.

- a. LIGHTS – Dayroom lights, individual cell day/night lights shall be controlled from the CS. If the lights are on, the light icon shall be yellow. If the lights are off, the light icon shall be gray.
- b. TELEPHONES – Inmate telephones shall be controlled from the CS. If the telephones are on, the telephone icon shall be yellow. If the telephones are off, the telephone icon shall be gray.
- c. TV RECEPTACLES – TV receptacles shall be controlled from the CS. If the TV is on, the TV icon shall be yellow. If the TV is off, the TV icon shall be gray.
- d. WATER VALVES – Water solenoid valves shall be controlled from the CS. If the valves are on, the valve icon shall be yellow. If the valves are off, the valve icon shall be gray.

L. Page Operation

- 1. The CS operator shall have the ability to address individual paging zones or all page zones at once using an “All Call”.
- 2. To address individual page zones, the CS operator shall first select the page zone by direct selecting the desired page icon or dialing the page zone up in the intercom keypad. (see “Intercom Operation”)
- 3. When a page zone is selected, the corresponding page icon will illuminate green.
- 4. While a page zone is selected, sound shall be transmitted from the CS to the corresponding paging speakers.
- 5. Once a page is complete, the CS operator shall end the page by direct selecting the page icon or by pressing the Reset button on the keypad.
- 6. The page icon shall be gray when the corresponding page zone is not selected.
- 7. The CS software shall support a facility wide all-call. To perform an all-call, the CS operator shall dial “AC1” into the intercom keypad on the CS and press the Select button. All paging zones shall be selected and sound shall be transmitted from the CS to all page zones.
- 8. The all-call shall be reset by pressing the Reset button on the intercom keypad.

M. Site Screen Operation

- 1. The CS shall have a separate screen which shows a site plan. The site plan shall show a graphical rendition of all areas of the facility under the CS’s control.
- 2. Pressing an outlined area for a particular section of the facility shall cause the CS to go directly to the screen that controls the touched area.
- 3. As an option, the site plan shall be located on each screen. If this option is used, the site plan shall be sized to prevent obstruction of the floor plan on each screen. The area on the site plan that represents the current screen shall be highlighted in white so that the operator knows exactly what screen is active in relation to the other parts of the facility.

N. Power Supply Alarm Operation

- 1. When the loss of main AC power is detected and the control system reverts to UPS or emergency power, the power supply alarm icon shall flash red and an alarm shall sound. The power supply alarm shall remain in alarm mode until main AC power has been restored.
- 2. The alarm shall be silenced and the power supply alarm icon shall be solid red when the Alarm Silence button is pressed.
- 3. Once main AC power has been restored, the power supply alarm shall automatically clear if the alarm has not been silenced. If the power supply alarm is silenced and main AC power has been restored, the alarm shall clear when the Alarm Reset button is pressed.

O. Ground Fault Operation

- 1. When a ground fault is detected, the ground fault icon shall be solid red. The ground fault icon shall remain solid red until the ground fault has been cleared from the system.

P. Fire Alarm Operation

1. The CS provides secondary annunciation of fire alarms.
 2. Once a fire alarm has been detected, the corresponding fire alarm icon shall flash red and an alarm shall sound. The fire alarm shall remain in alarm mode until the fire alarm has been reset at the fire alarm panel.
 3. The alarm shall be silenced and the fire alarm icon shall be solid red when the Alarm Silence button is pressed.
 4. Once the fire alarm has been reset, the fire alarm shall be cleared by first pressing the Alarm Silence button and then the Alarm Reset button. If the fire alarm was silenced prior to the fire alarm being reset at the fire alarm panel, the alarm shall clear when the Alarm Reset button is pressed.
- Q. Alarm Silence Operation
1. Pressing the Alarm Silence icon shall silence the audible enunciators used to indicate alarms.
- R. Alarm Reset Operation
1. Pressing the Alarm Reset icon shall reset an alarm as long as the cause of the alarm has been addressed.
- S. Right Click Menu Options
1. The following software functions shall be selectable from a menu when an operator is logged in with administrative privileges.
 - a. Prop Alarm
 - 1) If the Prop option is selected for a door and the door is propped or held open longer than the assigned time, an alarm will sound at the CS, notifying the operator of an unsecured condition. An operator must have administrator rights to set a Prop alarm.
 - b. Breach Alarm
 - 1) If the Breach option is selected for a door and the door is opened by any means other than from the CS, a breach alarm will sound at the CS, to notify the operator of that condition. An operator must have administrator rights to set a Breach alarm.
 - c. Hold Open
 - 1) If the Hold Open option is selected for a door, the door lock for the selected door shall be held in until the Hold Open option is turned off for that door.
 - d. Protect
 - 1) If the Protect option is selected for a door, the door shall not open by any other means than by the operator directly selecting the door. If the Protect option is selected for an intercom, the intercom icon shall flash but not sound when the call-in button is pressed at the remote intercom station. Icons that are 'Protected' shall be shaded gray on the CS.

PART 2—PRODUCTS

2.01 2.1 EQUIPMENT AND MATERIALS

- A. Control Station Computer:
1. The computer shall have the following minimum requirements:
 - a. Processor: Intel Core i7-6700, 3.4GHz, 8MB Cache, 4 Cores
 - b. Operating System: Windows 7 Professional 64 bit
 - c. Internal Memory: 8GB, DDR4, 2133 MHz
 - d. Storage: 128GB Solid State Drive (SSD)
 - e. Graphics Card: 2GB Dedicated RAM, Dual Outputs
 - f. Network: Gigabit Ethernet Adapter
 - g. Keyboard/Mouse: Wireless
 2. Computer shall be powered via a local UPS.
 3. Approved Manufacturers:
 - a. HP

- b. Dell
- B. Touch Screen Monitor:
 - 1. Display Size: 22" (diagonal)
 - 2. Backlight Type: LED
 - 3. Native resolution: 1920 x 1080
 - 4. Colors: 16.7 million
 - 5. Brightness: 250 nits
 - 6. Response time: 5 msec (typical)
 - 7. Horizontal Viewing Angle: 170 degrees
 - 8. Vertical Viewing Angle: 160 degrees
 - 9. Contrast Ratio: 1000:1
 - 10. Input Video: DVI and VGA Connector
 - 11. Input Audio: 3.5mm TRS Jack
 - 12. Speakers: Two 2W Internal
 - 13. Input Data: USB
 - 14. Power Dissipation: 29W (typical)
 - 15. Temperature: Operating: 0C to 40C
 - 16. Approved Manufacturer
 - a. ELO Touch Systems 2201L
- C. CS HMI Software
 - 1. The software shall consist of a human machine interface (HMI) system with support for supervisory and process control, real-time data acquisition, alarm and event management, historical data collection, report generation, local or remote telemetry communications to PLC's, and internet/intranet access. The software shall be easy-to-use, with an object-oriented graphics development environment and have an open architecture, which utilizes the latest in Microsoft client/server networking technology.
 - 2. Runtime User Interface Software Requirements:
 - a. The software shall be licensed to support any of the hardware levels of user interface (i.e. server, PC, tablet) running the latest Microsoft Windows operating system.
 - 3. Runtime Security:
 - a. The runtime software shall include a security system under Windows security to enable various operator tasks based on the user level and password. Access to all displays and to all command functions shall be based on the operator's security level to protect against unauthorized use. After initial creation, only an assigned user with proper authorization or the system administrator shall modify the password.
 - b. The security system shall be capable of disabling access to all Microsoft Windows controls (file menu, close, minimize, etc.) and keyboard commands (Ctrl-ESC, Alt-Tab, and Ctrl-Alt-Del).
 - 4. Logging Operator Actions:
 - a. All operator actions shall be logged to an event logger. The event logger shall keep track of each new operator log-on, log-off or device control.
 - b. Each event log shall record the date, time, operator logged in and the type of action taken.
 - 5. Alarm Management Functions:
 - a. Alarms shall be detected and reported by an Alarm Manager Service. The Alarm Manager Service shall support no less than forty (40) simultaneous alarm client displays.
 - b. It shall be possible for the operator to filter the alarm display based on priority level, groups or process area. In distributed network systems, alarms shall be viewed and acknowledged from any workstation and the information shall be distributed to all clients. The name of the operator and the node acknowledging the alarm shall be capable of being displayed in the Alarm Summary.

- c. The alarm display shall support up to eight different combinations of colors based on the priority of the alarm and whether it is acknowledged or unacknowledged.
 - d. The system shall provide a method of notifying the user when a new alarm has occurred.
 - e. The operator shall be able to select and acknowledge alarms individually, by group or area. The operator shall also be able to acknowledge only those alarms visible in the display, only those selected, only the most recent alarm or all alarms in the system. The alarm display shall allow alarms to be selected by clicking on them with the mouse at runtime.
 - f. The operator shall be able to select an alarm from the alarm summary display and the system shall switch to the corresponding screen as to the particular section of the control system where the alarm originated.
 - g. It shall be possible to inform the operator of an alarm condition via an audible tone, a pop-up display, or any combination of animation types on the screen.
 - h. Alarms shall be logged to the SMS.
 - i. Alarms may be printed to a locally connected or network printer from the SMS.
6. Approved HMI Software:
- a. MTI ProVision
 - b. Wonderware
- D. CS Development Software
- 1. Each CS shall have a full version of the CS database development software.
 - 2. The CS database shall be developed using a standard Windows based software package and is 100% compatible with the specified PLC programming software.
 - 3. The software manufacturer shall provide a regular schedule for training classes to be held at the manufacturer's factory.
 - 4. The software manufacturer shall provide free phone technical support for the life of the software.
 - 5. Approved Development Software
 - a. MTI ProDesign

PART 3—EXECUTION

3.01 3.1 GENERAL

- A. All work required herein shall comply with section 28 05 00 Basic Materials and Methods for Electronic Systems.

END OF SECTION

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SECTION 31 1000 - SITE CLEARING

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.
- B. Documents:
 - 1. Soil borings, site preparation, and pavement recommendations – herein specified as the Geotechnical Report. Copies of report available from Architect's office upon request.

1.2 SUMMARY

- A. Section Includes:
 - 1. Removing existing vegetation.
 - 2. Clearing and grubbing.
 - 3. Stripping and stockpiling topsoil.
 - 4. Removing above- and below-grade site improvements.
 - 5. Disconnecting, capping or sealing, and removing site utilities.
 - 6. Temporary erosion and sedimentation control.
- B. Related Requirements:
 - 1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.
- C. Related Requirements:
 - 1. Section 01500 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or video recordings.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify Louisiana One Call for area where Project is located at least forty-eight (48) hours prior to beginning site clearing operations.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree-protection measures are in place.
- D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 2010 "Earth Moving (Site)".
 - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in this section.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two (2) days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
 - 3. Use only hand methods or air spade for grubbing within protection zones.
 - 4. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Surplus soil material and unsuitable topsoil shall be stockpiled within the property boundary and outside of the limits of construction. Stockpile location shall be determined in the field with the project owner.

END OF SECTION 31 1000

SECTION 31 2010 - EARTH MOVING (SITE)

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.
- B. Documents:
 - 1. Soil borings, site preparation, and pavement recommendations – herein specified as the Geotechnical Report. Copies of report available from Architect's office upon request.
- C. All references to LADOTD specifications are to the Louisiana Standard Specifications for Roads and Bridges, 2016 Edition.
- D. Refer to section 31 2000 "Earth Moving – Building Pad" for earth moving requirements beneath proposed building.

1.2 SUMMARY

- A. Section Includes:
 - 1. Excavating and filling for rough grading the Site outside of the building pad.
 - 2. Preparing subgrades for walks, pavements, turf and grasses.
 - 3. Structural fill for concrete pavements.
 - 4. Base course for concrete pavements.
 - 5. Bedding course for utility trenches.
 - 6. Geotextile fabrics.
 - 7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.3 DEFINITIONS

- A. Backfill: Soil material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Granular layer placed over the excavated subgrade in a trench before laying pipe.
- C. Base Course: Granular layer placed over the prepared subgrade.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Select of Structural Fill: Fill material meeting the criteria established in subsequent sections, and that is suitable for placement beneath areas of proposed pavement.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below base, drainage fill, drainage course, or topsoil materials.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 SUBMITTALS

- A. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D2487.
 - 2. Laboratory compaction curve according to ASTM D698.
- B. Laboratory gradation reports for specified base course and bedding course.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.6 FIELD CONDITIONS

- A. Utility Locator Service: Notify Louisiana One Call (811) for area where Project is located before beginning earth-moving operations.
- B. Do not commence earth-moving operations until plant-protection measures specified in Section 31 1000 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils for Select or Structural Fill: Soil Classification CL or SC in accordance with the United Soil Classification System (USCS); inert (non-expansive); free of rock or gravel, debris, waste, frozen materials, vegetation, and other deleterious matter, and with maximum particle size of less than 2 inches. This material shall conform to the following criteria:
 - 1. Liquid Limit: 45 maximum.
 - 2. Plasticity Index: 10 minimum, 22 maximum.
- C. Satisfactory Soils for Non-Structural Fill: Soils used for fill outside of areas of proposed pavement or other structures shall be free of rock or gravel, debris, waste, frozen materials, and other deleterious matter. This material shall conform to the following criteria:
 - 1. Liquid Limit: 55 maximum.
 - 2. Plasticity Index: 10 minimum, 40 maximum.
 - 3. Percent Passing U.S. sieve #200: 12 minimum.
- D. Base Course: Material required beneath areas of pavement shall be granular, free-draining, and compacted over the prepared subbase or subgrade.
 - 1. Crushed stone in accordance with LA DOTD Standard Specification Sections 302 and 1003.03.
- E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand in accordance with LADOTD Standard Specification Section 1003.10.2.

2.2 GEOTEXTILES

- A. Provide Class 'D' in conformance with LADOTD specification section 1019 and all referenced sections.

2.3 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 - 2. Provide temporary pumping systems to dewater all excavations that become inundated. Dewater within 24 hours of inundation.
 - 3. Install a dewatering system to keep subgrades dry and to convey ground water away from excavations. Maintain until dewatering is no longer required.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Do not discharge sediment-laden water into existing public or private drainage systems.
- E. Remediation of compromised soils resulting from failure to comply with temporary drainage measures shall be performed with no changes in the Contract Sum or the Contract Time.
 - 1. Methods of remediation will be determined by the Geotechnical Engineer.

3.3 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
 1. Clearance: 18 inches on each side of pipe or conduit.
- C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
- D. Excavations greater than 4 feet in depth shall require temporary shoring, bracing, or sheeting in lieu of unsupported trench sides.

3.6 SUBGRADE INSPECTION

- A. Notify Geotechnical Engineer when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll all pavement subgrades with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 20 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades. Proof-roll under areas of proposed walks is not required.
 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in opposite direction. Limit vehicle speed to 3 mph.
 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and remediate as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 1. Deficient areas as outlined in paragraph 3.3.C.2 shall be recorded on a project site plan by the Geotechnical Engineer, with the location and dimensions of the deficient areas indicated. This map shall be provided to the Architect before a change in Work will be considered.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation as directed by the Engineer.

3.8 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Initial Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.10 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use of satisfactory soil material is not required.
 - 2. Under walks and pavements, use satisfactory soil material.
- C. Place select fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
 1. Under pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95% percent.
 2. Under pavements, compact base course material at 100 percent.
 3. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 4. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
 5. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1½ inch.
 2. Walks: Plus or minus 1/2 inch.
 3. Pavements: Plus or minus 1/4 inch.

3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and the following inspections:
 1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material classification and maximum lift thickness comply with requirements.
 3. Determine, during placement and compaction, and at the required frequency, that in-place density of compacted fill complies with requirements.
 4. Establish optimum moisture content and stabilization ratios for the sub-base, if required.
 5. Recommend remedial measures for areas of unsuitable or unstable soils beneath proposed pavements.

- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Testing agency will determine classification of soils to be used for select of structural fill in accordance with United Soil Classification System (ASTM D2487). Atterberg Limits for the same samples shall be determined according to ASTM D4318.
- D. Testing agency will determine moisture content of fill material in accordance with ASTM D2216.
- E. Testing agency will test compaction of soils in place according to ASTM D1557, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 5000 sq. ft. or less of paved area, but in no case fewer than four tests per layer for each lift.
 - 2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than three tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
- G. Testing agency will provide all test results to Engineer within forty-eight (48) hours of conducting each respective testing procedure.

3.15 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
 - 1. Surplus soil material shall not be deposited in Special Flood Hazard areas.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 2000

SECTION 31 2100 – EARTH MOVING (BUILDING PAD)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section
- B. Geotechnical Investigation by ECS Southeast, LLP., dated August 31, 2023. Geotechnical report may be obtained from Architect's office.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Preparing subgrades for buildings.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Drainage course for slabs-on-grade.
 - 4. Excavating and backfilling for utility trenches.
 - 5. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Division 03 Section "Cast-in-Place Concrete".

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Drainage Course: Course beneath the slab that minimizes upward capillary flow of pore water.
- E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- I. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
 - 2. Test reports on borrow material.
 - 3. Field density test reports.
 - 4. One optimum moisture-maximum density curve for each type of soil encountered.

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Perform work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- C. Testing & Inspection Service: Owner will engage and pay for soil testing and inspection service for quality control testing during earthwork operations. Contractor shall pay for all retesting of failed tests.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Existing Utilities: Locate existing underground utilities before performing earthwork. If utilities are to remain in place, provide protection from damage during earthwork operations.
- C. Interruption of Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soils:
 - 1. **Imported soil fill material used to raise the site grade shall be either a low plasticity silty or sandy clay (USCS Classification, CL) or a clayey sand (SC), shall be free of roots, construction debris, organic matter or any other deleterious materials, have a maximum clay lump size less than two (2) inches and have a liquid limit of less than 45 and a plasticity index value between 10 and 25. If a fine-grained sandy clay soil is used for select fill, close moisture content control will be required to achieve the recommended degree of compaction.**

2. **Sand Fill: A free draining sand free of roots, construction debris, organic matter or** any other deleterious materials in accordance with ASTM C33. Sand fill shall have a maximum plasticity index of 7 in accordance with ASTM D 4318 and not more than 10% passing a No. 200 sieve, in accordance with ASTM C 117]
- B. Unsatisfactory Soils: Soils other than satisfactory soils.
1. Unsatisfactory soils also include **satisfactory soils not maintained within -2 to +3 percentage points of the optimum moisture content at time of compaction as determined by the Standard Proctor test (ASTM D 698).**
- C. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- D. Drainage Course: Provide a stone or sand drainage layer (per list below) at contractor's option beneath the concrete slab and vapor retarder.
1. A 4" thick layer of number 57 crushed and washed limestone per ASTM C33. complying with the following gradation:
- | Sieve Size | Percent Passing |
|------------|-----------------|
| 1-1/2" | 100 |
| 1" | 95 to 100 |
| 1/2" | 25 to 60 |
| No. 4 | 0 to 10 |
| No. 8 | 0 to 5 |

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

- B. In order to prepare the building and pavement areas for fill or for insitu soils to be used as a final subgrade, the site shall be stripped of all vegetation, soft or loose surface soils, obstructions and all deleterious materials. This includes any loose or water-softened surface materials.
 - 1. When trees are removed, the entire root ball shall be excavated such that the remaining roots measure 1/2 inch in diameter, or less.
 - 2. Strip 6 inches of topsoil minimum at building pad and within 10 feet of the building. Additional stripping may be required in some areas. The actual removal depth shall be determined in the field by the Testing Agency.
- C. Additional information for preparation requirements of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface, and treatment or improvement are specified in Division 31 Section "Site Clearing."
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.
- E. If unstable subgrade is encountered after initial topsoil stripping, the Architect or Testing Agency may require the grading contractor to perform processing and drying of the upper maximum 12 inches of native subgrade by frequent windrowing with a dozer or plowing with a set of heavy duty disc harrows for at least three consecutive working days to achieve stable conditions for fill placement before consideration other mitigation approaches. The windrowing and drying effort shall be performed during a period with at least three consecutive days forecasted to be dry. The processed areas shall be sealed with the dozer at the end of the day in case of unanticipated overnight rain. The subgrade drying effort described above shall be included in the base bid.
- F. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated materials as directed by Architect.
- G. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction (including all OSHA requirements). Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- H. See Section 3.7 below for required proofroll of existing subgrade to be performed immediately after preparation work noted above is complete.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Avoid opening excavations during inclement weather.

- C. Excavations shall not have deleterious effects on adjacent foundations or structures. Sequence construction as required to avoid deep excavations adjacent to foundations or structures, or when deep excavations adjacent to foundations or structures are unavoidable, provide temporary shoring as required in consultation with Geotechnical Engineer.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
 - 3. The base of all excavations for structures shall be free of water, loose soil, unsuitable bearing materials including soft soil, and other foreign materials.

3.6 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 8 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 8 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill. Alternatively, excavate the trench 6" deeper than the bottom of the pipe and provide 6" bedding course.
 - 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll existing subgrade (after preparation as noted above has been completed) below the building slabs with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Contact Architect, Engineer, and Testing Agency 48 hours prior to proof-rolling. A representative of the Testing Agency must be on site during proof-rolling operations.

2. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
3. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
4. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Testing Agency and as directed by Architect, and replace with compacted backfill or fill as directed.
 - a. Prior to consideration of removal and replacement of existing soils, drying and processing of existing subgrade for three consecutive dry days shall be performed as described in Section 3.1 and existing subgrade shall be retested by proof-roll immediately after drying and processing period is complete.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2000 psi, may be used when approved by Architect.
 1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.11 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with a lean concrete fill to elevation of bottom of footings. Provide a lean concrete fill with a 28-day compressive strength of 2500 psi.

- D. Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. All utility trenches that penetrate the building shall be effectively sealed to restrict water intrusion and flow through trenches that could migrate below the building. An effective clay "trench plug" that extends at least five (5) feet out from the face of the building exterior shall be constructed at each utility trench which penetrates the building perimeter. The plug material shall be a clay satisfactory soil compacted at a water content at or above the soils optimum water content. The clay satisfactory soil shall be placed to completely surround the utility line and be compacted.
- I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under steps and ramps, use satisfactory soil material.
 - 2. Under building slabs (and within 10 feet of building slab edges), use satisfactory soil material.
 - 3. Under footings and foundations, use satisfactory soil material
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within **-2 to +3 percentage points of the optimum moisture content at time of compaction as determined by the Standard Proctor test (ASTM D 698)**.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds the optimum moisture content allowance stated above and is too wet to compact to the specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials only after the site has been proof-rolled.
- B. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- C. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- D. Compact all satisfactory soil materials to at least **95 percent of the maximum dry density as determined by the Standard Proctor compaction test (ASTM D 698)**.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
 3. Compact grading fill materials outside of building slab limits to at least **90 percent of the maximum dry density as determined by the Standard Proctor compaction test (ASTM D 698)**.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Subgrade shall be inspected by Testing Agency after compacted fill is complete and immediately prior to placement of drainage course.
- B. Provide a drainage course using granular material as defined in part 2 of this specification.
- C. Place drainage course on subgrades free of mud, frost, snow, or ice.
- D. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends. Geotextile fabric is only required for a sand drainage layer.
 2. Place drainage course 6 inches or less in compacted thickness in a single layer.
 3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 4. Compact each layer of drainage course to a minimum relative density of 75 percent as per ASTM D4253.

3.17 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
 2. Determine that fill material and maximum lift thickness comply with requirements.
 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- C. Provide inspections and test in accordance with Chapter 17 of the International Building Code.
- D. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- E. Testing agency will test compaction of soils in place according to ASTM D 1557, ASTM D 2167, ASTM D 2922, ASTM D 2937 and ASTM D 698, as applicable. Tests will be performed at the following locations and frequencies:
1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of building slab area, but in no case fewer than 3 tests.
 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 100 feet or less of trench length, but no fewer than 2 tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.
 - G. Testing agency shall verify materials below shallow foundations are adequate to achieve the design bearing capacity.
- 3.18 PROTECTION**
- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
 - B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Architect (or Engineer); reshape and recompact.
 - C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
- 3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS**
- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off of Owner's property.

END OF SECTION 31 2100

SECTION 31 3116 - TERMITE CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Chemical soil treatment.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Vapor barrier placement under concrete slab-on-grade.

1.03 REFERENCE STANDARDS

- A. Title 7, United States Code, 136 through 136y - Federal Insecticide, Fungicide and Rodenticide Act; 2022.

1.04 SUBMITTALS

- A. See Section 01 3000 - Submittal Procedures.
- B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
- C. Test Reports: Indicate regulatory agency approval reports when required.
- D. Warranty: Submit warranty and ensure that forms have been completed in Owner's name.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing this type of work and:
 - 1. Having minimum of three (3) years documented experience.
 - 2. Approved by manufacturer of treatment materials.
 - 3. Licensed in the State in which the Project is located.

1.06 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year installer's warranty against damage to building caused by termites.

PART 2 PRODUCTS

2.01 CHEMICAL SOIL TREATMENT

- A. Toxicant Chemical: EPA Title 7, United States Code, 136 through 136y approved; synthetically color dyed to permit visual identification of treated soil.
- B. Manufacturers:
 - 1. Bayer Environmental Science Corp: www.backedbybayer.com/pest-management.
 - 2. FMC Professional Solutions: www.fmcprosolutions.com.
 - 3. Syngenta Professional Products: www.syngentaprofessionalproducts.com.
 - 4. Or prior approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
- B. Verify final grading is complete.

3.02 APPLICATION - CHEMICAL TREATMENT

- A. Comply with requirements of U.S. EPA and applicable state and local codes.
- B. Spray apply toxicant in accordance with manufacturer's instructions.
- C. Apply toxicant at following locations:
 - 1. Under Slabs-on-Grade.
- D. Under slabs, apply toxicant immediately prior to installation of vapor barrier.

- E. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.
- F. Re-treat disturbed treated soil with same toxicant as original treatment.
- G. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 PROTECTION

- A. Do not permit soil grading over treated work.

END OF SECTION

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SECTION 32 1313 - CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes exterior concrete paving for the following items:

1. Driveways.
2. Parking lots.
3. Sidewalks.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.
- C. Reinforcing Bars: ASTM A615, Grade 60; deformed.
- D. Joint Dowel Bars: ASTM A615, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar

supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.3 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C150, Type I or Type II.
 - 2. Fly Ash: ASTM C618, Class F.
 - a. Product shall be restricted to suppliers and sources provided on LA DOTD QPL 50.
- B. Aggregates: ASTM C33, uniformly graded. Provide aggregates from a single source.
 - 1. Maximum aggregate size: No greater than 1/4 of the depth of each respective slab thickness.
- C. Air-Entraining Admixture: ASTM C260.
- D. Chemical Admixtures: ASTM C494. Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- E. Water: Potable and complying with ASTM C94.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
- E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

- A. Joint Fillers (vehicular pavement only): ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Cold-Applied Joint Sealants:
 - 1. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, non-sag silicone sealant complying with ASTM D5893 for Type NS.

- a. Product shall be restricted to suppliers and sources provided on LA DOTD QPL 42.
- 2. Type SL Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D5893 for Type SL.
 - a. Product shall be restricted to suppliers and sources provided on LA DOTD QPL 42.
- C. Joint-Sealant Backer Materials:
 - 1. Round Backer Rods for Cold-Applied Sealants: ASTM D5249, Type 3, of diameter and density require to control sealant depths and prevent bottom-side adhesion of sealant.
- D. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type, strength, and thickness of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash or Pozzolan: 20 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 4.5 percent plus or minus 1-1/2 percent.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing admixture in concrete as required for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- E. Concrete Mixtures: Normal-weight concrete.
 - 1. Compressive Strength (28 Days):
 - a. Pavement and barrier curbs: 4000 psi.
 - b. Sidewalks: 3000psi.
 - 2. Maximum W/C Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll prepared subbase surface below areas of proposed concrete pavements in accordance with Specification Section 31 20 00, "Earth Moving (Site)" to identify soft pockets and areas of excess yielding.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.6 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbing concrete but before float finishing.

- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these methods.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 1/4 inch.
 - a. Maximum variations in surface tolerance shall not exceed 1/4 inch in 10 feet.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Joint Spacing: 3 inches.
 - 4. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 5. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C31; cast and laboratory cure one set of four standard cylinder specimens for each composite sample. One specimen shall be retained for later testing, if required.
 - 6. Compressive-Strength Tests: ASTM C39; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no individual compressive-strength test value falls below specified compressive strength by more than 500 psi.

- D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
 - 1. Concrete paving that has been determined to be defective shall be replaced at no additional cost to the Owner.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.11 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

SECTION 32 1723 - PAVEMENT MARKINGS

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 painted markings applied to concrete pavement.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, 55 deg F for water-based materials], and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction, and ICC A117.1.

2.2 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type S; colors complying with FS TT-P-1952.
 - 1. Color: As indicated on drawings.
- B. Glass Beads: AASHTO M 247, Type 1.
 - 1. Roundness: Minimum 75 percent true spheres by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
 - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 32 1723

SECTION 32 3113 - CHAIN LINK FENCES

PART I - GENERAL

1.01 SUMMARY

- A. Provide arched and straight chain link fence systems where shown on the project drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work:
 - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions and other sections of these specifications.
- C. References for material specifications:
 - 1. American Society for Testing and Materials (ASTM) Standards:
 - a. Test method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
 - b. Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 - c. Test Method for Weight of Coating on Aluminum-Coated Iron or Steel Articles.
 - d. Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
 - e. Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
 - f. Specification for General Requirements for Steel Sheet, Zinc - Coated (Galvanized) by the Hot-Dip Process.
 - g. Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet Strip, Commercial Quality.
 - h. Specification for Metallic-Coated Steel Wire for Chain Link Fence Fabric.
 - i. Ready Mixed Concrete.
 - j. Specification for Fence Fittings.
 - k. Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain-Link Fence.
 - l. Federal Specifications (Fed. Spec.):
 - 1) RR-F-191H/GEN Fencing, Wire and Post, Metal
 - 2) RR-F-191/1D Fencing, Wire and Post, Metal
 - 3) RR-F-191/2D Fencing, Wire and Post, Metal
 - 4) RR-F-191/3D Fencing, Wire and Post, Metal
 - 5) RR-F-191/4D Fencing, Wire and Post, Metal

1.02 SUBMITTALS

- A. Submit the following:
 - 1. Materials list of items proposed to be provided under this section.
 - 2. Manufacturer's specifications and other data needed to prove compliance with the specific requirements.
 - 3. Shop Drawings showing all fencing components and details of fencing, gates, post tops, tensions bands and bars, sleeves and corner post attachments. These Shop Drawings shall be accompanied by a layout drawing showing spacing of posts and location of gate, corner, end and pull posts.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Deliver fencing materials to the site in an undamaged condition. Carefully store materials off the ground to provide proper protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.01 MATERIALS COATING

- A. On steel framework and appurtenances, provide galvanized finish with not less than the following weight of zinc per square foot:
 - 1. Tube: 1.1 +/- .10 ounce per square foot, complying with ASTM A525
 - 2. Appurtenances - Per ASTM F626

3. On fabric, provide finish with not less than the following weight of zinc or aluminum per square foot, as indicated below:
 - a. For 3/8" fabric, use aluminized, Type I, complying with ASTM A817.
 - b. For 2" fabric, comply with ASTM A817, using either aluminized, Type I or galvanized, Type II.

2.02 FABRIC

- A. On the top section of the "Type A" fence, provide number 14 gauge wire in 3/8" mesh. This section of fabric shall be 8'-0" wide. Salvages shall be knuckled.
- B. On the bottom section of the "Type A" fence, provide number 9 gauge wire in 2" mesh. The width of this section will measure 6'-0" above grade level. If fabric is buried, refer to Shop Drawings for actual width of this section of fence fabric. Salvages shall be knuckled.
- C. Height of fabric shall be as indicated in Project Drawings and shall be one continuous fabric width for fencing up to 20' height for each gauge required.

2.03 POSTS, RAILS AND ASSOCIATED ITEMS

- A. End, Corner, Slope, Pull, Line and Gate Posts: Provide at least the following minimum sizes and weights:
 1. Material and dimensions: Lbs per lin ft:
 2. Class 1, steel pipe, Grade B 4.64
 3. Wall thickness: .160"
 4. Yield Strength: 50,000 psi min (RR-F-191)
 5. Comply with RR-F-191
 6. Outside dimension: 4.0"
 7. Internal support tube:
 - a. Material and dimensions: Lbs per lin ft:
 - b. Class 1, steel pipe, Grade B 4.64
 - c. Wall thickness: .160"
 - d. Yield Strength: 50,000 psi min (RR-F-191)
 - e. Comply with RR-F-191
 - f. Outside dimension: 2 3/8"
 8. Rails: Provide at least the following minimum size and weight:
 - a. Material and Dimensions: Lbs per lin ft:
 - b. Class 1, steel pipe, Grade A or B 2.27/1.82
 - c. Wall Thickness: .14"(A), .11"(B)
 - d. Yield Strength: 25,000 psi min (A)
 - e. 50,000 psi min (B)
 - f. Comply with RR-F-191
 - g. Outside dimension: 1-5/8"
 9. Post tops:
 - a. Provide steel post tops designed as weather tight closure caps.
 - b. Provide one cap for each post.
 - c. Do not use loop caps.
 10. Stretcher bars:
 - a. Provide one-piece lengths equal to full height of fabric with a minimum cross-section of 3/16" x 3/4" or 3/8" round.
 - b. Provide one stretcher bar for each gate and end post, and two for each corner and pull post.
 11. Stretcher bar bands:
 - a. Provide steel bands to secure stretcher bars to end, corner, pull, and gate posts.
 - b. Bands may be used also with rail end combinations for securing rails to end, corner, pull, slope and gate posts.
 12. Minimesh end/corner assemblies

- a. Provide 3/16" x 3" x 45" galvanized flat steel bar slotted 6" on center and 3/16" x 2" x 45", galvanized flat steel bar slotted 6" on center for each end, corner & gate post.
- b. Provide 45" end assembly, for each end post, gate post, and 45 degree corner post, and 60" assembly for 90 degree corner post.
- c. Secure end/corner assemblies with 3 each 1" x 1/8" heavy steel tension bands.

2.04 GATES

A. General:

1. Fabricate gate frames of tubular members.
2. Provide additional horizontal and vertical members to assure proper operation of the gates, and for attachment of fabric, hardware and accessories.
3. Fabricate gate frames from:
 - a. Material and Dimensions: Lbs per lin ft:
 - b. Class 1, Steel pipe, Grade A or B
 - c. Wall Thickness: .145" (A), .120 (B)
 - d. Yield Strength: 25,000 psi min (A) (RR-F-191)
 - e. 50,000 psi min (B)
 - f. Comply with RR-F-191
 - g. Outside dimension: 1-7/8"
4. Fabrication:
 - a. Assemble gate frames by welding.
 - b. Use 14 gauge x 3/8" to cover gate frame.
 - c. Attach gate fabric to the gate frame with tension bands and bars on all four sides. Weld tension bars at each corner.
 - d. Tension bands are to be spaced not more than 12" on centers.
 - e. Spot weld nuts, peen bolt ends, or slash threads on all clamps and bands to provide security against removal.
 - f. Provide diagonal cross-bracing consisting of 3/8" diameter adjustable length truss rods on gates where required to provide frame rigidity without sag or twist. Gate leaves greater than 6 feet wide will have truss rods or intermediate braces.
 - g. Arrange latches for padlocking so that padlock will be accessible from both sides of the gate.
 - h. Provide 13 gauge x 1/2" expanded metal panels for side panels and soffits of gates. Weld in place and paint welds per ASTM 780.
5. Gate hardware for swing gates. Provide the following for each gate:
 - a. Hinges:
 - 1) Pressed or forged steel, or malleable iron, to suit the gate size.
 - 2) Provide 1-1/2 pairs of hinges for each leaf over 6 feet in nominal height.
 - b. Latches:
 - 1) Provide forked type or plunger-bar type to permit operation from either side of the gate.
 - 2) Provide padlock eye as integral part of latch.
 - c. Keeper: Provide keeper for vehicle gates, which automatically engages the gate leaf and holds it in the open position until manually released.
 - d. Double Gates:
 - 1) Provide gate stops for double gates consisting of mushroom or flush plate, with anchors.
 - 2) Set in concrete to engage the center drop rod or plunger bar.
 - 3) Provide locking device and padlock eyes as an integral part of the latch, requiring one padlock for locking both gate leaves.
6. Slide gate hardware. Provide the following for each gate:
 - a. Sliding gate assembly, complete with sliding gate, support columns, overhead truck assembly, bottom guide assembly, and locking assembly. Fabricate with mitered, welded, weather-tight joints. Hot-dip galvanized construction.

- b. Steel pipe frame, with steel tube bracing, adjustable tension rods and chain link fabric.
- c. Overhead Sliding Track, (enclosed): As manufactured by Richards Wilcox Industries, 600 South Lake Street, Aurora, Illinois 60508-5566, (1-708-897-6951); P. C. Henderson, Inc., 4600 Highlands Parkway, Smyrna, Georgia 30082, (1-404-438-1232), or equal.
- d. Tension Rods: Steel truss rod tension bracing.
- e. Chain Link Fabric: Gauge of chain link fabric indicated on drawings. Where not indicated, provide same gauge as fabric on fence, in which gate is installed.
- f. Bottom gate guides employed in such a manner as to prevent the gate from being pushed away from the gate guide posts when the gate is closed.

2.05 BARBED TAPE

- A. Wire-Reinforced Tape: ASTM F1910; continuous coil with four-point, needle-sharp barbs permanently cold clenched around a core wire.
 - 1. Core Wire: High-tensile-strength.
 - a. Stainless steel.
 - 2. Configuration:
 - a. Single coil
 - b. Double coil
 - 3. Style:
 - a. Concertina
 - 4. Coil Diameter(s):
 - a. 30 inch
 - 5. Coil Loop Spacing(s): [12 inches (305 mm)] [Manufacturer's standard] [As indicated on Drawings] [Insert spacing].
 - 6. Barb Length Classification: [Long, 1.2-inch (30.5-mm)] [Medium, 0.4-inch (10.2-mm)] [Short, 0.1875-inch (4.76-mm)] barb.
 - 7. Barb Spacing: [4 inches (102 mm)] [Insert dimension] o.c.
 - 8. Barb Set: [Straight] [Offset] [Manufacturer's standard].
- B. Clips: Stainless steel, 0.065 inch (1.65 mm) thick by 0.375 inch (9.5 mm) wide; capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
- C. Tie Wires: Stainless steel, 0.065 inch (1.65 mm) in diameter.
- D. Ground-Barrier Stakes: 3/8-inch- (9.5-mm-) diameter galvanized reinforcing bar, 18 inches (457 mm) long with 180-degree end hook 3-1/2 inches (89 mm) long.

2.06 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Wire ties:
 - 1. For tying 2" fabric to line posts and rails, use 9 gauge steel wire with coating to match fabric material. Max. 15" O.C. for post and 24" O.C. for rails
 - 2. For tying 3/8" fabric to rail, use number 12-1/2 [11] gauge steel wire ties, 2' O.C. with coating compatible to match fabric materials. See option B.2 TEK Screws.
 - 3. If fabric is not buried, "Military" ties must be used to attach fabric to bottom rail, (24" on center).
 - 4. TEK Screws:
 - a. For attaching 3/8" mesh to post use #14 X 1 1/2" TEK Screw and 1/4 X 1 1/4 " fender washer (Stainless Steel or Hot Dip Gal.) Minimum of 4 per post.
 - 5. Hog rings:
 - a. For attaching 3/8" mesh fabric to 2" mesh fabric, use pneumatically applied high tensile steel (250-lb. test) 11 gauge hog rings.
 - b. To apply hog rings, use a Spenax SC 50 tool as manufactured by Stanley Spenax, 860 Elston Drive, Shelbyville, Indiana 46176, (1-317-398-0761) or approved equal.

6. Concrete: ASTM C 94 3000-psi compressive strength at 28 days, using 3/8" maximum size aggregate. Site mixed concrete will be acceptable. Grout shall consist of one part cement to three parts clean, well-graded sand and the minimum amount of water required to produce a workable mix.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.
- B. Establish a graded fence line prior to the installation of fencing. The ground along the line of the fence shall be solid, and dirt fill used to establish the fence line shall be thoroughly compacted. The fence line shall be cleared of all trees, brush or other obstacles that will interfere with the fencing or facilitate breach.

3.02 INSTALLATION

- A. General:
 1. Install posts at a maximum spacing of 10 feet on centers.
 2. For all terminal points in the fence line, including ends, corners, gates and significant changes in grade, install posts only as indicated in Project Drawings.
 3. Install corner or pull posts where changes in direction exceed 30 degrees or significant grade changes are encountered.
 4. Corners and terminals are to be executed in a manner, consistent with Project Drawings, which absolutely precludes hand/foot holds for the length of the 3/8" mesh.
 5. Terminal posts at buildings shall be finished, consistent with Project Drawings, to provide closure to within .25" of the building.
 6. Excavating:
 - a. Drill holes for post footings in firm, undisturbed or compacted soil, strictly adhering to the dimensions and spacing shown in the Project Drawings.
 - b. Where the footing is in plain soil, excavate a 15" minimum diameter hole to a depth of 4' 6".
 7. Setting sleeve/bolt assemblies:
 - a. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
 - b. Center and align sleeve/bolt assemblies in holes. Ensure that sleeve/bolt assemblies are plumb on two perpendicular planes.
 - c. Ensure that the support bolt at the bottom of the sleeve is the correct depth below grade level, as shown in the Project Drawings.
 - d. Place concrete around sleeve/bolt assemblies in a continuous pour, and vibrate or tamp for consolidation.
 - e. Grout-in those sleeve/bolt assemblies which are set into concrete constructions, using non-shrink Portland cement grout.
- B. Inserting Posts:
 1. When concrete has attained sufficient strength, as indicated in paragraph E below, insert posts into sleeve/bolt assemblies.
 2. CORNER POSTS DIFFER FROM LINE POSTS. 90 DEGREE CORNER POSTS DIFFER FROM 45 DEGREE CORNER POSTS. ENSURE THAT THE CORRECT POSTS ARE INSERTED IN THE CORRECT LOCATIONS. THE CORNER POSTS ARE COLOR CODED WITH A PAINT SWIPE.
 3. Concrete strength: Allow concrete to attain at least 75% of its minimum 28-day strength before installing rails and fabric.
 4. Rails and bracing:
 - a. Install fence using horizontal rails, as indicated in the Project Drawings.
 - b. Install rails using boulevard clamps, end rail clamps and rail ends.

- c. Brace end, corner, gate and pull posts to the nearest posts with horizontal braces used as compression members. Weld the horizontal braces to the posts.
- 5. Installing Fabric:
 - a. Install fabric on the secure side of the fence, on the underside of the arch, as indicated by Project Drawings.
 - b. Pull fabric taut and tie to posts and rails. Anchor the fabric to the framework so that the fabric remains in tension after pulling force is removed.
 - c. Attach all fabric to line posts and rails using U-shaped wire ties, conforming to diameter of pipe to which attached. Attach fabric to line posts using ties spaced 15" maximum on centers. Attach fabric to rails using ties spaced 24" maximum on centers..
 - d. Join rolls of fence fabric by weaving a strand of fabric through the ends of rolls to form a continuous mesh.
 - e. Cut the fabric at all terminal posts. Make bias cuts to obtain smooth finish around corners.
 - f. Attach the 2" fabric to terminal posts using stretcher bars and stretcher bar bands or other approved devices standard with the manufacturer. Secure the 2" fabric and stretcher bars to posts with metal bands spaced 12" on centers.
 - h. To attach 3/8" fabric to terminal posts, weld a galvanized steel plate measuring 3/8" x 3" x 48" lengthwise along the terminal posts from just above the mid-rail boulevard clamp to just below the top rail boulevard clamp. The plate must be punched 6" on centers to allow for 3/8" carriage bolts. Attach the 3/8" fabric using a 3/16" x 1-1/2" retainer bar and 3/8" x 2" carriage bolts spaced at a maximum of 6" on centers.
 - i. Install the 3/8" fabric so that it overlaps the 2" fabric by 3" to 6". The 3/8" fabric must overlay the 2" mesh. Where both fabrics meet a post or rail, the 2" mesh will be between the 3/8" fabric and the post or rail.
 - j. Attach the 3/8" fabric to the 2" fabric at the bottom edge of the 3/8" fabric using pneumatically applied 11 gauge high tensile hog rings placed a maximum of 6" on centers.
 - k. INSTALL 3/8" FABRIC SO THAT THE TOP EDGE OF THE FABRIC EXTENDS A MINIMUM OF 4" BEYOND THE POST CAPS.
- 6. Installing Swing Gates:
 - a. Install swing gates plumb, level and secure for full opening without interference.
 - b. Install ground-set items in concrete for anchorage in accordance with the fence manufacturer's recommendations as approved by the Architect.
 - c. Adjust the hardware for smooth operation and weld all hardware to prevent removal.
- 7. Installing Slide Gates:
 - a. Assemble gates to conform to Project Drawings.
 - b. Install gates plumb, level and secure for full opening without interference.
 - c. Adjust the hardware for smooth operation and weld all hardware to prevent removal.
 - d. Install gate operators mounted on concrete pads as recommended by operator manufacturer. Operators must be mounted level and parallel to the fence line as required by the manufacturer. Installer must ensure that the sliding gates slide properly before operator installation. If necessary, return to job site after final electrical connections are made to test operation of gates.
- 8. Miscellaneous:
 - a. Peen the ends of bolts to prevent removal of nuts. Weld nuts.
 - b. Repair coatings damaged in the shop or during field erection, using a repair compound applied in accordance with its manufacturer's recommendations.

END OF SECTION

SECTION 32 9200 - TURFS AND GRASSES

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.
- B. All references to LADOTD specifications are to the Louisiana Standard Specifications for Roads and Bridges, 2016 Edition.

1.2 SUMMARY

- A. Section Includes:
 - 1. Seeding.
 - 2. Sodding.
 - 3. Erosion-control material(s).
- B. Related Requirements:
 - 1. Section 31 1000 "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Section 31 2010 "Earth Moving (Site)" for excavation, filling, backfilling, and rough grading.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For erosion control blanket from manufacturer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

- B. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.
- C. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.

1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

- A. Provide seed materials conforming to the following criteria:
 - 1. Grass Seed: Fresh, clean, dry, new-crop seed complying with table 717-1 of LADOTD Specification Section 717.
 - 2. Grass Seed Mix: Seed mix based on the planting dates as follows:
 - a. March to September: Type A
 - b. September to February: Type C
 - c. February to March: Type B

2.2 SOD

- A. Provide seed materials conforming to the following criteria:
 - 1. Rolls or slabs of field grown Bermuda grass in accordance with LADOTD Specification Section 714.

2.3 EROSION-CONTROL MATERIALS

- A. Erosion Control Blanket: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel-wire staples, 6 inches long (minimum).
 - 1. Blanket durability: 12 months (minimum).

2.4 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
- B. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - 1. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep. Do not obtain from agricultural land, bogs, or marshes.

2.5 FERTILIZER

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
 - 1. Composition: 1lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous material and legally dispose of them off of Owner's property.
 - 1. Apply fertilizer directly to subgrade before loosening.
 - 2. Thoroughly blend planting soil mix off-site before spreading.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within 3 days.
 - 3. Spread planting mix to a depth of 4 inches but not less than required to meet finished grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately $\frac{1}{2}$ the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil mix.
- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus $\frac{1}{2}$ inch of finished elevation. Roll and rake, remove ridges, and fill depressions to meet finished grades. Limit finished grade to areas that can be planted in the immediate future.
- D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Before planting, restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of [1-2 lb/1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:20 and where indicated on Drawings with erosion-control blankets installed and stapled according to manufacturer's written instructions.

3.6 SODDING

- A. Install rolls or slabs of field grown Bermuda grass sod in accordance with LADOTD Standard Specification section 714.
- B. Water and establish according to LADOTD Standard Specification Section 714.07 and 714.08.

3.7 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and

become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass to a height of 1/2 inch or less.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.9 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 33 1416 – SITE WATER DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service mains.
- B. All fees assessed by Water Company for tap, service extension, and meters shall be included in the original contract sum.

1.3 DEFINITIONS

- A. PVC: Polyvinyl Chloride
- B. DI: Ductile Iron

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
- C. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASTM F645 for selection, design, and installation of thermoplastic water piping.
- E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
 - 1. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.8 COORDINATION

- A. Coordinate connection to water main with utility company.
 - 1. Water Company will provide tap from existing water main, service extension, and water meters.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 PVC PIPE AND FITTINGS

- A. Domestic Service: PVC, Schedule 40 Pipe: ASTM D1785.
 - 1. PVC, Schedule 40 Socket Fittings: ASTM D2466.
- B. Domestic Service: IPS PVC Pressure Pipe: ASTM D2241
- C. Fire Service: PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
 - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.3 JOINING MATERIALS

- A. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.4 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 - 1. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
 - a. Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
 - 1) Standard: AWWA C500.

- 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.
2. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
- a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig.
 - 3) End Connections: Flanged.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.6 CHECK VALVES

- A. AWWA Check Valves:
1. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
 - a. Standard: AWWA C508.
 - b. Pressure Rating: 175 psig.

2.7 PLUG VALVES

- A. Plug Valves:
1. Description: Resilient-seated eccentric.
 - a. Standard: MSS SP-108.
 - b. Body: Cast iron.
 - c. Pressure Rating: 175-psig minimum CWP.
 - d. Seat Material: Suitable for potable-water service.

2.8 WATER METERS

- A. Water meters will be furnished by Water Company.

2.9 BACKFLOW PREVENTERS

- A. Backflow preventer shall be located immediately downstream of water meter and shall have thermal protection as listed in this section.
- B. Reduced-Pressure-Principle Backflow Preventers:
1. Standard: ASSE 1013, AWWA C511.
 2. Operation: Continuous-pressure applications.
 3. Size: Shall match service main size indicated on Drawings.
 4. Pressure Loss at Design Flow Rate: Coordinate with plumbing engineer for requirements.

5. Body: cast iron or steel with interior lining complying with AWWA C550 or that is FDA approved.
 6. End Connections: Flanged.
 7. Configuration: Designed for horizontal, straight through flow.
 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
- C. Double-Check Backflow Prevention Assemblies:
1. Standard: ASSE 1015 or AWWA C510.
 2. Operation: Continuous-pressure applications.
 3. Size: Shall match service main size indicated on Drawings.
 4. Pressure Loss at Design Flow Rate: Coordinate with plumbing engineer for requirements.
 5. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
 6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 7. Configuration: Designed for horizontal, straight through flow.
 8. Accessories:
 - a. Valves: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.10 PROTECTIVE ENCLOSURES

- A. Freeze-Protection Enclosures:
1. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F when external temperatures reach as low as 0 deg F.
 - a. Standard: ASSE 1060.
 - b. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
 - c. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
 - 1) Housing: Reinforced aluminum construction.
 - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
 - b) Drain opening for units with drain connection.
 - c) Access doors with locking devices.
 - d) Insulation inside housing.
 - e) Anchoring devices for attaching housing to concrete base.
 - 2) Electric heating cable or heater with self-limiting temperature control.
- B. Enclosure Bases:
1. Description: 4-inch minimum thickness precast concrete, of dimensions required to extend at least 6 inches beyond edges of enclosure housings. Include openings for piping.

2.11 FIRE HYDRANTS

- A. Wet-Barrel Fire Hydrants:

1. Description: Freestanding, with one **NPS 4-1/2** and two **NPS 2-1/2** outlets, **NPS 6** threaded or flanged inlet, and base section with **NPS 6** mechanical-joint inlet. Include interior coating according to AWWA C550.
 - a. Standard: AWWA C503.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 31 2010 "Earth Moving (Site)" for excavating, trenching, and backfilling.

3.2 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, metal-seated gate valves with valve box.
 2. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, rising stem.
 - b. Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, metal seated.
 - c. Check Valves: AWWA C508, swing type.
 3. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
 4. Relief Valves: Use for water-service piping in vaults and aboveground.
 - a. Air-Release Valves: To release accumulated air.
 - b. Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
 - c. Combination Air Valves: To release or admit air.

3.3 PIPING INSTALLATION

- A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.
- B. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- C. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration.
- D. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- E. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.4 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
 2. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - a. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
 - b. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.

3.5 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
1. Concrete thrust blocks.
 2. Locking mechanical joints.
 3. Set-screw mechanical retainer glands.
 4. Bolted flanged joints.
 5. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

- G. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass.
- H. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

3.7 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.

3.8 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install concrete base level and with top approximately 2 inches above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

3.9 CONNECTIONS

- A. Connect water-distribution piping to utility water main extension.
- B. Connect water-distribution piping to interior domestic water piping.

3.10 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Backflow preventers shall be tested in accordance with International Plumbing Code Section 312.10 and all referenced standards.
- D. Prepare reports of testing activities.

3.11 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 31 2010 "Earth Moving (Site)".
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel.

3.12 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
 - 3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 1416

SECTION 33 3113 - SITE SANITARY SEWER

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. PVC pipe and fittings.
 - 2. Expansion joints and deflection fittings.
 - 3. Cleanouts.
 - 4. Manholes.
 - 5. Concrete.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Non-pressure couplings
 - 3. Expansion joints and deflection fittings.
 - 4. Cleanouts.
- B. Shop Drawings:
 - 1. Manholes: Include plans, top and invert elevations, pipe elevations, sections, details, reinforcement, frames, and covers. Manholes shall be identified by the designations provided on the construction drawings.
- C. Field quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

- A. Gravity Piping: PVC Type PSM Sewer Piping, Cell Class 12454
 - 1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends.
 - 3. Gaskets: ASTM F 477, elastomeric seals.
- B. Force Main Piping: PVC, Schedule 40, Cell Class 12454
 - 1. Pipe: ASTM D1785, Schedule 40 PVC, with plain ends for solvent-cemented joints.
 - a. Force main piping shall be green in color.
 - 2. Fittings: ASTM D2466, Schedule 40, socket type.

2.2 EXPANSION JOINTS AND DEFLECTION FITTINGS

- A. Ductile-Iron, Flexible Expansion Joints:
 - 1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.
- B. Ductile-Iron Expansion Joints:
 - 1. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig minimum working pressure and for expansion indicated..
- C. Ductile-Iron Deflection Fittings:
 - 1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.3 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Top-Loading Classification(s): Medium Duty and Extra-Heavy Duty.
 - 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts:
 - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.4 MANHOLES

- A. Standard Precast Concrete Manholes:
1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Diameter: 48 inches minimum unless otherwise indicated.
 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 4. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
 5. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
 6. Top Section: Concentric-cone type with top of cone of size that matches grade rings.
 7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
 8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
 9. Steps: Do not provide.
 10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

2.5 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318 and the following:
1. Cement: ASTM C150, Type II.
 2. Fine Aggregate: ASTM C33, sand.
 3. Coarse Aggregate: ASTM C33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A615, Grade 60 deformed steel.
 - 3.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312010 "Earth Moving (Site)".

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install cleanouts at changes in direction. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
 - 2. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 3. Install ductile-iron, gravity sewer piping according to ASTM A746.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join PVC Type PSM sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.
 - 2. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - 1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

- c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
2. Use pressure pipe couplings for force-main joints.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 1. Use Medium-Duty, top-loading classification cleanouts in unpaved areas.
 2. Use Extra-Heavy-Duty, top-loading classification cleanouts in all paved areas.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 22 13 00 "Sanitary Waste and Vent Storm Drainage".

3.6 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.

- c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
- 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.7 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 33 3113

SECTION 33 4200 – SITE STORM DRAINAGE

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.
- B. All references to LADOTD specifications are to the Louisiana Standard Specifications for Roads and Bridges, 2016 Edition.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Cleanouts.
 - 3. Stormwater inlets.
 - 4. Stormwater manholes.

1.3 SUBMITTALS

- A. Product Data: For drainage structures, pipes, and fittings.
- B. Shop Drawings:
 - 1. All drainage structures shall be identified by the designations provided on the construction drawings.
 - 2. Manholes: Include plans, top and invert elevations, pipe elevations, sections, details, reinforcement, frames, and covers.
 - 3. Stormwater inlets: Include plans, top and invert elevations, pipe elevations, sections, details, reinforcement, frames, and grates.
 - 4. Subsurface stormwater detention systems: Include plans, top and invert elevations, pipe connection locations and elevations, inlet locations and elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes in accordance with manufacturer's written rigging instructions.
- D. Handle stormwater inlets in accordance with manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 PLASTIC PIPE AND FITTINGS

- A. PVC Gravity Sewer Piping:
 - 1. Pipe and Fittings: ASTM F 949, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
- B. HIGH-DENSITY POLYETHYLENE (HDPE) GRAVITY PIPE AND FITTINGS
 - 1. Pipe and Fittings: Pipe and Fittings: ASTM F 2306, HDPE gravity-flow storm sewer pipe with integral bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
- C. POLYPROPYLENE (PP) GRAVITY PIPE AND FITTINGS
 - 1. Pipe and Fittings: ASTM F 2881, HDPE gravity-flow storm sewer pipe with integral bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.2 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Pipe and Fittings
 - 1. Provide in accordance with LADOTD specification Section 701 and all referenced sections.

2.3 CLEANOUTS

- A. Cast-Iron Cleanouts:
 - 1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside caulk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 2. Top-Loading Classification(s): Medium and Extra-Heavy Duty
 - 3. Pipe Fitting and Riser to Cleanout: PVC Schedule 80 or SDR 35 plastic pipe and fittings.

2.4 PRE-CAST CONCRETE DRAINAGE STRUCTURES

- A. Provide structures in accordance with plans, conforming to dimensions, reinforcement, and appurtenances as indicated.
- B. Standard Precast Concrete Drainage Structures:

1. Description: ASTM C 913, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C 923, cast or fitted into structure walls, for each pipe connection.

C. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch inside diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

D. Stormwater Inlet Frames and Grates: Include flat grate with short-slotted drainage openings.

1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
3. Material: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading.

2.5 POLYMER STORMWATER STRUCTURES

A. Provide structures in accordance with plans, conforming to dimensions, materials, and appurtenances as indicated.

B. Polymer Drainage Structures:

1. Description: ASTM D1784, Polyvinyl Chloride, of depth indicated, with provision for sealant joints.
2. Joint Sealant: ASTM F477
3. Pipe Connections: ASTM D3212, fitted into connection stubs provided on basin channel.
4. Bedding Material: ASTM D2321, placed to dimensions required by manufacturer and uniformly compacted.

C. Frames and Grates for Inlets: Provide square frame and grate fitted onto circular basin channel.

1. Size: As indicated on drawings.
2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
3. Material: ASTM A536, Grade 70-50-05, ductile iron designed for AASHTO H10-44 or HS20-44 structural loading.

2.6 CONCRETE

A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:

1. Cement: ASTM C 150/C 150M, Type II.
2. Fine Aggregate: ASTM C 33/C 33M, sand.
3. Coarse Aggregate: ASTM C 33/C 33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 31 2010 "Earth Moving (Site)".

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Stormwater runoff shall not be directed towards or allowed to shed into open pipe trenches.
- G. Adequate ground cover, as determined by manufacturer, shall be provided over installed pipe to prevent flotation. If adequate depth cannot be achieved, anchor system per manufacturer's recommendation shall be provided at no additional cost to Owner.
- H. Install gravity-flow, nonpressure drainage piping in accordance with the following:
 1. Install piping pitched down in direction of flow.
 2. Install PVC sewer piping in accordance with ASTM D 2321 and ASTM F 1668.
 3. Install reinforced-concrete sewer piping in accordance with ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
 1. Join PVC corrugated sewer piping in accordance with ASTM D 2321 for elastomeric-seal joints.
 2. Join PVC sewer piping in accordance with ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.

3. Join perforated PVC sewer pipe and fittings according to ASTM D3212 with loose bell-and-spigot, push-on joints.
 4. Join reinforced-concrete sewer piping in accordance with ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 5. Join dissimilar pipe materials with nonpressure-type flexible couplings.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use plastic pipe fittings in sewer pipes at branches for cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Medium Duty top-loading classification cleanouts in areas of grass, landscaping, or that will be subject to foot traffic only.
 2. Use Extra-Heavy Duty top-loading classification cleanouts in areas of proposed vehicular use.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 DRAINAGE STRUCTURE INSTALLATION

- A. General: Install manholes and inlets, complete with appurtenances and accessories indicated.
- B. Install precast drainage structure sections with sealants in accordance with ASTM C 891.
- C. Where specific drainage structure construction is not indicated, follow manhole manufacturer's written instructions.
- D. Precast Concrete Manholes:
1. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.
- E. Precast Concrete Inlets:
1. Construct catch basins to sizes and shapes indicated.
 2. Set frames and grates to elevations indicated.

3.6 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping in accordance with ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- E. Maintain stormwater pollution prevention measures at each drainage structure and conveyance system throughout project duration. Clean interior of piping and drainage structures of dirt and superfluous materials (do not flush into outfall system).

END OF SECTION 33 4200